Integrated Science 7

Nima Rezaei
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Thinking

Bioengineering of Science and Art

Springer

Integrated Science

Volume 7

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ISSN 2662-9461 ISSN 2662-947X (electronic)
Integrated Science
ISBN 978-3-031-04074-0 ISBN 978-3-031-04075-7 (eBook)
https://doi.org/10.1007/978-3-031-04075-7

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

This book series would not have been possible without the continuous encouragement of our families. We dedicate this book series to our parents, who taught us how to see the world and think.

Preface

Thinking: Bioengineering of Science and Art follows a rule that it does not stick to any rules, any limits, any boundaries, any interpretations, any levels, any dimensions, any concepts, any words, any worlds, any reason, any science, any laws, any environments, any principles, any states, any conditions, any patterns, any connotation, any commons, any currents, any horizon, any measurable, any sensible, any traditions, any explanations, any conventions, any language, any communication, any functionality, any account, any images/concepts of self, any separation, any rigidities, any classification, any time, any space, any time-space, and even any human power when it is given, "I think." It, based on this mind map, therefore, feels free to embrace viewpoints from philosophers, naturalists, physiologists, biologists, biologists, physicists, mathematicians, chemists, pathologists, economists, and computers scientists to emphasize universal thinking is an accomplishment of thoughts of all kinds of professions.

Greatest thoughts are future bright achievements of those who become aware of present instabilities and have passions to improve their skills and abilities patiently and integrate themselves into the multidimensional world. In the book, a broad range of abilities will appear: orientation, embracing contradictions, risk taking, understanding, information interpretation or evaluation, open-mindedness, intellectual empathy, fluent idea expression, thinking modality-shifting, understanding, translation, and encoding symbolic information, elaboration, abstract reasoning, reading between the lines, dealing with uncertainty, investment decision-making, fine discrimination, conflict resolution skills, complex problem-solving, risk recognition, bias detection, developing perspectives of a given situation with remarkable differences, problem space dissection using systematic approaches, framing, root cause identification and analysis, information processing, perceptual learning and knowledge acquisition, leading design transformation models, design thinking, artistic interpretation, questioning, inference-making ability, social self-care, self-management, self-projection, using observation and data curation tools, understanding conspecifics' mental states, intuition, theory of mind, empathy, evaluating the speech and related properties, experiencing and expressing emotions, seeing new relationships, learning, language, sense-making, averting ecological crises, imagination, alliance formation, self-organization, communication, simulation, seeing alternate realities, predicting actions' consequences, linguistic acquisition, explaining complex information, actualization and consciousness of reality, concentration, speaking, and dialoging.

From this book, we cannot expect to find a word with the same application, implication, meaning, activity, or ability throughout the book. Just as an example, three of "generation"! We see "generation" as a part of the generation of novel ideas, which is practiced at the end of creativity elsewhere, and here it occurs as regular and spontaneous, not as the first priority! Mostly, this book, however, pays attention to "generation" when expressing very concerns about our children and children of these children. Continuously, we move our thoughts from passing generation to future generations, from this generation to that generation, between generations, and across generations. This movement's target is "science of education of thinking," regarding creativity, criticality, finance and economy, world complex problems, global challenges, problem-solving, ecosystem, and maybe a very small nudge to the biophilosophy of birth, life, and death. And this movement is inclusive of what we call regeneration and degeneration both at the level of thinking brain cells, neurons, and the level of thinking sustainability, policies, environment, and society.

Life stands under frequent discussions in the book. It includes our thought on the lives of non-human species and laboratory beings. It is, however, mostly focused on the life of human beings at the level of individual and society, on the life of ourselves and of others, and on the life of a body and of a mind. It elaborates on human life, about its idea, quality, levels, forms, characteristics, history, standards, flow, change, use, origins, reproduction, manipulation, transmutation, circle, conception, process, conditions, science, autonomy, philosophy, stages, dialectic, evolutionary roots, inseparability, inaccessibility, appearance, occurrence, and emergence. And again, this elaboration does not think of life as the same but considers it differently, as a phenomenon, as a position, as a category, as a class, as a moment, as information, as a whole.

Thoughts cover a spectrum of power or force that ranges from empty thinking to pseudo-thinking to real thinking. When thinking in real, thoughts can reach the level to penetrate, so changing the inner states/structures of the people/things. We, in the book, see how music and listening to music in a conscious, attentive, real-time, skilled, and active manner; aesthetic appreciation and performing art; visualization and understanding images, symbols and using symbolic objects for data categorization; language and speaking out of conventions into a poetic manner; soul and unbounded expansion in believing the being are powerful in inducing as well as accelerating thinking that is both real and strong; therefore, pleased.

Act of thinking is the book pivot with pillars of many other acts, such as denotation, creation, life, making sense of complexities, perception, directing inner and outer energies, translating spirituality or beauty into a comprehensible object, judgment, drawing conclusions, linking, enumerating, creativity, interpretation, power, reason, understanding, knowing and knowledge, love, contemplation, asking, writing and rewriting, and reconstruction.

It has been, without any bias to choose one side, our pleasure to build the world of arguments in this book. You will find narratives against reductionism, between hemispheres, between natural and eternal law, the dialectic of mind and matter, in favor of vegetarianism, between human and non-human life, and between signs and symbols in the context of marginal analogy, about the beginning of religion, and taboo and penalty functions. It is a powerful building that could keep our minds warm, moving from one argument to another.

Discourses happen of their own accord. They begin to speak to make thinking interested on soaring journeys to mind, matter, world, complex problems, design, language, speaking, nature, information, signals, symbols, human, being, environment, identity, learning, education, forbidden sentences, God, divine, mathematics, biology, evolution, life, rationality, philosophy, aesthetics, emotions, truth, will, and theology; thought without any efforts of being competitive to put an end in themselves. It remains for us again, either to consider a given discourse has reached the point of conclusion or instead to continue its flow.

The book affords to enable our eyes to see the sky of different worlds, somewhere over the clouds of sound, reality and virtuality, individual, people, the universe, art and artist, culture, whole, disorder, order, hemispheres, present, Middle Ages, Western, religion, text, human beings, reflection, mind, matter, method, object, subject, language, rational and irrational, ethical, mechanism, literature, outer and inner, external and internal, emotions, empiric, outside and inside, chaos, thinking and thought, modernism, post-modernism, civilization, DNA, experiences, concepts, bioengineering, cyborg, animals, meaning, security, biophysics, immateriality and materiality, nature and supra nature, living things, ecology, ideas, interconnections, mentality and physicality, research and education, representations, actions, phantoms-appearances, events as a phenomenon, brain-body, environment, and existing. Going up to the clouds and enjoying more and more pure whiteness, we need more than ever to practice imaginative thinking to bring some purely born thoughts with ourselves along the vertical axis.

There is a beautiful movement between the internal and the external on the ground. Moving to the internal, we find reference, states, imagery, impression, processes, consistencies, mechanism of activities, focus, logic, problems, dialogue, mechanisms of feedback, sensations, telos, structures, connections, sensory powers, language, entity, represented form, force, organization, the configuration of the unity, limits of knowledge, anchors, feelings, interfaces, guide, and debt. Moving to the external, the environment, which is a part of the external world, includes reference, extension, input, entities, some parts of the brain and body, relationships, inferences, social occurrences, consistencies, processes, problems, changes, interactions, obligation, inputs, stimuli, actions, objects, five senses, realities, execution, causes, goals, and observer. Walking along the horizontal axis, we have to maintain the balance while permitting ourselves to repeat reflection on problems and questions hidden on the horizon.

The book has its own way working though problems with regards to the world, universe, mind, mind-brain, mind-body, nonlocality, entanglement, binding, multisensory integration, cognitive neuroscience, technology and learning, multifactorial interactions among human activities, environment, and ecosystem, eutrophication in water bodies, data available not enough for large-scale analysis and management decision-making, modern thinking theories and methodologies, economic thinking, carbon dioxide, cultural diversity, disengagement, society, science and religion, business law, environment, and social responsibility, humanities and the natural sciences, dialectic of mind and matter, cognitive processes, mental realities, global warming, wars, design, metaphysics, thinking and its essence, philosophy, knowledge and limits, mathematics, language-games, variation, growth, and co-evolution of symbolic forms in living systems, form, organism, attention layer, uncertainty of paternity, social sciences, identity stability, politics, education, energy, climate change, biosecurity, financial security, crises, awareness of being, life, forces, visual information transmission, the relationship among thought, language, and speech, and human consciousness. The book peacefully arranges a collection of knowledge without being obsessed with a single reason or solution.

Integrated Science: Science Without Borders is the title of the first volume of the *Integrated Science* (Int Sci or IS) Book Series—that is intended to integrate things which are different and otherwise come separately to scientific argument and discussion—that though it is a short title but is a big enough subject to satisfying the first movement of our intention to show that the needs of the changing man, the changing world, and the changing problems are too complex for an isolated, specific type of knowledge, thought, science, system, or context. Still, we can manage them effectively by defining different kinds of useful integration *at present* and then applying them to understand how a sustainable future is achievable. The mystery *co-fly by Int Sci globally* hidden in the puzzle of the Integrated Science: Science Without Borders explicitly itself states what do we expect our idea to bring for scientists: a flight of largest living diversity, and therefore, of highest thoroughness.

Integrated Science: Transdisciplinarity is a subsequent volume moved on to see how the practice, with the presence of integrated science, is in its way. From the window of *Transdisciplinarity*, there is a new light that changes our way of looking, guiding us to see and communicate with different knowledge works at the same time: archeology, architecture, sport sciences, biology, chemistry, ecology, environmental sciences, agriculture, economics, mathematics, engineering, industry management, information technology, marketing, nanoscience, neuroscience, space exploration, philosophy, design, marketing, psychology, and social sciences. The mystery *science and society* hidden in the puzzle of *Transdisciplinarity* is a simple reflection that we think *Transdisciplinarity* can address challenges, overcome limits, and cross all bridges that occur between science and society and serve to diversify the applications of science for its intended audience, society.

Integrated Science: Multidisciplinary and Interdisciplinary in Health came after the above volumes to put in the integrated context the *health* that will concern both scientists and society people. It is the text written based on interdisciplinary studies (IDS) where the brain, lifestyle behaviors, pandemics, drug discovery, nuclear medicine, dentistry, neuropsychiatric conditions, artificial intelligence (AI), information technology (IT), medical education, social capital, and discrimination in research happen—in a non-specialized way—to at least two academic fields of science. *Let isolation die let IDS dance us* hidden in the puzzle of *Multidisciplinary and Interdisciplinary in Health introduces* our latest idea that it is for their isolation that the health sciences are imperfect and IDS provide higher levels of thinking that is *from above* where seeing is not labor possible owing to our eyes, but it—without effort—is only the consequence of being there.

Art and science have been the parents of all the above volumes and will remain at the end of their integrated kind for this and our future volumes. Each chapter begins with a famous quote to show that the very meaning of the chapter is as insightful as the multiple core messages of the text are thoughtful. Also, each chapter contains—in addition to the narrative Summary—a Graphical Abstract/Art Performance to makes a specific sense in which the very idea of the chapter is as simply expressed as the code of the chapter is beautifully in order with the very mystery of the book that is hidden in the puzzle of the book. For *Integrated Science: Science Without Borders, Integrated Science: Transdisciplinarity,* and *Integrated Science: Multidisciplinary and Interdisciplinary in Health*, there is a binary code for each chapter that immediately appears after Graphical Abstract/Art Performance. This code is associated with letters that make up the keyword of the chapter, a word that occurs in the chapter's text and should be put in place in the puzzle according to the clues provided in the last chapter of each volume. For *THINKING: Bioengineering of Science and Art*, there is a QR code, instead of a binary code, for each chapter. Scanning this code directs to the word cloud of the chapter that is made up of words we will discuss throughout the whole book in relation to the keyword of the chapter that is intentionally not included in the word cloud. Finding out what is the chapter keyword promotes integrated thinking, using the abilities to design search strategies, hypothesize, and finally deduce. The keywords should be put in place in the puzzle according to the clues provided in the last chapter (Chap. 36), where you will get a surprise of this volume!

Future thoughts are the integral we end each volume with. Despite the ubiquity of thinking about the future, the idea that integrated frameworks of thinking are that can retain our position as a passionate thinker, our prestige as an all-time master, and our presence as a perfect parent still seems to not have happened. We have so far built three of such frameworks in the last chapter of each volume. Another specific to *Thinking: Bioengineering of Science and Art* will appear in Chap. 36.

Welcome to worlds of thoughts, fears, and hopes in *Thinking: Bioengineering of Science and Art*.

Tehran, Iran
January 2022

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Contents

1 Introduction on THINKING: Bioengineering of Science and Art

Nima Rezaei and Amene Saghazadeh

"Not two cultures—one scientific and the other aesthetic, or one rational and the other irrational—but one. The scientist and the artist, far from being engaged in opposed or incompatible activity are both trying to extend our knowledge and experience by the use of creative imagination subjected to critical control."

Brian Magee

Summary

THINKING: Bioengineering of Science and Art is inclusive of the philosophy of *thinking* by using different *knowledge works*. This chapter is, therefore, no longer an attempt to introduce the book. Rather, we notice thoughts of different contexts and many relations among them, giving rise to various sets of integrations. One important result of this introduction is that integrated thinking represents the highest level of development, and scientific thinking may be only one of many integrant elements and a range of integrative relations—the point to which we devote our attention in *THINKING: Bioengineering of Science and Art*.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_1

Bioengineering of science and art: simple or complex?
[Adapted from the Association of Science and Art (ASA), Universal Scientific Education and Research Network (USERN); Made by Mona Mirbeyk.]

Keywords

Art · Engineering · Education · Integrated · Science · Thoughts · Worlds

QR code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

Whether it is correct or not, thinking is regarded as the most closely related to what humans know of themselves, personhood or identity, and why we say it is not correct lies in that it is language, not thinking, that is unique to homo sapiens, while, thinking occurs in non-human primates [1]. Is the human identity similar to non-human primates' identity? Or should there exist a language of thinking specific to us? That we are writing about *THINKING* means we are, of course, with the latter and that the book title includes *Bioengineering of science and Art* means now we talk of integration as the language of human thinking.

Art-science meeting is a sustainable phenomenon. In relation to science, art was once believed to be a separate culture, then became a tool to obtain representations initially for scientific communications and descriptions that are in the representational space of science—the so-called representational art—and now is, also, employed for *thinking* through *everything* that is in the non-representational space of science, also known as the "sea of ignorance." Art is, therefore, with its non-representational mode of thinking, encouraged to meet science to manage the risks of what are *misdiagnosed* as bifurcations in views of nature, e.g., the objective versus the subjective, the matter versus the mind, the nature versus culture, the body versus mind, and in parallel to all of this, scientific thinking is treated to be abstract enough, yet not reductionist, to welcome and work with what that is otherwise the invisible and so remained *undiagnosed* [2], simply to think in the world "*from above*." From above, there is a present ground, but also are the past and the future grounds: *all in one*. So, is not *from above thinking* superior (better to say speedier) to *long-term thinking* in providing sustainability [3]?

From the discussion of scientific thinking as a dual system of intuitions (*fast thinking*) and reasoning (*slow thinking*), it emerges that all a science of rationality and a homogenous team of scientific experts and a scientific worldview are imperfect [4]. But, breakthroughs in science come from novel ideas, from a heterogeneous group made randomly from people, and from remote associations. Factors that trigger these events include having empty time and breaks for reflective thinking to work, nonselective exposure to information through attending informal gatherings and social meetings, and a complementary partner. Who can be a *perfect* partner for science in the way of sustainable innovations?

Art is a partner of science. When fields are defined as a function of (i) process, analytic versus synthetic; and (ii) content, symbolic versus real, we will have four main classes of fields: analytic symbolic, synthetic symbolic, analytic real, and synthetic real. There are two pairs of exactly complementary fields:

(i) science and design; science is a field dominated by analytic process and symbolic content, whereas design by synthetic process and real content; and
(ii) medicine and art, medicine mainly relies on analytic process and real content, whereas art on the synthetic process and symbolic content [5].

This implies that decision-making tends to be defective in science and medicine, and design and art solutions can help them to complement this defect.

Primary artists-secondary scientists are the proof of the above. Following the history of science, we see how nonverbal thinking has led to the development of verbal thinking in the form of painter-scientists, poet-scientists, and musician-scientists, called *correlated talents* (Fig. 1.1) [6]. High-level creative scientific thinking is what we mean by verbal thinking here. We use development as these scientists were first painters, musicians, or poets and then became scientists; we call them secondary scientists. Imaginative thinking is the art of nonverbal thinking skills that include a wide range of thoughts listed in this chapter.

Fig. 1.1 Painter-invertor-engineers. Robert Fulton (1765–1815) was a portrait and landscape painter who engineered the first steamboat. Samuel Morse (1791–1872) was a portrait painter who developed the telegraph. (Adapted from Wikimedia Commons, the free media repository, https://en.wikipedia.org/wiki/Robert_Fulton#/media/File:Fulton.jpg; https://en.wikipedia.org/wiki/Samuel_Morse#/media/File:Samuel_Morse_1840.jpg)

Art and science, however, suffer from the same: both are rather subjective in their approach. Design science came into existence to fill the gap by an objective, rational approach to working. On the other hand, complex real-world problems often engage engineers to make things or to make things better. For example, climate changes have caused the need for adaptation strategies to provide resilient infrastructure. Its thinking begins with risk assessment and cost-effectiveness evaluation of adaptation strategies using modeling approaches and proceeds to recommendations that are risk-reducing and economically feasible [7]. Indeed, engineering is the mainstay of the treatment of infrastructure. The objectivity and rationality of design thinking turned out to be an interest to, particularly, engineering branches of science [8]. This movement arrived at engineering art and science to design. It is worth mentioning that we valued design and science as complementary pairs of fields earlier. We, more precisely, emphasize they are engineering design (synthetic, real) and engineering science (analytic, symbolic).

Taking part in art, design, engineering, and science meetings requires recognizing the basics of thinking in these contexts. Then, it is interesting to address which forms of thinking are they integrated? and for what purposes? Throughout the chapter, formally agreed to the definition of most forms of thinking is lacking; however, there have been referred to representative lists of features characterizing each of them.

Scientific Thinking

Knowing and knowledge are said to be the nature of science [9]; so, “knowledge seeking” defines the core of scientific thinking that presents a type of highly developed thinking, but not the only one [10]. Scientific thinking development begins early in life since four years of age [11], when humans begin to build experience-based constructs and continue to revise these constructs as they grow longer and encounter more experiences. Theory of Mind (ToM) is an important facet of this development and is referred to as the ability essential to understand what beliefs are false and be aware of what the knowledge sources are. Then, the knowledge sources we choose as theoretical and experimental, and the evidence we choose as determinate versus indeterminate lies in this awareness [11]. When conceptually revising the initial constructs, theories, and beliefs, humans enjoy making sense of the world and phenomena that become less and less imperfect and, in this process towards perfection, lie from knowledge acquisition to reconstruction of conceptions and thoughts to understanding [10].

Scientific thinking is crucial to argument formation. We form arguments in every decision-making step, holding a belief, stating or referring to a judgment, and drawing an inference or a conclusion [12]. There is a range of scientific thinking skills that are mainly employed in relation to either an investigation or inference. The investigative skills enable one to design experiments and produce evidence, and this evidence is that on which inferential activities are based. Investigative and inferential skills prompt scientific thinkers to claim in different ways theoretically. The type of claim one makes reflects the degree to which he/she views the world wisely, and the more compatible the theoretical claim is with the real world, the wiser the claim. And the more those investigative and inferential activities are integrated, the more compatible the theoretical claim [11].

Altogether, making-mistaking-re-making enjoyment is a way scientific thinking development empowers humans in terms of a shift from theories-based to evidence-based responses and more and speedier spontaneous and prompted responses we make. Scientific thinking skills are teachable from elementary school [13]. Therefore, scientific thinking strategy development is a lifelong process that can happen throughout the mentally normal life cycle, instantly regenerating the feeling that we can be better thinkers: we are still four years old!

To practice science means to seek information in an intentional way, which is associated with gain-of-knowledge, change-of-knowledge, and produce-of-knowledge activities that have their roots in cognitive spaces related to hypothesizing, investigating, and evaluating and come about question formulation, modeling, investigation planning, data analysis, evidence interpretation, and constructing explanations, and designing solutions [14]. Many aspects are proposed to represent the nature of scientific thinking, for example, anticipatory, social, and situated, to name some [15]. Scientific thinking requires one to solve problems, reason, formulate, investigate, use real and symbolic objects, and revisit hypotheses/theories [16]. For these abilities to emerge, individual factors are important as well as context-related factors. Individual factors are mainly cognitive and metacognitive skills. In this context, there is an environment that provides science-supporting tools and instruction. At a higher level is a scientist who is a prospective thinker who knows the world is a dynamic system that is changing and has a desire to know and make hypotheses about what is accounting for the change. These qualify the process of scientific thinking development from basic cognition to prospective cognition [15]. Scientific thinking models result from endeavors of two groups: educators and researchers, which, through the years, have made three perspectives of science thinking: science-as-practice, science-as-reasoning, and science-as-conceptual change [17]. And now, there is a need for an integrative framework.

Design Thinking

We can follow this form of thinking in history by two main terms of design and Dasein. The roots of Desein are Da and Sein; the former, in German, is meant as there and the latter as being, collectively, “being there.” Known for his contribution to the principle of uncertainty, Heidegger uses the term Dasein regarding modes of being there. There is no need to mean design, given the all-clear to draw, plan, mark out, etc. (for review; see [18]). Important that design reveals a modern, practical variant of Dasein regarding being in the world and other differences, as reviewed in [18].

Design thinking dates back to the sixteenth century. It has had a long run of evolution characterized by several peaks [19]. Focusing on the twentieth century, the Arts and Craft movement was developed in response to a series of nineteenth century-driven efforts towards increasingly industrialized and seriously standardized goods and services to bridge the gap between craft and technology. Design thinking then was integrated into science and activities like mass production and industrial education, giving rise to modern products like refrigerators, cars, etc. However, it was until world war II that human–machine interaction became important, leading to the integration of human dimensions, like aesthetic appreciation, into design products, the first example of which is the receiver speaker. International movements and systems design were put forward to build relationships between different cultures' design; the former bridges nations and the latter bridges home and work. Of most recent discussions of design thinking is concerning social responsibility and environmental factors that we are humans, design for humans, and live in an environment; so, another movement, humanitarian design, get started to design sustainable products with low environmental impact. It is still in its infancy, and cradle-to-cradle and cradle-to-grave are some of its attempts. Nowadays, we see design thinking contributing to multidisciplinary educational and learning education and improving creativity, innovation, imagination [20, 21]. Interestingly, it can particularly apply to both rural and remote systems.

For a design insight to become preferred and for a design product to become desired is a long way that economic, technological, social, and consumer-related factors play a role. Design thinking process steps vary significantly through literature. For example, it might begin with observation-inspiration, ideation, testing, definition-synthesis, prototyping, and communication. Elsewhere, it is a process that requires "problem definition, insights and empathy, iterative approach, abductive reasoning, an ethnographic approach, brainstorming and ideation, prototyping techniques, co-creation, and learning launch, pilot, and field experiments" [22]. An important note is a bidirectional flow between steps [23].

Metaphors can be utilized to define design thinking. Bricolage is a metaphor [24], referred to as "the creation of structure out of events." The designer, the so-called bricoleur, works with *what is available*. For this purpose and given that there is a closed collection of tools, the bricoleur is powerful in making an adaptive dialogue with his tools and redefining means using semi-defined elements that are abstract like a concept and concrete like an image, the so-called virtual signs, and dynamically changing his decisions about "which" and "where" an element is used. To replace or remove an element means to reorganize the structure. The final work is not ideal in terms of consistency with his preferences or imagination and the project requirements, but it is unique in terms of its unpredictability imposed by internal and external influences, e.g., limitations, adversities, and idiosyncratic thinking. The direction of thinking is from events to the structure (*events imposed on structure*), simply events synthesis.

This thinking applies to different areas of science, art, and engineering [25]. Design thinking is characterized as follows;

(i) it is a human-centric, empathic way of thinking;
(ii) it is a union of thinkers coming from a variety of professions, departments, and groups;
(iii) for being both a problem- and solution-based approach, design thinking incorporates the holistic understanding of the consumer/customer' needs, wants, thoughts, and behaviors into the producer knowledge and expertise;
(iv) it is a way of improving thinking; it continuously tries to improve the collective mindset of a given problem through re-definition of problems and solutions that are not well-defined and posing questions to run previously defined problems, solutions, and assumptions into challenges;
(v) it is a way of innovative, outside-the-box thinking, it the initiative of defining new/alternative problems and solutions and making a prototype;
(vi) it is a way of scientific thinking; it deals with experimentation and simulation of new/alternative solutions to assess potential challenges and refine the product to maximize effectiveness;
(vii) it is a way of thinking within the box, the method it employs to undertake the process of selection among potentially identified solutions is nothing than rational thought that constitutes in itself the analysis-based results monitoring the relation of solutions with the current circumstances and conditions;
(viii) it applies an integrated approach, also known as the "third" way of thinking, that is the combination of both scientific thinking and thinking with empathy; in other words, as a representative of both quantitative thinking and qualitative thinking, to solve complex problems of the real-world as well as to facilitate communication between designer people;
(ix) it is a non-linear way of thinking with bidirectional interactions between or cyclical flow of different stages of thinking mentioned above; and
(x) it is a thinking for all.

Therefore, design-based firms can play a complementary role to knowledge-based firms. They offer an embodied approach introducing knowledge to practice to deal with world problems that are often wicked. In contrast, the theoretical aspect of knowledge-based firms remains dominant in investigating scientific issues. Moreover, creativity is the center of design thinking, while rationality is for knowledge work [26].

Engineering Thinking

In contrast to bricolage, an engineer evaluates what the project needs to make them available. Like a scientist, an engineer has a universe of tools, and therefore, engineering thinking dialogs engage the universe, not a collection as it is in design thinking. Engineering thinking is a process of creating means using concepts that are abstract [24]. Therefore, the primary results of engineering thinking satisfy the project's predetermined assumptions, regardless of secondary outcomes and events in the meantime. The direction of thinking is from the structure to events (*structure imposed on events*); simply structure synthesis.

The following six skills characterize engineering thinking:

(i) systems thinking, the ability to view the whole system and its parts, reason on how these parts connect and depend upon each other, and synthesize a new thing;
(ii) problem-finding, the ability to define the problem, find whether any relevant solutions are available, do a search on the issue, and verify solutions;
(iii) visualizing, the ability to make connections between abstract and concrete terms, manipulate materials, and mentally rehearse the physical space and solutions;
(iv) improving the ability to build better things by constantly attempting to investigate, design, hypothesize, conjecture, and prototype;
(v) creative problem-solving, the ability to use tips, tools, and techniques from different cultures of knowledge, has a teamwork view of engineering, and effectively make an opinion and work within a team to achieve new ideas and solutions;
(vi) adapting, the ability to test, analyze, reflect, re-think, and be mentally and physically flexible

The above characteristics, known as engineering habits of mind (EHoM), are used for real-world learning (RWL), a program aimed at engineers' mental preparation to overcome the shortage of engineers in the future [27].

Engineering thinking is all-ages thinking. It can be practiced using different models that are easy to understand for different age groups, such as playing with blocks, objects, and materials in prekindergarten children [28–30]. Engineering thinking is an all-emergencies approach. It is, as general thinking to enhance the ability to innovate and create new versions and employ the current versions to new situations of interest to many disciplines and professions. Also, engineering thinking is educable via both in-person programs and virtual internships [31]. This possibility that engineering thinking can be cultivated on a large scale has added an attempt to diversify the community of engineering. However, to ideally accomplish all of these potential advantages, engineers need to take technical proficiency and social responsibility into account [32]. This consideration is the result of a higher level of understanding that the world' problems are, only in part, the function of which are known as the engineering knowledge' errors and deficiencies, but in another important part, are due to the gap between what are the community' needs and the solutions designed in response to those errors and deficiencies.

Systems Thinking

Like many forms of thinking, systems thinking is controversial regarding meanings, origins, and approaches. Some consider it a methodology of specific applicability and of specific social movement, whereas others see it as a collective of methods of general implications and general dynamics [33]. Against both of these groups is the third group that no longer tries to address what systems thinking is clearly referred to as and where systems thinking come from but characterize systems thinking in terms of ideas, approaches, methods, theories, sciences, problems, and solutions it can encompass [33]. From such a perspective, a big picture of thinking that involves both short-term and long-term goals is attributed to systems thinking that uses both measurable and unmeasurable variables to guide the understanding of interdependent dynamics of complex systems [34]. Keeping in mind that we ourselves are a part of this comprehensive viewpoint, systems thinking has many tools that lead to the development of something rich that will be referred to as a framework, a language, a model, or simply a way that applies to problems dealing with different disciplines simultaneously (multidisciplinary), between disciplines (interdisciplinary), and across disciplines (transdisciplinary). What else can one expect from thinking that has opened many hands to put a systems' end embracing us directing towards *wholeness*?

Computational Thinking

It is a universal language different from mathematical and engineering thinking but acts in a complementary way. Computational thinkers can understand human behavior and design systems rooted in need for complex problem-solving. Given that no discipline exists free of complex problems, computational thinking is important to different disciplines. In addition to abstraction ability, different computation, computational, and computing skills play a role in making a computational thinker competent [35]. Despite being highly recognized in practice, there is a need to overcome different challenges for computational thinking to become integrated into curriculum and learning programs for secondary and undergraduate education. Some experiences for the K-12 curriculum are described in [36]. In particular, people from non-computer sciences, e.g., departments of art, history, music, biology, humanities, politics, and economics, need to show interest and extend the scope of their collaboration, so the product of their activities become tangible, for example, an international curriculum of integrated computational thinking.

Art Thinking

It is a radical form of design thinking; the design thinking works in a user-oriented manner aimed at arriving a better position than before design thinking is operated, while for art thinking that works in a breakthrough-oriented manner, better is not good; there is an optimal position that needs to be filled [22]. To become possible, art thinking is a much more time-demanding task than design thinking. If we consider it as a type of breakthrough thinking, then it is characterized by a long search process while significant progress is not visible, followed by a precipitating phenomenon that leads to a relatively short search process, finding a solution (cognitive snap), and so, surprise (sense of transformation) when remembering *where I was and where I am* [37]?

Art thinking is also different from scientific (engineering) thinking in terms of the figure of speech [24]. Art uses metaphors or homologs for an order, whereas scientific (engineering) thinking works through cause and effect metonymies. In terms of the direction of thinking, art thinking is a combination of design and scientific thinking [24]; it provides a representation of the structure that is in representational space (structure imposed on events) and also a representation of events shaped by intrinsic and extrinsic properties of the subject and related context and their interactions with themselves and their world and with the artist and the artist's world (events imposed on structure). It is, therefore, simply a structure-events integration.

Creative Thinking

It is a multidimensional concept that a range of cognitive and metacognitive abilities, skills, and interactions contribute to developing what is considered creative. Looking at the top 15 skills for 2025, we see creativity, originality, and initiative have occupied the 5th rank after analytical thinking and innovation, active learning and learning strategies, complex problem-solving, and critical thinking and analysis [38]. *On the ground*, the creator is one who can create while standing at the center of a system of forces and relationships between them. The culture, society, social environment, groups, individual differences, personality traits, affective and cognitive skills, training, a systems approach, and a neurological basis are all suggested to be integrated into a systems view of creativity [39]. To review other integrated models of creativity, see [40]. Creative thinking is characterized by different lists of features [5], which mainly consists of four components of the person, product, process, and press, also known as 4Ps [40]. Some argue that creative thinking is cross-disciplinary; it means creative thinking in discipline A can interact with and improve creative thinking in discipline B [41]. On the other hand, we have multiple intelligence theories that value one intelligence superior to the other. In this chapter, where is our position is clear when different combinations of creative thinking come to exist!

The Importance of Problem Discovery

The first moments of creative thinking are to define the problem. Importantly, to which extent solutions are creative depends on which extent problems are creative; so, how a problem is creatively defined is important. Studies associate creative performance with a range of exploratory problem-discovery behaviors in different domains. With regards to non-verbal thinking, for example, the time used for the exploration of objects and the number of explored objects before drawing are of such behaviors that have been corresponded to the amount of originality of the artwork in art students. As for verbal thinking, the number of explored objects indicates the number of changes in reality and the originality of essays in children who write creative essays. Even if the essay is not creative, the number of explored objects corresponds to the fluency of the assay, as represented in the essay's word count. Also, these studies show differences between the position the problem is presented to us and that we ourselves discover the problem. Students have a better creative performance for problems they themselves discover in terms of the number of ideas they can draw [42].

From Leisure Activities of an Adolescent to Job Accomplishments and Life Satisfaction of an Adult

Giftedness is an element that crucially determines creative thinking and performance. It is, in turn, a composite, four-dimensional concept where socioeconomic status (SES), age, culture and subculture, sex, autonomy, learning style, and task commitment are personality-related factors playing a role. Giftedness ranges from no and mild to moderate and profound levels. Its definition occurs in relation to the study setting, i.e., community, home, and school. Giftedness is of main four categories:

(i) general intelligence, this is the intelligence from which we can develop different thoughts, e.g., abstract thinking, systematic thinking, and logic thinking; so, it is a means of problem-solving;
(ii) specific intellectual ability, this is the intelligence that enables the individual to develop domain-specific thoughts, e.g., mathematical thinking, musical thinking, scientific thinking, language learning, aesthetic appreciation, etc.;
(iii) general original thinking that is creativity allows one to be a highly qualified problem solver who comes up with ideas and solutions which are unexpected, surprising, and brilliant; and
(iv) specific creative talent is domain-specific and corresponds to creativity in the domains as mentioned above, similar to specific intellectual ability.

Longitudinal studies that followed individuals during a long-term period provide explicit evidence that our real-world creativity in adulthood is a function of our creative performance during adolescence. Creative performance is defined in terms of leisure activities that students enjoy making them outside school. Engaging with these voluntary activities, including playing music and scientific lab experiments, students reach a high level of hard-working, intellectuality, and pleasure, which totally and gradually embrace the adolescent turning him/her into a great achiever. However, it is noteworthy mentioning that such development depends meaningfully upon how creative performance in adolescence is matched with that of adulthood. An 18-year follow-up study shows that those who had matched leisure activities during adolescence were better in job accomplishments and life satisfaction [43]. Creativity development will be influenced by the teaching method. In grade 3 students, synectics appear better than brainstorming patterns and brainstorming patterns better than traditional teaching in developing students' creativity, as assessed by the production of creative solutions with the Torrance test of creative thinking (TTCT) [44]. We can, therefore, summarize creativity as the sum of giftedness, discovery behaviors, teaching methods, and leisure activities.

Critical Thinking

Critical and analytical thinking are of higher-order thinking considered as art, helping to improve communication, collaboration, innovation, and flexibility, all of which are required for fitness and survival in today's world that competitiveness is globally distributed and the key for success is to solve complex problems that arise with the changing needs of society [45, 46]. Critical thinking is not a type of thinking, but a spectrum of thinking which depends on two components: skills or abilities to generate reasons of acceptable relevance and strength, collectively referred to as good reasons, as well as dispositions taking these reasons into systematic or routine use, here called productive dispositions. The good reasons include beliefs, actions (and respective mechanism), judgments, and productive dispositions: open-mindedness, fair-mindedness, independent-mindedness, inquiry-mindedness, and international-mindedness that is respectful to others and their values [47]. Therefore, a critical thinker might expect to build up some intellect through knowledge acquisition, operationalization, and standardization, as well as the formation of the body of effective habits and heuristics in mind [48].

Visual Art Thinking

Visual art is a resource of thoughts that goes beyond the base art, playing the beautiful game of expanded thoughts with non-art sciences; so, it is regarded as an engine of thinking [49]. However, from the scientific point of view, art, especially visual art, still receives less support to transfer to other schools of thinking. The neglect behind this is a lack of understanding of the cognitive domain of art. This has caused even misunderstandings that, to the extreme negative, are, for example, that arts do not need any skills and thoughts, and so to learn arts does mean to think nothing important. Whereas Arnheim, in *Visual Thinking*, says "unless the stuff of the senses remains present, the mind has nothing to think with" [50]. Moreover, below are eight tasks/behaviors we see in the art classroom that, in Winner' words [51], are interpreted as "studio habits of mind:"

(i) crafting, art is an experience filled with different craft techniques and tips learners need to draw a perspective or proportion, shade, shadow, create a composite, mix colors, etc.;
(ii) observation, being a visually literate person, it requires us to practice attentive observations of the world and the model. The view-finder is a tool teachers use to coordinate this practice, through which learners are encouraged to intentionally omit the complicated structure, for example, a composite, from their field of view and concentrate on simple elements, e.g., colors, lines, shapes, and textures, and their relation to each other, in terms of distance and thickness, that lie in the given structure they need to draw to build the given structure;
(iii) envisioning, this skill is developed and practiced more and more when learners are encouraged to draw not on the paper, but in their mind; in other words, to draw an imagination. By this, they need to go deeper and consider very details just in their mind and then, for example, present their imagined drawing of themselves when they are 60: how are the wrinkles? Which color the hair is?;
(iv) reflection, constructive reflective thinking occurs when art students are also asked to assess their works themselves: what and why did they intend to make? Was the process done as expected? Which were and how did they solve the challenges? Finally, how do they assess their work? And what did they learn they wish to apply to future work?;
(v) expression, this occurs at least once per artwork; when the artist makes a thing, he/she will put a part of his existence in that. This manner the artist undertakes to declare himself/herself is seen as many times as laborious and conceptual than the verbal message one might formulate for this purpose;
(vi) strechment and exploration, creativity, and innovation are products of such skills. And anyone can claim that two drawings are the same? Remember the school-age when we all used to draw a square and a triangle to build a home for our family, and all our homes were different and still are;
(vii) engagement and persistence to make a work in arts, like in other systems, can be a daunting task accompanied by challenges and even frustration. Even we know artworks that remain not completed. This implies how everything has been disappointing for the artist to cease work. Artists need to be competent thinkers not to give up and return to us.

Art students acquire domain-specific knowledge, for example, art history, as well as the collective knowledge of the community of arts. This understanding is required for them to initiate collaborative projects and choose their career in the future.

Imaginative Thinking

Imaginative thinking is a skill that allows us to think of all possibilities to see solutions beyond what is simply actual. It is, therefore, a means of creativity and innovation [52]. It is a part of the narrative mode of thinking, in which a range of notions, such as meaning and truth, metaphors, analogies, paradoxes, and irrational thoughts happen, that complements the paradigmatic mode of thinking, which is fundamentally concerned with logic, mathematics, arguments, and rational thoughts. Science education, by its definition, is, therefore, unlikely to support a balanced engagement in paradigmatic and narrative thinking. This calls for the integration of imaginative thinking into science education.

Metaphoric Thinking

Metaphoric thinking reflects poetry *in practice*; indeed, poetic thinking and poetry writing are the result of integrating metaphoric thinking and creative thinking [53]. It is not easy to find a science or education that does not bear a metaphor from the garden of poetry. An example is "the great tree" as used by Charles Darwin to explain life, along with "line of defense," "foreign," and "warning system," which are military vocabulary words but have been added to the science of immunology to explain what is and how does the immune system work [54]. More generally, as a prototype of sciences featured by high rates of uncertainties, medical sciences employ a language of metaphors. Thinking with metaphors has been a habit of medical specialists when dealing with medical conditions and diseases. For example, "*sticky* neurons" or "*sticky* brains" are metaphors used to characterize how a group of pediatric patients who are affected by pervasive developmental disorders (PDD) think; these children are very attentive, and their thoughts are said to be *preservative* [55]. Therefore, this metaphoric way of medical thinking incorporates scientific and humanistic thinking.

Thinking and the Box

Thinking outside of the box is simply innovative thinking through which the mind has to go beyond the general problem space and enter a new problem space. There is an enjoyment that is endless when seeing a new place and understanding a new phenomenon while finding new ways, strategies, and safe solutions pose labor to the mind. Storytelling is powerful in that they stimulate the mind to think outside the box and imagine specific, new situations, for example, a new world in the sky that has a beautiful city, where trees are humans of that world, they do not move, they have strong roots, so they have a home for all their life-time and are near to their father and mother to the end of their life; there is no end to enjoy life, love, and childhood.

Thinking within the box is simply thinking of problems that are already known to the mind knowledge space so that there have been developed patterns of problem-solving, *schemas*. Those who stick to these schemas for solving problems can solve repetitive problems but might be more likely to fail to solve sticky problems. A similar situation is that high school students with high academic grades often will be qualified with high academic grades in universities and colleges but might fail in job-related innovative accomplishments.

Janusian Thinking

It is referred to as "the capacity to conceive and utilize two or more opposite or contradictory ideas, concepts, or images simultaneously." This form of thinking, similar to that we see of "yin and yang," is mainly discussed for its role in creativity, making contributions to architecture, art, literature, mathematics, music, psychology, and science [56]. For this specific type of creative thinking, there is a special place for psychological factors to play artfully, a key to supporting the idea of psychotherapy [56]. Taking such a broad view, Janusian thinking is ubiquitous; however, it remains a less documented thinking in literature [57].

Wishful Thinking

It is a thinking that applies to conflict prevention in organizations and institutions that manage to make important decisions, policies, and democracy or critical strategies, for example, about a crisis. Conflict prevention is both a science and art [58] for which managers and practitioners not only need to hold meta-theoretical (practical) considerations, but also to take the potential psych(pathol)ogy of the organizational/institutional network based on person-specific skills, motivations, and abilities into account to define the organization and/or institutional goals, determine the assessment methods of performance and success, and plan the path of practice.

On the other hand, like Janusian thinking and for a similar reason, wishful thinking is ubiquitous. However, unlike Janusian thinking, it is well-recognized thinking behind all psychological biases people have with regards to optimistic information processing and respective beliefs, desires, preferences, and predictions that are false or wrong [59, 60]. In this way, this thinking causes prices that can be prevented through real-world information processing and by considering uncertainties; thereby, the truth and accuracy are promoted.

Manager Thinking

This heading discussion has a background addressing the two below:

(i) Is there a pattern?

It is a *very simple* formation if no interconnection exists between the individual units; it is a *fairly simple formation* when there are a few interconnections between a small subset of individual units; it turns into a *pattern* when all possible interconnections are established between the individual units [61]. Then, we can say it is simple or not, and there is a formation or pattern, but still unable to conclude that the pattern is complex. And what about the degree of complexity? So, complexity is not merely a matter of patterns of interconnections.

(ii) Is the pattern simple or complex? If complex, how much is complex?

Complexity is said to correspond to the length of the shortest message we can make using the collection of standards of wording, i.e., standard grammar and standard vocabulary, to “describe a system, at a given level of course gaining, to someone at a distance, employing language, knowledge, and understanding that both parties share (and know they share) beforehand” [62]. The length of the message indicates the amount of difficulties we experience of complexity. It is a practical, working definition; however, it seems to us it has ambiguities with regards to distance. Is it spatial? Or temporal? And with regards to someone: is the receiver, in nature, present as the sender? Suppose a student at two points of time, once when he/she is first given an assignment and when he/she is again given a similar assignment. In that case, it would be interesting to compare the length of e-mails written to his/her supervisor for the same purpose of, for example, updating the status of the project. Even if the student makes meetings, then again, he/she needs more and less length of oral communication. So, the project was, first, perceived as complex and then became simple. From the first, it was a simple one for the supervisor. What is happening?

Managing a complex organization inevitably involves thinking of complex systems, which is mainly characterized by incompressibility and commensurable pluralism [63]. The former indicates that complex systems cannot be reduced to representations that are simpler than the systems themselves; i.e., they are incompressible or irreducible. The latter implies that there is a fundamental language in terms of which all complexity-related laws are expressible, i.e., a language of every complexity. Complexity thinking can be accomplished in three main contexts of neo-reductionism, metaphorism, and critical pluralism, as reviewed in [63].

Teacher Thinking

Like manager thinking, teacher thinking is both an art and science. It is an art when making conversations is important to understanding the learners' psychological constructs, such as intentions, behaviors, and needs [64]. As for its science, teacher thinking plays a crucial role in cultivating scientific thinking to improve learning and motivation in primary education [65]. Anti-science attitudes, for example, anti-vaccination attitudes, are an inevitable consequence of scientific illiteracy, and scientific illiteracy is due to failures of preparation systems that teach thinking about science. Often, teachers have a good public image of science. Such an image, Cobern and Loving developed and revised [66], includes *epistemology* of science, *science and the economy, science and the environment, public regulation of science, science and public health, science and religion, science and aesthetics, science, race, and gender, and science for all*. They, however, need to practice thinking about science. An explicit and reflective approach has been shown to be more effective for teachers in terms of becoming familiar with the nature of science than an implicit approach [9]. Also, teacher thinking needs to be sustainable; i.e., it evolves professionally to embrace and inform learners of the most recent scientific developments [65].

Integrating Creative and Critical Thinking

It is so traditional that we choose to use creative mode or critical mode of thinking independently. Instead, criticality and creativity have long been inseparable elements of thought required to do meaningful work, e.g., from reading and learning to listening and writing about language, concepts, logic, and science [67, 68]. Moreover, creative thinking skills and critical thinking remain related significantly to each other as well as to the total cognitive learning results in university students [69, 70]. It is, therefore, a fair claim that one who can, at the same time, think creatively and critically when facing complex problems is both a scientist and an artist; a scientist who conducts some analysis and an artist who is able to deduce new things from his/her analysis results [71]. Thinking skills (TS) strategy is based on the integration of both creative and critical thinking, with the mind, that the interaction between these thinking skills results in the development of strategies. When compared to the control group, students in the TS group have better creative thinking performance in terms of fluency, flexibility, and originality [72]. Also, problem-based learning (PBL) allows students to balance the creative and critical forces to integrated thinking [73].

Integrating Creative, Critical Thinking into Clinical Thinking

We require that creative, critical thinking is not far from practice. This issue is of particular importance to fields where there is a research-practice gap and creative and critical thinking skills are believed to be sufficient to support academic purposes and seem not necessary to be transferable to clinical settings [74]. Education of creative, critical thinking is a tangible step to reduce this gap, for which context-specific courses are required to take place in the clinical environment, for example, regular journal clubs, conferences, and events for nursing students [74].

Integrating Visual Art Thinking and Scientific Thinking

Visual thinking has been shown to help secondary scientists move from initial observation to extrapolation and the imagination of models. Visual thinking also means seeing with the eye of the forehead but reading with the eye of mind boosts information filtering. This ability enables the mind to exclude unnecessary information from the image while keeping the necessary information there. Even the mind might decide to include new information! Such professional thinking and decision-making are done on raw data to make perceptions, referred to as the process of mental visualization. Generously gifted with this process, one can experience doing science all in mind, from mixing current ideas to sorting and standardizing their mixtures to generating correlated ideas and drawing new diagrams. This non-linear thinking is useful in dealing with complex problems when correlations between variables are non-linear, but our verbal thinking is linear [6]. Also, there seems to be a positive correlation between visual thinking and geometric reasoning. Art students who had training in the visual arts were higher in geometric reasoning skills than psychology students who had no such training [75]. Examples of this type of secondary scientists are Louis Pasteur, Theodor Boveri, Santiago Ramon y Cajal, Wilhelm Ostwald, James Clerk Maxwell, J. Willard Gibbs, and Albert Einstein for their works on asymmetry, cell mysteries, brain anatomy, physical chemistry, electromagnetic fields, phase diagram, and relativity (for review see [6]).

Integrating Musical Thinking and Scientific Thinking

The ear can recognize patterns as the eye can, but also it gives us more power of analytical thinking in terms of the higher number of variables that occur simultaneously and are recognizable by the ear than by the eye. This analytical thinking is a part of what musical thinking can enhance. Indeed, musical thinking also uses kinesthetic, sensory, aesthetic, and analogizing abilities. We know composers who enormously contributed to scientific fields, including mathematics, chemistry,

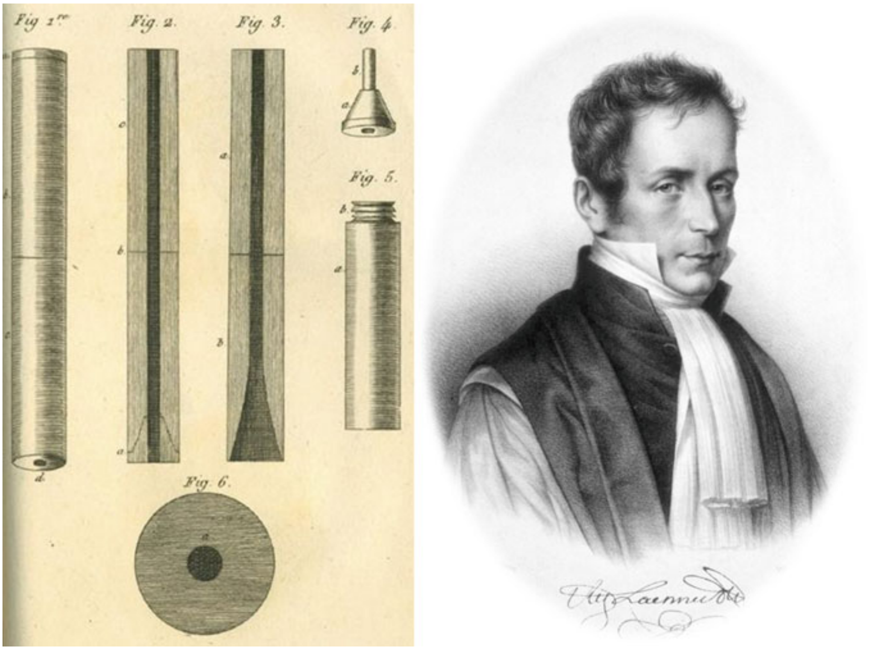

Fig. 1.2 A flutist-physician. René Laennec (1781–1826) was a flutist who then made the first stethoscope, an acoustic medical device used to listen to the body sounds, e.g., heart, lungs, and abdomen. (Adapted from Wikimedia Commons, the free media repository, https://upload.wikimedia.org/wikipedia/commons/e/eb/Rene-Theophile-Hyacinthe_Laennec.jpg; https://upload.wikimedia.org/wikipedia/commons/a/a6/Rene-Theophile-Hyacinthe_Laennec_Drawings_stethoscope_1819.jpg)

physics, medicine, surgery, medical specialties, microbiology, psychology, engineering, geology, astronomy, physiology, epidemiology, etc. [41] (Fig. 1.2). Of important accomplishments of musician-scientists are quantum physics and resonance.

Integrated Visual-Spatial Thinking and Scientific Thinking

Visual-spatial thinking involves both visual and imaginary cognitive skills [76]. With our head's eyes, we see and think about the world, objects, events, and other subjects and discover the position of ourselves in relation to all these phenomena. With our mind's eyes, we make mental images through a series of internal processes that occur due to our intents while no visual stimulus is present. Observation, recognition, and orientation are the major processes engaged by the former, whereas generation, inspection, and transformation are by the latter. Visual perception and memory contribute to both. Through pattern, color, and movement detection and estimation, visual perception represents a three-dimensional mental image, and this representation would be influenced by our prior knowledge that is our memory that takes the responsibility of recording our life and learnings instantly. Yet in an asymmetric manner, both brain hemispheres are working to make such representation possible: the right hemisphere is mainly for processing the imagery part of visual-spatial thinking, while his left counterpart is for structural information processing.

As a part of evolution, visual-spatial thinking is seen in both non-human and human primates by varying degrees. Training improves the ability, and the more visual-spatial ability, the higher the ability to adapt to the environment. A higher imager or stronger visualizer might be more likely to be a creative scientist/engineer, given that creativity in science/engineering is completely dependent upon the imagination of images, metaphors, and themes, that if this was not the case, from Mathewson' view, then we could expect computers to process entirely from scientific investigations to scientific discoveries to engineering buildings. Despite the importance of visual-spatial thinking in scientific discoveries as well as the influence of practice on its development and improvement, it remains less considered in science education [76].

Visual Thinking at the Entrance to the Science-Society Gap

Visualization offers an effective, multimodal approach that can influence multiple literacies and cultures [77]. Using a symbolic language, a visual thinker can re-formulate and re-semiotize meanings of, for example, the very ideas and principles between contexts of different semiotic senses, a process referred to as meaning transformation. This way, visualization would more strongly influence the audience and can even engage a non-specialized audience in communication with a specialized community.

Visual Thinking at the Entrance to the Education

Not only can visual thinking serve as a means of communication, but it is an approach to learning in science and engineering. Brilliant resources are the outcome of knowledge-producing activities scientists could do in response to the changing problems. To search and acquire knowledge from these resources is, in itself, a task that requires integrated thinking, and visual thinking has a lot of tools, strategies, technologies, courses, and programs in her hands to make this not only possible but also through paving the way for active learning, do more to engage *all* students, even underrepresented students, exposing them to problem-solving, enabling them to creative thoughts and actions, leading them to technical degrees and certificates, and ultimately introducing them to science and engineering careers [78]. The periodic table is, for example, just a very simple frame of view, without which it could be not as easy and fast to memorize elements, groups, charges, and etc. [79].

Visual Thinking at the Entrance to the Integrated Science

No doubt remains that how visual thinking is helpful to adopt a transdisciplinary approach for sciences to tackle "societal dilemmas," which is, Ravetz and Ravetz say, like "seeing the wood for the trees" [80]. Earlier, we discussed argumentation under the heading scientific thinking; however, the point is that scientific arguments need to be understandable by people of different disciplinary works, and this is where visual thinking can fulfill another purpose: argumentation. Social Science 3.0 gives an example we can find the importance of visual thinking to connect scientists of socio-cultural, policy-making, ecology, economics, and technology domains with regards to the problem of climate and enabling them to learn and share knowledge in a synergistic manner [80], without which scientists might remain disconnected, being susceptible to syndromes–consequences of working within a specialized domain and dealing with a given level of uncertainty–that simply attack humanities in unexpected conditions and circumstances, but are fully expected given a resistance the mindset has towards being resilient enough to see beyond, think above, and prepare for other complexities. The reader is supposed to see how our experience of the pandemic COVID and related mortality and morbidity is as preparing this book and then answer to the question: do we move on so?

Integrating Scientific Thinking, Religious Thinking, and Art Thinking

While science uses methods to measure the truth quantitatively, art and religion must view aesthetic and ethical angles qualitatively; this is Plato's triad of "true good," in which the importance of integrated qualitative and quantitative thinking is embraced [81]. Matrix thinking is the product of this integration [82]. Archaeological and evolutionary science is the basis of the proposal of this integration, and matrix thinking was initially applicable to signs, but in its modern form, it covers symbols, models, relationships, perception, and emotions. Matrix thinking is an adaptive cognition that favors human evolution and leads to flexibility and creativity [82]. *In the process*, matrix thinking leads to the representation of components in the form of a mental matrix, for example, through tabulation, by which the mind will be able to compare, extrapolate, and imagine. The product of this process is a new culture of knowledge [82].

Integrating Design Thinking and Creative Thinking

Creative scientists are finders or makers: the former work in an analysis-oriented manner to investigate less understood issues (scholars), and this understanding is directed to discovery (scientists); the latter work in a synthesis-oriented manner to synthesize their knowledge directed to architect (architectures), design (designers), engineer (engineers), and make (artists) new ones (simply invention) [5]. Designing is, therefore, necessarily a creative activity. For a creative design, a feedback-based process deals with the design's function, structure, and behavior, involving the formulation, synthesis, analysis, evaluation, documentation, reformulation, and modification of the design [40, 83]. Creative design thinking is influenced by a range of metacognitive processes, such as divergent thinking, convergent thinking, constraint satisfaction, problem finding, and problem-solving [84].

Integrating Creative Thinking and Scientific-Engineering Thinking

Thinking in science and engineering is associated with a circular, dynamic model, including the possibility of tacking back at all stages: immersion, incubation, illumination (insight), explanation, and creative synthesis of some product [83]. Finally, through a validation procedure, the product validity is determined based on personal or collective experience. Noteworthy mentioning is that affects, moods, and emotions can modulate the process negatively and positively, influencing the thinker's mental and physiological states and concentration; therefore, the ultimate invention.

Integrating Art Thinking and Creative Thinking

Art education opens the inquiry from finding to solving problems [85]. To make an artwork is a process from idea conceptualization, development, and realization to the work finalization. It is a dynamic practice, and its product is creativity by a non-linear function along with experience, knowledge acquisition, and cognitive perceptions [40]. Meta-analyses reveal correlations between studying art and creativity performance, particularly figural creativity, but not verbal creativity [85]. However, the main limitation is that studies included in these meta-analyses are of correlational type; so, the cause and effect cannot be established [85]. Therefore, an art approach is among activities that can apply to classrooms to enhance scientific creativity [86]. This application can be effectively supplemented with science learning, as shown in, for example, a study of arts and science high-school students who improved in creative thinking following arts education, either visual art or music [87]. We must, however, notice that the effect of this supplemental education does not uniformly happen to all students. Instead, there is a need for arrangement to adjust according to the grades and departments in place.

Integrating Art Thinking and Design Thinking

Despite its breakthroughs, art is, however, a soft branch; and so is largely separated from technology, a hard branch. For these two, arts and technology, integration is needed to become meaningful to the community. Integrator is the design thinking, a consumer-centered style of thinking [22].

Integrating Art Thinking and Engineering Thinking

Art narrative modalities apply to speaking and writing strategies to convey a communicative objective. These modalities include rhetorical, opinion, knowledge, understanding, and evaluative outsideness [88]. The inclusion of artistic-narrative modality in the classroom appears to enhance critical thinking in engineering students [89].

Integrating Engineering Thinking and Architectural Thinking

Both engineering and architectural thinking apply design thinking for building [84]. However, they are different from each other. In general, the design approach in engineering is rather linear and technical than it is in architecture. Particularly, engineering thinking is directed towards functionality, building efficient structures that comply with the codes of practice and safety requirements, while architectural thinking is user-centered and so needs to meet underlying aesthetic aspects as well. These two similar, yet different, builders are increasingly working together for solving complex problems, like climate change resilient constructions.

Four main factors contributing to creativity are fluency, flexibility, originality, and usefulness. The role of expertise in creative engineering design is not clear; originality and usefulness showed no correlation with total creative engineering design score, while fluency and flexibility did it [84]. It seems originality and usefulness can compensate for lack of expertise somehow.

Integrating Critical Thinking and Engineering Thinking

A representative model embedding this integration is found in [45]. It considers six main skills:

(i) interpretation (classification, meaning clarification, and significance determination);
(ii) analysis (hypothesis (investigation and argument identification and analysis);

(iii) inference (evidence extraction, exploration of alternative hypotheses, and drawing conclusions);
(iv) evaluation (evaluation of claims and arguments);
(v) explanation (organization of obtained results, justification of the procedure, and presentation of arguments); and
(vi) self-regulation (self-examination and self-correction).

Integrating this model into the engineering classroom can improve students' participation and interpersonal communication skills, oral speaking, and understanding of the problem. This integration is not only modeled but also has been a part of engineering programs, for example, writing and critical thinking (WAC) in the ABET (the Accreditation Board for Engineering and Technology); however, it poses challenges [90]. Cognitive strategies to improve critical thinking in engineering students include vocabulary enrichment, formulation of coherent speech patterns, and argumentative practices.

Integrating Design Thinking and Engineering Thinking

Both design thinking and engineering thinking can assist with complex environmental problems. A qualitative study investigated how civil engineering students approach a water problem in the local environment. The responsive themes proved that competency in reaching novel and feasible solutions was higher in those who used a design thinking approach than those who used problem-solving strategies as usually are present in engineering [23]. It carries the capacity of integrated design thinking in engineering programs to solve problems as well as define problems. O-CDIO (Observing–Conceiving–Designing–Implementing–Operating) is a variant of the CDIO engineering program that considers design thinking, especially focused on its user-centered feature [91]. The *observing* component of O-CDIO indicates a kind of *dance* where there is an ambiguity that is before being involved in a solution-containing zone. It is, probably, the end of creative, radical thinking when the ambiguity can no longer be tolerated, that the problem solver moves ahead with the next steps that mainly rely on natural sciences and systems thinking. The O-CDIO program has been shown to enhance tolerance to ambiguity [91].

Integrated Computational Thinking and Art Thinking

Interest in this integration is increasing given the increased application of digital media. Computational skills enable artists and art students to develop code-based artworks. As a part of new art media, code-based artworks can incorporate visual, auditory, and other sensory areas. Indeed, they provide learners with multisensory integration [61] and improve studio art practice [92].

Integrated Data-Based Thinking and Art Thinking

Data art is the product of this integration. Data is not vital but valuable for that it offers a lived … about real, complex life and all that it embraces, and for that this … is measurable, analyzable, and completely objectively interpretable. Data, therefore, calls us outside our old traditions to necessarily and merely endeavor to be understandably, narratively, and qualitatively explainable. We can, therefore, see in the perfect friendship between data science and art that extraordinary ability to do art performance with data, to visualize data, to manipulate data, to monitor data, to manage data. Then, it is an effortless task to present and disseminate the forms that emerge, i.e., visualization, manipulation, management, and monitoring [93].

Integrated Thoughts Products: STEM, STEAM, and STEMM

STEMM

Arts, crafts, and design (ACD) practices have been shown to improve modeling and playing skills being considered as important thinking tools in science, technology, engineering, mathematics, and medical (STEMM) programs [94]. These tools include logic, intuition, visual imaging, verbalization, non-verbal imagery, abstractions, analogizing, mental models, physical models, and playing.

STEM

World problems are evolved in nature, so linear thinking is not sufficient for solving them, but non-linear thinking that can take complexity into account is required [95]. Therefore, science, technology, engineering, and mathematics (STEM) emerged as a cross-disciplinary education approach to meet this issue.

STEAM

The current educational setting benefits from STEM; however, it is cautious with STEAM, which is the STEM plus arts. In line with STEAM, arts are catalysts helping students reach STEM goals, i.e., thinking creatively and learning from different disciplines or transdisciplinary learning [35, 95]. Human-centered design can help the implementation of STEAM in education. Also, the PBL approach can pave the way for STEAM integration in learning, for example, acid and base in the context of a chemistry classroom, and increase the engagement of students to develop creative and critical thinking skills [96].

Integrating Artificial Thinking and STEAM Thinking

Artificial intelligence (AI)-based approaches have been of recent interest to improve STEAM students' learning. These approaches can take different circumstances and constraints into reasoning and prompt students to shape well-defined problems and come across respective solutions [97].

Thinking in Classroom

Constructivist Classrooms

STEAM programs and courses offer such a classroom. It is a place where conversations can be constructive for a learning journey, when the students ask other classmates and then all, together, do to answer for themselves [98]. The teacher acts as a frame of reference for such students in such a classroom. An example STEAM program includes the main phases of discovery, project-based learning, and creation. In the first phase, they are to make their own knowledge through discovering principles of mathematics, science, technology, and engineering through experience-based discovery: they do and they learn. In the learning phase, they will apply the knowledge to real projects. And in the last phase, they are expected to do nothing other than enjoy doing projects. All art and design are in the last two phases.

Such classroom is so different from what we remember from our school-age when the teacher was the center of the class, she taught, we should not talk to other classmates even throughout the hour of a class, listen to the teacher, and write everything she said, and very occasionally, we had a lab class when we could only observe some limited experimentations and should be continuously worried that nothing was damaged.

Thinking Differences

Yet, thinking is vulnerable to a variety of biases [99]. Thinking differences may be a source of peace for those who are used to thinking *fairly*, considering differences between professions, intelligence types, novices and experts, circadian typologies, genders, personality types, cultures, etc. [100].

Profession

Studies show that art and science students might have slight differences in the speed of creativity and also learning styles; however, they are comparable in terms of creative problem-solving performance [101, 102].

Circadian Typology

That you are a morning-type, intermediate-type, or evening-type individual is also important in style you prefer to think; morning-type individuals are better in left thinking and evening-type individuals are better in right thinking. More interesting is that while, with regards to lateralized thinking, i.e., left thinking and right thinking, the effect of this, the so-called circadian typology, seems to be more than that the effect of gender, for integrated thinking, no such a circadian typology effect exists, but instead a gender effect is rather significant: women are better in integrated thinking than men [103].

Expertise

As mentioned earlier, problem decomposition crucially takes place in the design process that leads a designer to define a new well-structured problem and/or refine an ill-structured problem by defining well-structured subproblems. The level of experience influences designer's problem-decomposing strategies of thinking; generally, the strategy an expert designer follows is explicit and working-forward, also known as top-down, that moves from the initial state, i.e., design problem, to the goal state, i.e., design solution, through which the designer applies knowledge-seeking strategies and incorporates design criteria and his/her experiences, whereas that a novice one follows is rather implicit and working-backward, also known as bottom-up or data-driven approach, that moves from the goal state to the initial state [104].

Intelligence

Intelligence measures correspond to divergent thinking varying by types of intelligence and divergent thinking-related parameters. Studies of university students show a direct relationship between ideational fluency, for example, and total creativity and creativity pertaining to crafts, performing arts, and math science. Also, the ability to develop abstract ideas, as an indicator of verbal intelligence measured by the concept mastery test (CMT), is positively related to total creativity and creativity specific to art and literature [105].

Personality

When students from natural sciences, social science, and arts were compared, natural sciences students showed the best divergent thinking fluency, while arts students were highest on self-rated creativity and creative achievement. Demographic variables did not show any significant interaction, but personality traits did: openness and conscientiousness with divergent thinking fluency; openness and extraversion with self-rated creativity; and neuroticism and extraversion with creative achievement [106]. In another study of science and arts university students, psychoticism is positively associated with several divergent thinking-related parameters, e.g., pattern meanings, uses, similarities, and line meanings [102].

Culture

Cultural differences remain a deterministic factor to the styles of thinking, e.g., thinking of uncertainty or probabilistic thinking [107], critical thinking [108], creative thinking [70], and holistic versus analytical thinking [109]. This emphasizes the diversity of human thinking and the role of understanding cultural diversity. Therefore, the Symbiosis of civilizations is crucial to coordinating scientific thinking, as exemplified for Uzbekistan in [110].

Gender

Female students are more confident to think computationally and take part in computational thinking-related activities, such as STEM careers [111]. With regards to creative thinking, there is an interaction among the effect of gender, the effect of education, and the subdomain of creativity: among university-educated people, women exhibit higher creativity in terms of verbal fluency than men; among those in primary and secondary education, women display lower creativity in terms of figural originality and figural creativity than men in the same level of education [112]; and among school-age children, girls do thorough thinking more than boys, while they are rather weak in using a boundary-breaking method of thinking than boys [113]. Also, as mentioned above, women appear to be generally better than men in integrated thinking. A study of undergraduates confirm this result and add that it might be, at least in part, owing to women' attitude of research that tends to conservative, explicit, and integrated approaches, standing in contrast to men' attitude that relies rather on personal opinions and decisions [114]. Despite their potential creativity plus better integrative thinking ability, women mostly remain underrepresented in creative fields of education and the workplace [115], posing a complex problem that needs international investment.

Thinking Sustainability

As thinking complexity is an inevitable aspect of living and working in a complex world and system, so as thinking ecological sustainability to wish and act for a better future for the next generations [3]. Thinking of the future and corresponding decision-making and judgments all call for thinking of problems that will emerge in the long term, which are, in nature, a matter of time.

Integrating Critical Thinking, Metacognition, and Scientific Thinking

Looking for critical thinking, we see many processes and corresponding products very close to our eyes. In summary, critical thinking is a lived process that is generated in response to positive and negative events. Probably it will have certain tools, such as using propaganda, clarifying hidden assumptions, knowing intentional deception, searching on information credibility, identifying problems, and appraising related decisions. So, it is easy to manipulate a thinker's mindset to be more resilient, willing to do so, persistent, and self-correct, thereby positively influencing the thinker's science to achieve consensus. Dynamic awareness is the main feature of such deep manipulation; i.e., not only the thinker is not blind to what is happening in his/her thinking, but he/she is aware of what patterns are adapting, and of course, loves this adaptation. This self-awareness and likeness to adaptation are the fundamental constructs of metacognitive abilities that are used to check and control the self-related development in different cognitive domains, particularly judgments, insight, and confidence, preparing the self for future situations that might be novel and are at present unpredictable. In the context of thinking sustainability, we view judgments as the most important category that involves subcategories, "ease-of-learning judgments," "judgments of leaning," and "feeling-of-knowing judgments." When the thinker' mindset complies with all these judgments, the thinker is both a competent and a metacompetent; one who not only can effectively manage changes and uncertainties to survive but also undertakes this management confidently to sustain supply, and comfortable smiling is the product of management effectiveness and confidence [116].

Integral Thinking

Fragmented thinking is against us in our way of sustainability. Integral thinking is an advanced modality of thinking mainly derived from the holonic theory, which concerns both the whole and the parts constituting the whole and relationships between the whole and related parts. Integral thinking is moving the thinker a step closer to awake, aware, and thinking infinitely, without being contaminated to boundaries, limits, and borders that are continuously trying to keep the parts separate from each other, which of interest to the present chapter are science and art, mechanistic and materialistic philosophy, and many alike, which are not necessary to be mentioned here as they are the main subject of most chapters of the *THINKING: Bioengineering of Science and Art*. Advanced modalities of thinking include logic-formal thinking, mythic-religious-cultural thinking, rational, dialectic, rhetoric thinking, design-oriented, creative, positive thinking, symbolic-spiritual thinking, post-formal, vision-logic thinking, thinking of the "branches," spiritual advanced, metaphysical thinking, and integral thinking, to name some [117].

Holistic Thinking

Integral thinking variants emerged in need for different conditions and contexts. Holistic thinking is, for example, known for its contributions to medical sciences, for the view of a human being as the whole, not the parts, e.g., bodily systems, organs, tissues, cells, etc. This does not mean ignoring the parts completely, but it is to appreciate the presence and status of these parts in relation to the condition of the whole continuously. To better understand the study of these relationships, we get help from the concept of holarchy, a form of hierarchy composed of holons ad their relationships, as reviewed in [117].

Conclusion

From the above long list of integrations of thoughts, we can think of levels above the present; both higher and even the highest ones are possible, with higher levels achievable through each integration. Education is needed to ensure all strategies mentioned above are *learnable* and thinking is *teachable* in the *real world* (proving it is not a type of pseudo). In the next volume: Integrated Education and Learning, you will find how learning styles can be integrated into different education departments to guide thinking outside the box and thinking within the box. Therefore, the integrity of these two bases of thinking is maintained, thereby taking a step closer to bridging the gap between pre-practical (education) and practical (employment and corporation) worlds.

Core Messages

- Art-science meeting is sustainable.
- Art is a partner of science.
- Art and science, however, suffer from the same: both are rather subjective in their approach.
- Design and engineering can complement integrated science and art.
- Thoughts under the umbrella bioengineering of science and art can be integrated to fulfill different purposes.

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2 Thinking as a Philosophical, Theological and Psychological Phenomenon

Sergey S. Horujy

THE TEACHER: One can grasp the essence of the nature of thinking only if we turn back from thinking.

[1, p. 31]

Abstract

The chapter presents a concise history of the comprehension of thinking through all ages of Western culture, from Greek pre-Socratics to today's radical constructivists. The analytical presentation identifies principal structures and paradigms inherent in Western thinking over thinking. The first and most long-lived of them is what I call the pre-Socratic matrix: a structure comprising two kinds of thinking, namely, "ontological thinking" (a universal collecting-and-uniting activity) and the "individual thinking" (belonging to an individual human) connected with each other in some way. The exposition represents brief descriptions of the set of principal landmarks in the history of thinking. Thinkers chosen as the landmarks are as follows: pre-Socratics (Parmenides and Heraclitus), Aristotle, Thomas Aquinas, Descartes, Hegel, Husserl, Heidegger, and Wittgenstein. Besides the landmarks, principal theories and conceptions of thinking created in the last century are described as well, such as the cultural-historical psychology of Lev Vygotsky, the conception of the action-thought by Georgy Shchedrovitsky, heterophenomenology of Daniel Dennett, and theories of enactivism and radical constructivism. The text concludes with a discussion of the present status of the problem of thinking.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_2

Graphical Abstract/Art Performance

Multidimensional thinking (*Adapted with permission from the Health and Art (HEART), Universal Scientific Education and Research Network (USERN); Painting by Emanuela Ciupa*)

Keywords

Cognition · Epistemology · Mind · Ontological thinking · Pre-Socratics · Phenomenology · Radical constructivism · Thinking

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction: How to Approach Thinking?

According to the quoted words of the Swabian Teacher, thinking is surely one of the most controversial, elusive, and even mysterious subjects of our thinking. It would be natural to begin the systematic presentation of this subject with its formal definition. Such definitions abound in literature, but, as a rule, on closer examination, they turn out to be insufficient or incorrect or both.

For example, here is the definition found in a recent huge *Philosophical Encyclopedia*: "The thinking is the process of solving problems, which represents the transition from conditions determining the problem to the achievement of the result. The thinking involves constructive activity of restructuring the initial data, their breaking-down, synthesizing and complementing" [2, p. 626]. This formulation is not too long, but it contains multiple lacunae and implicit assumptions. What does the "problem" mean here? This term cannot be part of a definition because it needs a definition of its own. Moreover, such a definition would refer to a complicated context with many elements, which, in their turn, need to be defined. The term "process" also conceals important elements that need clarification. Is it a process in the empirical space–time? Where does it unfold? What is the substance of the process? Is it performed by some acting agent? Evidently, the context suggests implicitly that the thinking is a certain human activity, and the process in question is a mental process. But it means that, when it comes to the test, the definition implicitly involves some undefined things of both anthropological nature (human activity) and psychological nature (mental process). And these things are big and obscure: What is human? Must "mental process" be conceived as a process in the brain or consciousness or mind or somewhere else? All these options lead to very different conceptions of thinking. As a result, we conclude that the definition discussed is strongly deficient; it is only a pseudo-definition.

Now, let us take another example from the last period of classical metaphysics. At the beginning of the 20th century, the basic reference book in general philosophy was the fundamental *Wörterbuch der philosophische Begriffe* by Rudolph Eisler. Here the definition is split into two parts: "(a) Psychologically: [the thinking is] apperceptive activity, inner action of the will, by means of which representations are decomposed into elements, compared to and connected with each other, are acknowledged as the unity and intentionally and purposely joined together. Thus, the thinking is the analytic-synthetic, comparing-connecting, selecting, distributing priorities, restrictive (*hemmende*) activity, which presupposes associations, but is not an association; it forms-up associations actively and spontaneously, creating mental combinations. (b) Logically: the formation of notions, judgments, conclusions, of which that of judgments is the principal function. The (desired) function of the thinking is the establishment of objectively valid connections in the set of possible representations and notions, the search for truth, bringing-forth of the definiteness into the indefinite, the formation and division of the content of a representation into structures, in which the reality, the being of objects comes to the (symbolic) expression…. The concrete thinking works with visible images (*Anschauungen*) and images of recollections, the abstract thinking with notions, which are decomposed and united by it, and this is impossible without language" [3, p. 213].

This definition does not contradict the previous one but is noticeably different from it. Its advantage is that it is more systematic and scrupulous so that the conceptual context is now well-defined: the thinking has two principal aspects or dimensions, namely psychological and logical, which means that it is the activity, respectively, of human consciousness and the human mind. The thinking functions are basically the same in both definitions, but in Eisler's case, they obtained a more detailed and profound description. Nevertheless, the advantages of this very careful definition make it even more visible that it is also grossly incomplete. In several points, it includes undefined but highly meaningful terms with functions of prime importance in the discourse: will, truth, language. Each of them brings the definition out to some unknown semantic space so that it becomes an open text drastically different from an accomplished definition.

One can find many more definitions in philosophical and psychological literature, and the quality of the incompleteness and the absence of semantic self-sufficiency are common to all of them. History of the problem shows clearly that any definition of the thinking includes necessarily some undefined components, and any attempt to define these components would reveal in them, in their turn, new undefined components, and so on; and this *regressus* ad infinitum makes it impossible to achieve the accomplished definition. One must conclude that the thinking belongs to a certain specific kind or class of entities that cannot be given a rigorous definition. Characteristically, Martin Heidegger's text devoted especially to the concept of thinking does not manage to get any definition and leaves the problem open, ending with the question: *Was heisst Denken?* What is the thinking? [4, p. 17]. In logical terms, entities of this class belong not to phenomena *explanandum* but to those *explanans*. Undoubtedly, there are many particular kinds or concrete acts of thinking, which can be described and explained comprehensively, but they cannot exhaust the phenomenon of thinking as such. This makes us infer that things *explanans* possess some quality or predicate or dimension absent in things *explanandum*. In order to discover such a specific quality, we are going to begin *ab ovo*, from the most general principles, trying to see someplace, *locus* or *topos*, in their configuration, where the thinking could be located.

The very first principle that must be present in this configuration, which we shall call "the ontologic," is ***Difference***. The main reason for the primacy of the difference in the ontologic is its direct connection with what is, according to Heidegger, "fundamental question of metaphysics:" "Why are there entities (*Seiende*) rather than nothing?" [5, p. 3]. The answer to this question is exactly the difference: the existence of the difference means that there are certain things (= entities), which makes them different from each other. By definition, as things are different, entities are plural; hence, the existing reality or "present being" or the All is a plurality, the set of all entities. But, on the other hand, the All is one. By the mode of its existence, the All is given as a plurality, yes, but at the same time, it is inevitably considered as a single whole, as one; in other terms, we associate the All with the predicate of unity. As a result, the All is provided with two opposite predicates; it is both a plurality and a unity. But these two predicates are possessed by the All in two different ways. The All is a unity in a manner and, in a sense, radically different from those in which it is a plurality. In its present being, as empirical reality, the All is a plurality and nothing else, the pure plurality as such. It is a unity when it is considered by our mind that is in the representation or in the idea. It is also a certain mode of existence/being, and this mode is evidently different from a present being. We know nothing about this other mode of being, but we cannot reject it a priori as something fictitious.

This observation is an important contribution to our ontologic. It means that, besides the usual mode of existence of any entity, there is also another mode: the mode realized by the All-as-Unity. There is the "All-as-Plurality" and the "All-as-Unity," and "is" has a different meaning for them. In the first case, "is" means the existence or present being of any entity, while in the second case, it means the mode of existence of the One, the All as a single whole. And it is this mode that represents "is" pure and simple, "is" in its accomplished fullness. This pure "is" the mode of existence of the One, the All-as-Unity we shall call "***being***." Principles and notions connected with being will be called ***ontological***.

The way by which being enters our ontologic shows that it is a principle related closely to thinking. The key point in the above reasoning was the observation that the All exists as Unity "in the representation or the idea." From here, one can easily draw the conclusion that the All-as-Unity exists in the human mind, and hence it is nothing but a product of human thinking. Such a conclusion would be too hasty, however. One must slow down and look at the elements of the ontologic more closely.

What is necessary for the All, which is a plurality, to become Unity? Evidently, the All must be taken in the prism of a certain relating, collecting, connecting, and uniting activity. This activity is a new principle, which must be added to our ontologic. But we have no sufficient reasons to identify this principle with human thinking conceived as the ability of an empiric individual. On the contrary, we know that in most cases, this empiric thinking, being sound and fully-fledged by all criteria of human thinking, still is far from being able to collect and unite the All. Sure, it is a collecting and uniting activity, but in all such cases, it is simply not powerful enough. Hence it follows that at the initial stage, at least, we must distinguish between the human thinking inherent in empiric individuals and the activity shaping the All-as-Unity, which must be considered so far as an ontological principle on its own. The relationship between these two activities, respectively, empiric and ontological, is completely similar to the relationship between present being (= being of entities = being of the All-as-Plurality) and being as such; it is an exact parallel to this relationship in the predicative discourse. Based on this parallel, *the ontological activity that collects and unites the All constituting the All-as-Unity can be conceived as the thinking as such*; it can also be called the ***ontological thinking***.

Now we see why the thinking cannot be given an accomplished definition like ordinary things *explanandum*. It is its connection with being or, in other terms, the fact that the thinking is endowed with the ontological aspect or dimension. We also see the locus of the thinking in the ontologic of Difference: the thinking is closely connected with being and the empiric (human, individual) thinking. Thus, the study of the thinking as such must start with two ontological problems dealing with its relationship, respectively, with being and with the empiric thinking.

Coming to this conclusion, we notice that the treatment of the problem of the thinking in our ontologic of Difference almost copies the approach to this problem at the earliest origin of philosophy, in the thought of pre-Socratics. That approach recognized the ontological nature of the problem right from the outset. The Milesians starting with Thales, stated that the All is unity, while later pre-Socratics discovered a specific ontological status of the All-as-Unity and thematized the ontological difference between being and the entity. Parmenides focused on the connection of being and the (ontological) thinking, and Heraclitus concentrated on the relationship between the individual thinking ("logos of the soul," in his terms) and the ontological thinking (Logos as such or "Logos itself"). Subsequent philosophy followed this line, and the thinking was firmly, with rare exceptions, treated as an ontological principle. However, this situation changed in the last century: as we could see, both Eisler's definition (1910) and Lektorsky's definition (2001) do not mention the ontological dimension of thinking. What happened in the history of thinking was pushing away, forgetting, and sometimes outright denial of ontological aspects of the thinking. In the light of this, our presentation of the thinking as one of the principles in the ontologic of difference can be considered a reminder of and the introduction in the ontological context of the problem. Next, we turn to reconstruct this context in the diachrony, tracing its principal stages and conceptualizations briefly. Then we shall describe the later stages of the problem when it was gradually losing its ontological dimension.

Concise History of Thinking Over the Thinking

Indisputably, it is the pre-Socratics who opened up the Western history of thinking about the thinking. Their philosophizing was of a special type: they had no systems, theories or concepts, but possessed a specific philosophical vision, which made the ontological dimension of reality directly evident and accessible to them. Articulating their vision, they tried to describe this dimension, but their work has reached us in disjoint fragments only. Foundations of the discourse on thinking were established by ***Parmenides***. Certainly, the thinking is conceived by him as the ontological thinking, a general collecting-and-uniting element or activity, which must be there if the All is unity.[1] The central theme of his discourse of thinking is the relation between thinking and being. The only known Parmenides" work, the poem "On Nature," is written in a strong, laconic, and categoric style and the relation in question is summarized here in two brief formulas: "Thinking (*noein*) and the thought that it is (*noema*) are the same" (Fragment 8, 34); "For to be aware (*noein*) and to be are the same" (Fragment B 3). Taken together, they represent a fundamental ontological thesis known as "Parmenides" identity of being and thinking."

This formula is too simple, however. The relationship between the two principles is most intricate, and new interpretations have been produced until now. Of course, the fragment (B 3) is a direct statement of the identity, but this statement is purely declarative and enigmatic without further explanations. Such explanations are provided by (8, 34), and also by (6, 1–2) and (8, 36): "What can be spoken and thought is; for it is possible for it to be, and it is not possible for what is nothing to be" (6, 1–2); "There is not, and never shall be, anything besides what is" (8, 36). It means that the object of thought ("what can be thought") does exist, and the only existing entity is "what is" (*estin*) that is being, whence it follows that the object of thought is being. And now the (8, 34) adds the decisive final point. It refers to the crucially important difference of thinking from all other activities: the thinking does not use any tools different from itself, and the object of thought is an *intelligible* object; in other words, it is thought too. Thus, thinking and the object of thinking coincide.[2] But, as shown above, for Parmenides, the object of thought is nothing but being, and, as a consequence, we come exactly to the thesis (B 3): thinking and being are identical.

Parmenides's identity is the first cornerstone in the big Western tradition of thinking about thinking. In no way is it a solution to the problem of thinking, but it is the best way to enter this problem. It makes one ask many further questions. First of all, we see that the problem of thinking includes that of identity. Clearly, being and thinking are not the same thing in the sense of the formal tautological identity

[1] This key discovery of pre-Socratic thought, "the All is unity," is clearly stated by Parmenides, cf., e.g.: "… epei nyn estin homou pan hen syneches… now "it is," all at once, one, continuous," Fragment 8, 5–6. transl. by J. Burnet.

[2] Let us note that this conclusion is valid equally if thinking is conceived as the "ontological thinking," a generalized collecting-and-uniting activity.

A = A. It is impossible for many reasons. The first is that the poles of the identity are of different nature: thinking is a certain activity while being, as Parmenides insists, is the immobility and absolute rest. Then how must the identity be conceived? That is how another big problem of Western philosophy is opened, which has a long history. The solutions were looked for in two directions: on the one hand, alternative, non-tautological conceptions of the identity were propounded, and, on the other hand, many modifications of Parmenides's treatment of being were suggested, which complemented being with some aspects that now, after Aristotle has introduced the notion of energy, are usually called energetic and dynamical. We mention just two examples: a "weak form of identity" was suggested, according to which being and thinking are related coextensively (A.A. Long); another suggestion was to admit that being constitutes a necessary condition for thinking.

Another problem associated with Parmenides's identity is that of individual thinking. Evidently, it cannot be identical to being, so what is it? Just something seeming and illusionary, from the domain of opinions, *doxai*? What is its relation to true, ontological thinking? Parmenides's poem does not answer these questions.[3] But they belong to central themes of ***Heraclitus***, another great pre-Socratic thinker.

Due to the striking contrast between both ideas and styles of the two thinkers, their teachings are traditionally considered as opposite to each other in the history of philosophy. Now such a view is rejected; according to a recent capital study, "With both Heraclitus and Parmenides corresponding to the "One" and the becoming to the multiple conceived as the set of all pairs of the opposites. And… in both cases, the One is conceived as an intelligible truth, while the multiple as an illusion caused by the delusion of sensory perceptions. The only difference is that in Parmenides, the ontological Absolute is unchangeable and immobile, while in Heraclitus it is full of energy, motion and the incessant cyclic change" [6, p. 53]. One must add that Heraclitus's discourse is also full of metaphors and allegories, enigmas, and parables, so those special hermeneutics are needed for extracting his philosophical positions out of this striking and completely unsystematic abundance. Taking this into account, we restrict ourselves only to main subjects concerning our theme, namely the thinking. All this theme is organized around one key principle, the ***Logos***.

It is impossible to translate this Heraclitus's "groundword" (Heidegger's term) with any single term. Both in Heraclitus's discourse and in the common Ancient Greek usage, it is an extremely polysemantic word. According to Heidegger, it is a word of "boundless scope of meaning," and in Heraclitus's universe, it is an all-embracing and ubiquitous element. In the rich ensemble of its meanings, we find nearly all other "groundwords" or ontological principles: Heraclitus's Logos represents the cosmos and being, the All and the One; at the same time, it keeps its usual meanings such as word, speech, measure, or volume, etc. As for its relation to the thinking, it can be reconstructed via its connection with the key thesis "The All

[3] Although it mentions human thinking briefly: according to the Fragment 16, "thought … does come to men", and, coming to men, it keeps the principal property (8, 34) of the ontological thinking, "that which thinks is the same [as thought]"; at the same time, it is close to the sensation.

is unity": as we can see, this statement implies the presence of the ontological thinking, which is exactly the activity that represents the All as unity. Such a connection is firmly established, in particular, by one of the most important Heraclitus's fragments: "*ouk emou alla tou logou akousantas homologein sophon estin hen panta einai* – It is wise to hearken, not to me, but to the Word, and to confess that all things are one."[4] According to this fragment, if we have enough wisdom to hear the Logos, we spot the All in the Logos and find that the All is one or unity. In other words, it is the Logos that makes the All unity, which means that Logos is involved in a collecting-and-uniting activity, and hence represents what we call ontological thinking. Since it also represents being, we deduce that in Heraclitus's philosophy, the Parmenides's identity of being and thinking is implicitly present. Taking into account that Heraclitus's Logos is "full of motion and change," we also conclude that being of Heraclitus, contrary to that of Parmenides, is a dynamic principle.

It is time now to recall that our notion of ontological thinking is a general ontological principle or "groundword," which significantly differs from the usual conception of human thinking. The latter is very close to such concepts as (human) mind and reason, but it was noticed by scholars that Heraclitus avoids identifying his Logos with these concepts: "Nowhere in Heraclitus' texts the term logos means "reason": it is a later, basically Hellenistic meaning of the word" [6, p. 104]. However, there is another ontological principle in Heraclitus's discourse that is closely related to human individual thinking. It is the "***logos of soul.***" The soul (*psyche*, *anima*) in ancient philosophy is the essential quality of living, animated beings, and the specific distinguishing feature of the soul of a human is that it is endowed with logos. But the "logos of soul," which belongs to the human, is in no way identical to the logos as such or Logos. What is it then?

In Heraclitus's context, it is the principal predicate of the human soul often translated as its "measure," like in the key fragment 67/45: "*psyches peirata ion ouk an exeuroio, pasan epiporeuomenos hodon houto bathyn logon echei* – You will not find the boundaries of soul by traveling in any direction, so deep is the measure (logos) of it." Other fragments say that the logos of soul is endowed with the power of the unbounded expansion (cf. The fragment 112/115 from the Dubia: "*psyches esti logos eauton auxon* – To the soul belongs the self-multiplying logos."). But the real nature of this logos (sometimes called "small" or "human," in contradistinction to the logos as such or Logos) and the most essential of its properties we discover focusing on its relation to the Logos. This relation is not presented explicitly, and its reconstruction is one of the central problems in Heraclitus's studies. The necessity and importance of the relation can be seen by simple reasoning. Heraclitus states that it is good and desirable for the soul to be dry and [5]not humid. But the dryness is the effect of heat and hence also of fire, while the fire is Heraclitus's groundword closely connected with the Logos (they both rule the Cosmos and are identified with Zeus, etc.). Hence it follows that the "wisest and best" soul and its logos are

[4] Fragment 26 (by Markovich)/50 (by Diels-Kranz), the translation of John Burnet.

[5] cf. 68/118: "auge xere psyche sophotate kai ariste – The dry soul is the wisest and best".

connected with the Logos, and the character of this connection is such that the soul and its logos are accessible to the effect of the Logos.

Much more can be said about this connection if we look more closely at the key fragment 26/50. It describes a “wise” position of the human, which allows him to discover the truth that “all things are one.” This position is to “hearken the Word (*Logos*),” which means getting in touch with the Logos and following and obeying its call. Such hearing and obeying collaboration of the human, the soul, and the soul’s logos with the Logos are expressed by the verb *homologein* that means literally “to speak the same.” Thus, we can conclude that the position described grasps the very nature of the logos of soul: its mission is to hear the Logos and speak the same or, in other words, to establish the relationship with the Logos and act in accordance with the latter, in the same way. Essentially, it is the same conclusion that Heidegger has drawn in his scrupulous analysis of the relation between the two Heraclitus’s logoses: “The 50th fragment speaks about the homological relation of the human “logos” to the “Logos” itself… Human association with the Logos is *homologein*” [7, pp. 362, 428].

Coming back to the problem of thinking, we find that Heraclitus contributes some important content to the Greek treatment of this problem. In his philosophy, there are two different principles, the Logos (= the logos as such) and the logos of soul (= the small logos = the human logos), the first of which can be associated with the ontological thinking, in our terms, and the second one with the human individual thinking. One can also reconstruct from this philosophy what is the relationship between the two principles: the logos of soul (respectively, the human thinking) must actualize its relation to the Logos (respectively, the ontological thinking) and act in the same way as the latter. In other words, human thinking must participate in ontological thinking, and such participation is its only constitutive activity, a kind of its definition. Thus, the nature of human thinking is relational; one can say that this thinking is nothing but human’s relation and orientation to the Logos. The constitutive relation to the ontological thinking is very individual: Heraclitus’s view of the human is aristocratic. He holds that most humans are those who “don’t understand,” “humid souls” that cannot actualize their relation to the Logos. This relation is also dynamic: its actualization is a process in which the participation of the human logos in the Logos becomes more and more complete.

Summing up, we see that the pre-Socratics possessed and cultivated a generalized vision of the thinking, which did not restrict it to the activity of individual humans. Such a vision has let them develop a certain approach to the problem of thinking based on distinguishing between two different kinds of thinking, the generalized collecting-and-uniting activity, by virtue of which the All is One (we call it the ontological thinking), and the individual (human, empiric) thinking. This distinguishing was inherited by the subsequent philosophical tradition, and for many centuries the relationship between the two kinds of thinking became the main subject of the problem of thinking. This relation evolved in the course of history in a very definite way. The origin of the tradition was Parmenides’s philosophy with its radical ontologism, and here the ontological thinking had the absolute priority, while the individual thinking was hardly visible, having an insignificant and rather indefinite role and status. However, Heraclitus paid to the individual thinking (the logos of the soul) more attention, and due to this, the relationship in question was presented more clearly and precisely. Looking at the pre-Socratics à vol d'oiseau, we conclude that they have created the configuration of ontological principles that can be considered a paradigm or matrix for treating the problem of thinking. Western philosophy inherited this matrix and was guided by it during a very long period up to the end of classical metaphysics. The matrix represents basically the set of two kinds of thinking, the ontological and the individual, and the connecting principle of the participation of the latter in the former (the Heraclitean principle *homologein*).

The most general sense of this pre-Socratic matrix is the discovery that the thinking represents the unique ability to actualize a certain meta-empirical or "ontological" dimension of reality (in Heidegger's terms, to actualize the ontological difference between empirical entities and being). This surprising discovery, like Pandora's box, opens a vast set of fundamental questions and problems. The first and central of them is the mode of existence in this new dimension. *What is intelligible reality?* A priori plenty of options are possible here, from the Parmenidean standpoint, according to which the ontological dimension of being is the only true reality that is, to the predominant position of modern postclassical philosophy, according to which the dimension in question is not a self-consistent reality, but only an epiphenomenon of the activity of the human brain.

The story of the problem of thinking unfolds in the space between these two extreme poles. The general trend of the philosophical development was the gradual reduction of the distance and the difference between the two kinds of thinking. This process was one of many parts and aspects of the global cultural development that proceeded, in a grossly averaging view, in the direction of the emancipation and secularization of the human mind, the affirmation of its self-consistency and self-sufficiency. One of the first steps in this direction was the interpretation mentioned above of the Logos as the reason that took root in Late Antiquity and ascribed to the Logos closer ties with human rational thinking. In the final stages, during the crisis and the rejection of classical metaphysics, the ontological thinking was more and more drawn in the individual thinking, and eventually, in modern theories like analytical philosophy and cognitive science, it disappeared completely, with some of its dimensions and functions canceled and others transferred into the individual thinking. In terms of the opposition of principles of the transcendent and the immanent, such course of things can be qualified as the ***process of immanentization***. In what follows, we present the principal landmarks of this process.

For many centuries the word "philosopher," when mentioned without a concrete name, meant ***Aristotle***. And for a good reason: the entire conceptual framework of European philosophy has been created by him. The problem of thinking is no exception: in his all-embracing system, this problem is one of the central themes, and it is elaborated in great detail. Although he usually criticizes his predecessors (in particular, Parmenides), but *grosso modo*, his conception of thinking preserves the pre-Socratic matrix: it can be considered as a structure that includes two opposite poles corresponding to the ontological and the individual thinking added with the set of connections between these poles, and also some intermediate or hybrid types. The Aristotelian discourse of thinking (*dianoia, noesis*) develops chiefly as the discourse of mind (*nous*, also translated as thought) since "The motion of mind is thinking" (De Anima, 407a 20, transl. by J.A. Smith).

Let us first describe the ontological pole. Aristotle's thought is predominantly rationalistic, and his discussion of ontological subjects is usually rather cautious and laconic. There are few texts devoted to these subjects, and the principal of those that consider mind and thinking, are *Metaphysica*, Book XII (esp. Chapters 7–9), and *De Anima*, Book III, Ch.5. Here, we find that there is one exceptional kind of mind in the rich spectrum of its varieties, which is surely of ontological nature. In *De Anima*, it is called the active mind and characterized as follows: "One sort of mind (*nous*) exists by producing all things… like light… This mind is separate, unaffected, and unmixed, being in its essence actuality… this alone is deathless and everlasting… whereas the passive mind is perishable. And without this, nothing thinks" (De an. 430a 14,16–17, 23–25). Aristotle's thought usually tends to represent reality in the hierarchical paradigm, and he asserts that this sort of mind is the highest of all. In *Metaphysica* XII, this sort is presented in a more detailed way. It has two most important distinctions:

i. it is of divine nature; and
ii. the only object of its thinking is itself.

The closest connection of (the highest) mind/thought (*nous*) and God is stated repeatedly. Cf., e.g., "Thought is held to be the most divine of things observed by us" (Met. 1074b 16, the translation by W.D. Ross); "It [the highest mind/thought] thinks of that which is most divine (*theon)* and precious, and it does not change" (Met. 1074b 26), etc. Taken together, these two statements say that the highest thought and its object are both divine. Like in *De Anima* III.5, Aristotle states the active nature of the highest mind/thought again, stressing that it is not potency but the very act of thinking, actuality. And it is exactly its full actuality that makes it divine or even directly God: "The actuality of thought is life, and God is that actuality" (Met. 1072b 27). In most cases, Aristotle's discourse is vague on the subject of whether something called divine belongs actually in God or it is only a certain entity or a constituent in the human soul partaking of God. However, the last assertion is unambiguous, and it brings us the right to the conclusion that *the highest mind and God are the same*.

This ontological identity is considerably enriched when we take into account principal predicates of both its sides. For the highest mind, it is the property ii above, which lets us get deeper into the nature and structure of this sort of mind. According to Aristotle, "thinking in itself deals with that which is best in itself, and that which is the thinking in the fullest sense with that which is the best in the fullest sense. And thought thinks on itself because it shares the nature of the object of thought… so that thought and object of thought are the same" (Met. 1072b 18–22). Since the best in the fullest sense is divine, this characteristic of the mechanism of the highest mind shows the divine nature of the latter, and the further description reveals that this nature is eventually nothing but the thinking on thinking or (self-) contemplation (*theoria*): “The possession [of the object of thought] is the divine element which thought seems to contain … It must be of itself that the divine thought thinks (since it is the most excellent of things), and its thinking is a thinking on thinking … The act of contemplation is what is most pleasant and best” (Met. 1072b 23; 1074b 34; 1072b 24).

On the other hand, God is characterized as the first or unmoved mover *to proton kinoyn*, another fundamental principle of Aristotle’s system. It is introduced and discussed in detail in his theory of motion presented in *Physica*, Books VII and VIII, while in *Metaphysica* XII, he establishes its connection with–in fact, its identity too–God. “There is something which moves while itself unmoved, existing actually… being eternal, substance (*ousia*) and actuality… The first mover, then, exists of necessity, and in so far as it exists by necessity, its mode of being is good, and it is in this sense a first principle … On such a principle, then, depend the heavens and the world of nature. And it is a life such as the best… it is ever in this state, which we cannot be” (Met. 1072b 7, 1072a 25, 1072b 10–11, 1072b 14–15). Evidently, this description corresponds fully to God.

Summing up, we find that principal Aristotelian positions concerning ontological thinking can be brought together in the form of an ontological identity:

$$\begin{aligned}&\textbf{The highest mind/thought} = \textbf{The thinking on thinking (contemplation)}\\&\quad = \textbf{The unmoved mover} = \textbf{God}\end{aligned}$$

The question arises unavoidably about the relation of this identity to Parmenides’s identity of thinking and being. Formally, we could say that the latter is present in Aristotle’s ontology, at least, implicitly: indeed, if one more ontological identity, that of God and being, holds (which takes place in most metaphysical systems after Aristotle), then, by virtue of transitivity, the two identities, respectively, of the (highest) mind and God, and of the God and being, imply the identity of the highest mind and being, which is at the same time the connection of thinking and being since “the motion of mind is thinking.” This reasoning is too superficial, however. In contrast to Parmenides’s epic discourse with the absolute primacy of being, Aristotle’s big and subtle system is centered more on the principle of substance, *ousia*, and includes a sophisticated net of various kinds and sorts of being so that Stagirit never characterizes the relationship between thinking and being as a plain identity (although he accepts another basic thesis by Parmenides, that the (ontological) thinking and the object of thought are the same).

Finally, we should mention that the highest mind (and hence also other principles in the ontological identity) has an important ethical dimension: its basic predicates include happiness (*eudaimonia*) and pleasure. In Aristotle’s ethics, happiness is the supreme good, and since the thinking on thinking (contemplation) is the best of all kinds of activity, he concludes that “perfect happiness is a contemplative activity” (Nic. et. 1178b 8). This is equally true for God and man. The closely connected ethical principle is pleasure, and so “the act of contemplation is what is most pleasant and best" (Met. 1072b 24), and "its [the first mover's] actuality is also pleasure" (Met. 1072b 16). The general conclusion is that "for man … the life according to reason (*nous*) is best and pleasantest… This life is also the happiest" (Nic. et. 1178a 8).

Turning to the pole of the individual, common thinking, we find that it is not so much the opposite to ontological thinking as its dependent and imperfect form. Aristotle's thought, moderate and well-balanced, prefers subtle differentiations to sharp oppositions similar to Parmenides's oppositions of Being and Non-Being (*estin, to on* vs. *ouk on*) or truth and opinion (*aletheia* vs. *doxa*). Thus, the two kinds of mind/thought are related as the practical mind, directed to external goals, and the theoretical or contemplative mind directed exclusively to itself. The principal difference between them is that the former corresponds to the kind of mind, which is only "the faculty of thought," a potentiality, while the latter represents the mind in its actuality, *entelecheia*. "It thinks, but this depends on something else… that which is its substance is not the act of thinking, but a potency [so that] it cannot be the best substance" (Met. XII 1074b 18–20). As directed to some external goal, this kind of thinking is not self-sufficient but deficient compared to pure contemplative thinking. However, it can change and can diminish its deficiency. To some extent, the relationship between the two kinds of thinking follows the general paradigm of the Aristotelian hierarchical reality, according to which imperfect entities yearn to become more perfect. This paradigm that manifests itself in many contexts is rooted in the relationship between matter and form, which is described as follows: "There is something divine, good and desirable… there are two other principles, the one contrary to it, the other such as of its own nature to desire and yearn for it. … The form cannot desire itself, for it is not defective… The truth is that what desires the form is a matter as the female desires the male and the ugly the beautiful" (Phys. I.9 192a 16–24). Thus, we can say that common thinking is such that its own nature makes it desire and yearn for pure contemplative thinking.

Aristotle's method of analysis of thinking as well as of other phenomena is often called *hylomorphic* because it is based, as we have just seen, on general principles of matter (*hyle*) and form (*morphe)*, the relationship between which is described by the set of the four causes (material, formal, efficient, and final). Individual thinking is one of three basic faculties of the soul: nutrition, perception, and mind. The distinction of the mind is that it is connected with the body in no way: "Mind… cannot reasonably be regarded as blended with the body" (De an. III.4 429a 24). The hylomorphic reasoning produces a more precise comprehension of the key property of thinking: the thinking and its object are the same. Stagirit finds that "the same" in this formula should mean not the plain identity, A = A, but an isomorphism that is the coincidence of forms since "It is not the stone which is present in the soul, but its form" (De an. III.8 431b 29). The idea that the mind becomes isomorphic with its object implies that the mind is conceived as a unique faculty having unconstrained plasticity and an unbounded range of potentialities as soon as it is capable of acquiring any form of any object. Then, thinking is the activity that grasps structural features of objects of thought and cognition and creates isomorphisms between these objects and the potential or virtual world of our representations. One can agree that such a conception of thinking is quite shrewd and even modern since it is open in tune with some paradigms of contemporary cognitive science.

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We have deliberately paid such great attention to the Greek origins of Western thinking. These origins have determined the treatment of the problem of mind and thinking in the West for all further history. As said above, the pre-Socratics created the general matrix for this problem, and Aristotle equipped it with a rich conceptual foundation and framework. The Greek basis proved to be so substantial and powerful that the most systematic treatment of the problem in Christian époque followed the Aristotelian model very closely, notwithstanding the religious divergence and the historical distance of about one and half millennia.

This treatment was developed by medieval ***scholastics***. However, the reappearance of Aristotelianism took place in a radically changed intellectual and spiritual context. In contrast to the Greek one, God was transcendent to the world in the Christian universe, and this new relationship gave birth to a new kind of thinking and a new discourse called theology. The relation to the transcendent God had to be articulated by new ways and means on the basis of faith, Scripture, and Tradition (expressed in Church dogmas and writings of the Church Fathers). Being the thinking and the discourse on God, theology advances to its conclusions accepting the irrational dogmatic statements unconditionally and also relying on testimonies of faith about Christian experience, the ineluctable part of which is mystical experience dealing with supernatural phenomena. Hence it follows that theology is an epistemologically mixed discourse: it combines the discussion of dogmatic problems and supernatural subjects, which cannot be investigated and comprehended exhaustively by means of rational and non-contradictory reasoning, and the discussion of other problems and subjects, which can be studied deeply enough on the logical and rational basis.

Such a double structure of the dominant discourse of the Middle Ages brings us back to the pre-Socratic matrix, although it appears now in a considerably modified form. We see that medieval thought had to cultivate two kinds of thinking, mystical and rational. As a result, there were two lines in theology, one with the prevalence of the mystical discourse and the other with the prevalence of the rational discourse. The rational line included Abelard, Anselm of Canterbury ("Father of the scholasticism"), and, last but not least, Thomas Aquinas, the greatest medieval thinker. Aquinas's theological system, equally scrupulous and all-embracing, is based throughout on Aristotelian concepts, epistemology, and logic. It adopts basic dichotomies of form and matter (as well as the general paradigm of the hylomorphism), act and potency, substance and accidents, adding to them the dichotomy of essence and existence, and it exploits the discursive technique of propositions and syllogisms, divisions and subdivisions. The treatment of thinking also has the Aristotelian basis, although changes caused by the difference of the Christian ontology are considerable.

Aquinas distinguishes three different principles or faculties belonging to the domain of thinking: mind, intellect, and reason (*mens, intellectus, ratio*). Mind is a collective notion denoting all the soul areas that are not attached to sensual reality. It embraces both intellect and will; intellect means the faculty of thought and knowledge, and ratio that of reasoning. The intellect that includes reason and is itself included in the mind is the central principle of Aquinas's conception of thinking. The dichotomy of potency and act implies the similar dichotomy of the two kinds of intellect, the passive and the active. The passive intellect, also called possibilistic or the intellect in potency, is the lower form dealing with sensual reality only and devoid of any intelligible contents, like the Aristotelian soul in its initial state described by the concept *tabula rasa*. The active intellect, also called *parvum lumen*, small light, performs several cognitive operations successively:

- first, it creates intelligible notions and the language out of sensual images;
- then it creates judgments that relate notions to each other; and
- finally, it creates nets of judgments and chains of deductive conclusions.

The goal of the cognitive process is the same as it was for Aristotle, the contemplation of God. However, both God and human's relation to Him became radically different, and so the conception of contemplation changed radically too. Because of God's transcendence, the accomplished and perfect act of contemplation demands very special prerequisites such as the afterlife or the ecstatic state. Catholicism's act is conceived as *visio beatifica,* the immediate vision of God's essence granted to the elect. Its necessary supernatural component is *lumen gloriae*, the light of glory; the illumination that produces the elevation of intellectual powers of the elect.

Theologians described many kinds and grades of thinking and cognition that must lead to the higher contemplative state. Most versions of the cognitive and spiritual process represent it as a kind of a ladder with steps by which the intellect ascends from sensual phenomena to intelligible and then to the divine. Aquinas relies on the scheme of the six steps or the six types of contemplation propounded by Richard of St.-Victor (d. 1173) but presents his own interpretation of these steps. This interpretation gives pride of place to intellectual activities, developing subtle classifications of intelligible objects and stressing the role of such practices as lecture, listening to sacred texts, and meditation. An important detail of this ascending process is that on its lower steps, at least, dealing with sensual phenomena, the Aristotelian isomorphism between thought and its object (*adaequatio intellectus et rei*) holds. Moreover, as a separate and inaccessible top of the ladder of human thinking, Thomas placed God conceived as the absolute mind, fully actualized and alien to all potentiality, that is, the pure act, *Actus purus*.

The opposite line in theology that did not accept the Thomist primacy of reason and knowledge included chiefly thinkers from the Franciscan order who disagreed with Aquinas's disagreements with St. Augustin's teaching and insisted on sticking to the primacy of love and will. The most significant contributions of this line to the problem of thinking belong to Bonaventure (1221–1274) and Duns Scotus (1264–

1308), called respectively *Doctor seraphicus* and *Doctor subtilis*. In comparison with Aquinas, they pay more attention to mystical, ascetical, and liturgical aspects of theology and spiritual life; in particular, they reject his presentation of the highest grade of contemplation as a purely intellectual vision: for Bonaventure, it is the communion with God, and for Duns Scotus, it is the act of love for God. Duns Scotus created a big and minutely elaborated system, which represented a full-bodied counterpart to Aquinas's system, also built on the Aristotelian basis, but having different positions on the majority of principal subjects. In particular, he presented a different description of the basic structure *intellectus possibilis–intellectus agens*, interpreting the latter as a natural light that helps the former produce *species intelligibilis*, intelligible objects of the universal meaning. Using this notion, he developed the conception of cognition as the union of two cognitive activities, the intuitive that gains the knowledge about the existence of things only, and the abstractive that gains the knowledge of the essence of things. This conception proved to be valuable for future epistemology.

In spite of polemics between Thomists and Scotists as well as other hot disputes in the scholastic milieu, medieval scholastics can be considered as a single whole characterized by some important universal features. Both Aquinas and Scotus held that the Revelation does not contradict reason. Not all scholastic thinkers would accept the famous maxim *philosophia est ancilla theologiae* (belonging to Peter Damian, XI century), but all of them believed that philosophy is not a self-sufficient discourse capable of providing an accomplished system of knowledge embracing both sensual and intelligible reality (Duns Scotus, the acutest philosophical mind of scholastics, even presented a detailed proof of the insufficiency of philosophy), while theology with the assistance of philosophy can produce such a system. In particular, the higher, contemplative levels of thinking are definitely in the field of theology.

Thus, the thinking as it is conceived in medieval thought is essentially a *theological phenomenon*. It preserves basically the pre-Socratic matrix, i.e., a hierarchical structure that includes the higher and lower types of thinking with some dynamical connections between them. It exploits the Aristotelian form of the matrix intensely, but at the same time, it modifies it considerably and complements it with new, purely Christian types of thinking.

The next big landmark in the history of thinking is undoubtedly ***classical metaphysics***. There is no need to describe in detail its tenets since they are well-known and given in textbooks. *Grosso modo* represents the gradual but irreversible turn of the Western mind from the Christian paradigm of the dominance of God to the secular paradigm of the autonomy and self-sufficiency of the human mind. The turn has been resolutely announced by ***Descartes***, and the announcement has been made in terms related directly to the problem of thinking. The core of all Descartes's philosophy is his new and revolutionary theory of thinking. The initial basis of this theory consists of two fundamental statements called the first and the second truth:

i. I think hence I am; *Cogito ergo sum*; and
ii. Human being represents the sum of the thinking part, *res cogitans*, and the spatial or extended part, *res extensa*, which have nothing in common with each other.

The first truth is Descartes's conclusion drawn from his analysis of a certain mental experiment. It establishes that the human thinking Ego is the least and most elementary agent that undoubtedly and firmly *is*. Taken together, two Cartesian truths produce the conception that is strikingly different from all preceding theories of thinking, both Greek and Christian. I mention here just two of its principal distinctions:

- First, Descartes's model of thinking is unitary: in contrast to all past models, his *cogito*, the activity of thinking, is a unified activity that is not divided into any kinds or types or levels, which form some hierarchical structure. The notion of the *res cogitans*, the agent of this activity and the generating center of the cognitive act, was soon transformed into the concept of the (Cartesian) *subject of cognition*, which became the key concept of classical metaphysics. Descartes's description of the cognitive act based on this concept was the description from a new viewpoint, in the subjectivist perspective. It included initial stages of the radical doubt and concluding stages of correcting mistakes and distortions in the act by means of *inspection de l"esprit*. This procedure anticipates the intentional examination in Husserlian phenomenology; and
- Second, the process of thinking, i.e., cognition, must advance–again in contrast to all past models–not from sensual objects to intelligible ones, but in the opposite direction, from the first principles to the scrupulous study of empiric phenomena. Such an inversion of the process meant the diametrical change of the goal of the cognition and hence of the human destination as well: now the goal and the destination were seen not in the contemplation of and in union with God, but in the clear and distinct vision of worldly things. It was the sharp turn from God to the world, in other words, the resolute *secularization of thought*–the key component of the general secularization of European civilization.

Descartes's strategy was cautious, and he did not reject the orthodox religious ontology. Instead, he presented a new epistemology that was virtually independent of this ontology and strikingly efficient. The main accent of his thought was on the method: not so much he discussed what is thinking as demonstrated very precisely how it should work. One can say that he offered his new clear and distinct Cartesian coordinates not only to geometry but to all fields of human knowledge. This strategy proved to be overwhelmingly successful. It quickly became clear that the traditional ontology with its dependence upon theology is hardly compatible with Cartesian coordinates, and so it was gradually superseded by various secularized versions. In this process, Cartesian epistemology was quickly developing into a full episteme that was later called the classical episteme by Michel Foucault.

However, secularization was (and still is) a complicated process with many unexpected twists and turns. As said above, in the field of thinking, the general trend of this process is immanentization that is the gradual reduction of ontological and transcendent aspects of thinking. But our next landmark shows opposite features. Moreover, this landmark keeps a special place in the history of thinking: all immense ***Hegel***'s System is a theory of thinking developed in such a way that it embraces all fields of reality, turning into a true "theory of everything." Hegel liked to stress his elective affinity with Heraclitus, and, indeed, the affinity of his dialectics with Heraclitus's thought is evident and striking. But in fact, the succession of his System to Parmenides's poem is no less essential and profound. The System is a great paradox: undoubtedly, it belongs in the trend of secularization with its growing distancing and separating from religious thought and life, but at the same time, it demonstrates the unprecedented since Parmenides strict primacy of the ontological thinking over the empiric individual thinking (although Hegel's dialectical ontologism does not accept Parmenides" thesis that non-being is not absolutely).

According to Hegel's cognitive paradigm, it is not an individual human who cognizes and thinks. Thinking and cognition are the prerogative of the supreme principle of the System, the Absolute Spirit (*Geist*) that acts on all levels of both sensual and intelligible reality conceived as a *sui generis* many-level hierarchical universe. Its global structure is determined by the manifestations of the Spirit in three principal forms, respectively, the subjective (anthropology: soul and body, perception, reason), objective (law and morals, state conceived as a special kind of personality, world history) and absolute (art, religion, philosophy) spirit. On any level, in any part or cell of this universe, the Spirit puts (*setzt*) some particular kind or form of thinking. The universe is dynamic, and all forms of thinking are activities with the same universal dynamic nature that is the *dialectic*. "Dialectic represents the nature of the thinking as such… Dialectic is the moving soul of any scientific unfolding of thought" [8, §§ 11, 81]. Roughly speaking, the dialectical nature of thinking means that its structure "contains contraries within itself" so that it is based on the contradiction, and this contradiction becomes the moving force of the movement of thought, which is realized in the three stages*, thesis, antithesis and synthesis* (the Hegelian triad). These stages are identified as abstract or formal, concrete and speculative thinking, or, in other terms, as understanding (*Verstand*), judgment (*Satz*), and reason (*Vernunft*).

The ubiquitous presence of the Spirit and the thinking is the reason why Hegel's system is often qualified as the *panlogism* (in Hegelian discourse, "Logic is the science about thinking" [8, § 19]). Evidently, any panlogistic system tends to draw being in the thinking that it tends to implement Parmenides's identity in some way. Looking from this angle, we discover that the identity of thinking and being is one of the leitmotifs of Hegel's System that is found repeatedly in many themes and parts of it. Hegel states that this identity should not be postulated, as in Schelling's philosophy, but must be deduced. The relationship between thinking and being is discussed in many aspects, with careful distinguishing between abstract and concrete levels. Hegel focuses on their differences [8, § 51], stresses that their indivisibility inherent in *Cogito ergo sum* is the most authentic knowledge [8, § 76] and comes gradually to their identity (cf. "Being is identical to thinking" [8, § 413]). Eventually, this identity obtains a very sophisticated interpretation and finds its reflections or correlates in many important moments of the System, such as the famous maxim "What is rational is real, and what is real is rational" (*Phil. der Rechts*. Vorrede), the identity of form and content, etc.

Inevitably, the all-embracing System also includes such types of thinking that correspond to the "individual thinking" in our terms. Their place in the System is, of course, in part assigned to the Subjective Spirit. As Hegel says, "The thinking, as soon as it unfolds in time and belongs to individuality, has corporal manifestations and is actualized predominantly in one's head, in the brain, and in the system of sense organs in general" [8, § 401]. Like any element of the System, these types are described thoroughly, but nevertheless, they represent just initial and imperfect forms associated with the lower stages of the dialectical process. Thus, on the whole, Hegel's conception of thinking restores the pre-Socratic matrix reproducing basic motifs of both Heraclitus's and Parmenides's thoughts. In the further life of philosophy, Hegel's influence was strong and lasting, but his conception of thinking was not too popular. One can see two main reasons for that. First, it was too complicated: overburdened with nets of notions, multiple classifications, and minute details and hence too difficult to be widely used. Second, its absolute primacy of ontological thinking contradicted the principal philosophical trends of its time. One can say it was too Parmenidean to be modern. In both these points, Descartes's system, though it was much older, had an advantage over Hegel's one, and, as a consequence, in the overcoming of classical metaphysics, which soon became the main task of philosophy, its role was more significant. We are going to see this right now, discussing our next landmark.

The overcoming of metaphysics and the transformation of philosophy into the postclassical paradigm obtained the firm base in the phenomenology of ***Husserl***. The problem of thinking is at the center of phenomenology. One can say that Husserl's theory was essentially a new interpretation of thinking and hence a new philosophical method based on the principle of *intentionality*. Intentionality is a property of human consciousness, which is, according to Husserl (and F. Brentano before him), its main and constitutive predicate. It means basically that the consciousness has necessarily some object to which it is directed, and it has the ability to concentrate on this object closely, fixedly, and intently. When the consciousness exercises this ability, it becomes the intentional consciousness, its object becomes the intentional object, and the concentration on it is the intentional act. The core of Husserl's theory of thinking is the detailed analytic description of this act.

The crucially important preparatory stage is the *phenomenological reduction*: the consciousness must reduce the sphere of its experience, restricting it to the experience related directly to the chosen object. It is done by means of a special operation of excluding or "bracketing" all irrelevant contents, called *epoche* (the abstention from the judgment, Greek). This usual description of the reduction is too superficial; however, in fact, the consciousness does not cut off the experience of the outer world, outer but draws it into its inner world. The act itself represents the usual advancement from the sensual to the intelligible but performed in the specific, intentional perspective. As a result of the reduction, the consciousness changes its naïve "natural" attitude to the "phenomenological" attitude. It is divided by Husserl into three phases:

i. hyletic, dealing with the "matter" of the act, its sensual data;
ii. noetic, when the *noesis*, the intellectual grasping of the object is performed; and
iii. noematic, on which the *noema*, the noetically processed object, is contemplated.

The final result of the act, the noema, is one of the most complicated Husserl's notions that can be briefly defined as the experiential object, which is placed into the world of the subject of the experience (the reduction) and then is endowed with eidetic structures (structures of the meaning) induced from this world (the noesis). All phases are described in microscopic details, but this description is not subjectivist nor psychological since Husserlian phenomenology does not reconstruct subjective, but universal phenomena or, more precisely, *structures of transcendental subjectivity*. As Husserl, himself pointed out, the theory of intentionality resembles and continues Descartes's treatment of thinking. Indeed, the *epoche* can be likened to the Cartesian doubt; the famous cognitive act, in which the principle *cogito ergo sum* is discovered, can be considered as a prototype of the intentional act; and the Cartesian insistence on *clara et distincta visio* finds its parallel in the Husserlian insistence on *Evidenz*, the evidence.

The principal role in an intentional act belongs to attention and memory; hence Husserl's theory includes detailed conceptions of these activities. Husserl finds that certain varieties of attention overcome the Aristotelian opposition of the active and the passive (*to ergon–to paschein*), and such varieties are especially important for an intentional act. Indeed, this overcoming is the key predicate of intentional attitude, and corresponding kinds of attention, unnoticed by secular science, were always known and fruitfully exploited in spiritual practices. Another key feature of phenomenological attitude is that its discourse is of a new type: it is both experiential (and hence free of essentialist metaphysical concepts) and conceptual (and hence free of theoretical helplessness of bare empiricism). Thus, it is exactly what was needed as a renewal or replacement of classical metaphysics that was already strongly criticized on the verge of the twentieth century, when phenomenology appeared. For this reason, it was soon picked up by many followers, and a large phenomenological movement emerged. Phenomenology developed into a new epistemological paradigm and almost universal philosophical methodology that was in differing degrees adopted by many contemporary philosophical currents and disciplines such as existentialism, analytic philosophy, sociology, esthetics, etc., as well as theology.

With Husserlian phenomenology, European philosophy enters its postclassical period. On the whole, in this period, the further ousting and removal of the discourse of the transcendent takes place that implies the further immanentization in the treatment of thinking. The leading trend in this treatment is the interpretation of thinking as a psychological phenomenon. Phenomenology makes a considerable contribution to this trend, and it is a paradoxical fact since one of the main principles of Husserl was the struggle against psychologism in philosophy. The solution to the paradox is simple, however. The theory of an intentional act focuses chiefly on psychological subjects such as attention, perception, temporal consciousness and experience, etc., and the conceptual framework of phenomenology abounds with psychological notions; but the use of them does not mean psychologism because in the phenomenological attitude, this framework switches from the psychological discourse to the transcendental one. But it is very easy to start exploiting this rich framework forgetting about the phenomenological reduction and treating its elements as usual psychological notions. This happened repeatedly. But there was also one important philosophical phenomenon that runs counter to the dominant trend of the psychological interpretation of thinking.

In the context of the history of thinking, the role and place of ***Heidegger***'s thought is *mutatis mutandis*, similar to those of Hegel's. We see a grandiose system that categorically asserts the primacy of ontological thinking in defiance of the dominating historical trend going in the opposite direction; in both cases, this revenge is not complete and not long, despite the strong influence of the system as a whole. The form in which this primacy is stated by Heidegger is as extreme as it was in Parmenides: it is the thinking as such that is ontological, and any different form of thinking can only be deficient or illusory "simply put, thinking is thinking of being" [9, p. 316]. Moreover, any forms, which we have at our disposal, are not yet genuine thinking. Thus, we do not know what it is but can only ask about it so that the proper discourse of thinking is not its description or its study, but only the asking of the question: *Was heisst Denken?*

Nevertheless, principal predicates of (genuine) thinking can be pointed out. First of all, Heidegger discusses in detail the fundamental relationship between thinking and being (in one of his principal books, "Introduction to metaphysics," the largest chapter is "Being and thinking."). He is convinced that pre-Socratics had a unique ontological vision that gave them open access to the truth, and so, predictably, he takes Parmenides's side and shows that this relationship is an identity. But he presents his own interpretation of this identity based on a new in-depth analysis of the problem. Taking Parmenides and Heraclitus as his guides, he decides that being and thinking correspond to pre-Socratic groundwords *physis* and *logos*, and "being in the sense of *physis* is the power that emerges," while "the basic meaning of *logos* is the collection, to collect" [5, pp. 106, 105] (cf. our characteristic of the ontological thinking as a collecting-and-uniting activity).

He argues then that the identity is directly connected with the "ontological difference," that is, the difference of being and the entity, *das Seiende*. He characterizes this difference as a dynamic relationship that is, in fact, the unfolding of the unity and the difference: a specific dynamic formation that he calls *die Zwiefalt*, which means the fold or the doubling. The new concept of the fold with its dynamic nature helps very aptly elucidate and articulate the real heart of Parmenides's identity, which is the identity itself, *to auto*, the "enigmatic word" (Heidegger).

What is enigmatic is the seemingly incompatible nature of the poles of the identity. Indeed, thinking is always conceived intuitively as a certain activity while being as a kind of unchangeable state. As Heidegger argues, the mutual belonging (*Zusammengehörigkeit*) of thinking and being can be realized only due to the fact that being is involved into the fold with the entity and Parmenides's identity must be conceived, more precisely, as the identity of the thinking and the fold. "In the enigmatic word *to auto*, the same, the disclosing accomplishment of the mutual belonging of the fold and the thinking… maintains silence" [10, p. 45].

But, on the whole, Heidegger, unlike Hegel, and like most existentialist thinkers, does not dwell on the problem of thinking too much. In his early masterwork, "Being and Time," this theme is virtually absent. In the late philosophy of the Event (*Ereignis*), it is also not discussed because its central and generating principle, the Event, is supposed to be such that it is inaccessible for any thinking, "not thinkable." An exception to the rule is "Letter on humanism," in which a concise characteristic of "thinking of being" is given. Here the connection of this thinking with the constitutive human's mission of the "ecstatic stepping-out into the clearing of being" is disclosed. "Thinking listens to the clearing of being, investing what it says into language as the place of existence… What is done by thinking is neither theoretical nor practical… Thinking surpasses all practice. Thinking towers above all action and producing… The thinking of being… surpasses all theoretical consideration because it is concerned with that in light of which the theoretical vision can only take place and unfold" [9, p. 361–362].

The forgetting of being, the refusal of human's constitutive mission has its inevitable reflection in the domain of thinking. "Being as the element of thinking is abandoned in favor of the technical interpretation of thinking" [9, p. 315]. According to Heidegger, such a technical interpretation and exploitation of thinking is exactly what takes place in science. Thus, he makes a "scandalous statement" that "science does not think," and, what is more, there is "the abyss between science and the thinking, and there is no bridge from science to the thinking, only the leap" [4, pp. 7–8]. Due to this abyss, one can say that Heidegger's conception of thinking preserves the pre-Socratic matrix, at least, in its general structure, and, paradoxically, in the Heideggerian version of the matrix, the lower pole of the imperfect thinking is represented by science, while the thinking of an uneducated peasant toiling on earth is close to the higher, ontological pole. As for full-fledged ontological thinking ("thinking of being") is a privilege of philosophy. Such absolutization of philosophy is one more common feature of Heidegger and Hegel.

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There are two outstanding thinkers, Heidegger and ***Wittgenstein***, born both in 1889, whose thought was of decisive influence on Western philosophizing since the mid-20th century. In the field of thinking, their contributions succeed each other: *grosso modo*, Heidegger's thought finishes a great époque of history of thinking, and Wittgenstein's thought opens the next period (that does not look like another great époque so far). In this period, the global trend to treat thinking as a purely immanent phenomenon achieves its final stage: the pre-Socratic matrix and the ontological thinking are definitely left out, and conceptions of thinking become completely immanent and unitary.

Wittgenstein states directly that thinking is purely immanent: “Man’s thinking goes on within the inner recesses of his mind in a seclusion compared to which any physical seclusion is a lying in full view” [11, Pt. II § 316, p. 233]. But despite this outspoken immanentism, he dissociates his position from naturalistic and materialistic conceptions of thinking. In late “Remarks on the philosophy of psychology” (1946–49), he openly rejects such conceptions. He admits that there is some “system of impulses” going from one’s brain and correlating with his/her thought that was spoken or written, but such a system represents the thinking in no way. Thus, he insists that there is no process in the brain that corresponds to thinking. Contrary to all attempts to describe thinking in terms of such processes, he warns that it is “extremely dangerous” to reason on the level of physiological processes, and the conclusions of such reasoning are, generally speaking, invalid since “I don’t know whether the people of my surrounding have nervous system.” Eventually, he rejects any attempt to explain or define thinking. “We want to define the concept of “thinking.” But then we shall be told that thinking is indefinable. There must be some indefinable things” [12, p. 236].

His study of thinking unfolds within a novel discourse of analytic philosophy, which he creates himself (alongside Russell and Moore) and which is focused chiefly and almost exclusively on logical and linguistic problems. It means that he does not attempt to grasp the nature of thinking but asks methodological questions: Can thinking be observed? “How do we investigate the nature of thinking – or even know that that is what we investigate? What am I to observe in order to know the nature of thinking?” [12, p. 49], etc. Linguistic analysis is another principal working field: “We must talk of the peculiarities of the use of the word “thinking”” [12, p. 172]. Great attention is also paid to the psychological aspects of thinking. As he says in his Cambridge lectures of 1930, emotions like hope and fear, sensations like pain, perceptions like the feeling of color are all forms of thought, and he reflects on the structuring of such thoughts and their temporal dimension. He decides that the thought is a “temporal symbolic process” that lasts as long as its expression. At the same time, he warns, we should not mix up thinking and psychological phenomena (mental processes): “True, we sometimes call accompanying a sentence by a mental process “thinking”; nonetheless, that accompaniment is not what we call a “thought”” [11, Pt. I § 332, p. 107]. He studies mechanisms of lying and pretending, of mistakes of our perceptions, analyzes many specific kinds of thinking such as “thinking without words,” “thinking in a flash,” “outside speaking,” “calculating in one’s head,” etc. On the whole, his treatment of thinking is a synthetic approach; he identifies carefully logical, linguistic, and psychological dimensions of the phenomenon and then studies them both separately and in their connections and correlations using his specific technique of the “change of aspect (Aspektwechsel),” a shift or a turn of the point of view. One can see a certain parallel between this technique and Hegel’s definition of the experience as the “turn of the consciousness.”

The important problem of the relationship between thinking and talking–or thought, language, and speech–is discussed in-depth. Wittgenstein considers these activities as inseparable. “When I think in words, I don’t have “meanings” in my mind in addition to the verbal expressions; rather, language itself is the vehicle of thought… Thinking is not an incorporeal process which lends life and sense to speaking, and which it would be possible to detach from speaking” [11, Pt. I §§ 329, 339, pp. 106, 109]. To be more precise, the relationship is not symmetrical because “talking without thought” is possible. Yes, “the purpose of language is to express thoughts” [11, Pt. I § 501, p. 139], but this purpose may not be reached in some actual speech acts. Nevertheless, the connection of thinking with language is more profound and intimate than the connection with psychological phenomena like emotions or sensations. At the same time, Wittgenstein’s discussion leaves many questions open. For instance, besides verbal content, I have a stream of images flowing in my mind, and, evidently, this stream can also be accompanied by thinking. Is it true for this thinking too that it is not possible to detach it from speaking, or is it a different kind of thinking? The relationship between verbal and visual content and activities of consciousness is one of the big problems in cinematography theory. It is also investigated in today’s cognitive science. The mechanisms involved in the relation *thought–word* were studied in a more detailed and multifaceted way by authors using different approaches, in the first place, by Jean Piaget (the approach of genetic epistemology) and Lev Vygotsky (the approach of cultural-historical psychology, cf. below).

Bertrand Russell, Wittgenstein’s friend and great analytic philosopher, disapproved his works after “Tractatus logico-philosophicus” (1918) and said that there is nothing interesting in “Philosophical investigations,” his basic late text, in which his synthetic approach to thinking and consciousness was developed. However, we see in retrospect that it is exactly this approach that is the main reason why Wittgenstein is valued today as one of the greatest modern thinkers. In his late works, the rigorous discourse and discipline of analytic philosophy outgrew its narrow limits and started working on the whole transdisciplinary field of logic, linguistic, and psychology. Subsequently, analytic philosophy expanded into a large philosophical movement that was connected closely with the “cognitive revolution” of the 1950s and had many branches, the principal of which were logical positivism and linguistic philosophy. However, regarding the problem of thinking, this movement did not advance very far beyond Wittgenstein, moving mostly along the lines he traced. The main new (but not quite new) element was the strong enhancement of reductionist and materialistic trends stimulated by vigorous development of molecular biology, neuroscience, cognitive computer models, etc.

The conceptual content of these trends is concentrated in the so-called ***mind-brain identity theory***, which puts on a table a very simple message: all states and processes of the mind, including thinking, are identical to states and processes of the brain. The theory substantiates this general thesis in great detail based on the newest data from cognitive science, but the assertion as such is by no means new. It is just another reincarnation of an old idea that repeatedly appeared in Western philosophy. Leaving aside ancient materialists, we find similar statements of the mind-brain identity in materialists of the 17th century, in David Hume (the thinking is but “slight oscillations in the brain”), Charles Darwin (the thinking is a certain “secretion of the brain”), e.a. But today the theory appears in a much more solid form possessing both the phenomenal basis and conceptual elaboration. There are multiple versions of it, corresponding to many possible ontological and epistemological interpretations of the identity. The strongest and most radical form of reductionism is called *physicalism*. It is a materialistic conception that interprets the identity in a full ontological sense: it asserts that all the processes of mental experience are not merely correlated or connected with brain processes but are really and literally brain processes. Evidently, such an approach denies the existence of any *qualia* that is irreducible non-physical properties of mental phenomena and processes. Of all attempts to equip physicalism with a philosophical basis, the most well-founded is the conception of ***heterophenomenology*** by ***Daniel Dennett.***

Starting from Husserl’s intentional phenomenology (see above), Dennett tries to transform its “phenomenological attitude,” realized by an intentional subject, into a different attitude realized by an external observer. Such a transformation is the shift of the generating focus of the phenomenological description from the first to the third person, and that is why Dennett calls his theory the “phenomenology of the other.” The new *hetero*phenomenological description accepts the self-report of the intentional subject and then subjects it to a diversified verification procedure based on all relevant empirical data available to the “third person,” the researcher: subject’s bodily responses and environment, evidence provided by neurological and psychological studies, relevant researcher’s memories of his/her own experiences, etc. Epistemologically, such a description is not a true phenomenological, but a hybrid discourse combining in a forced way phenomenology and empiricism. Due to this combination, the heterophenomenological description, in contrast to the phenomenological one, does not create structures of transcendental subjectivity but bears a directly opposite, truly anti-Husserlian fruit: the description of mental acts that are in accordance with the materialistic mind-brain identity. Nevertheless, Dennett claims justly that it is a fully-fledged cognitive paradigm that is de facto used widely in studies of human consciousness. Moreover, the usual intentional cognitive paradigm needs some modification or complement in order to take into account intersubjective aspects of the cognitive act. This problem has been recognized by Husserl himself, and as long as it is not solved, Dennett’s theory can be considered a rough approximation to its solution.

The radical approach of physicalism is far from being generally accepted, however. A neighboring and more moderate reductionist position is *functionalism* that abstains from definite statements on the nature of mental states and processes and asserts only that they function identically to states and processes of the brain. Such switching from ontological to epistemological discourse prompts one to suggest that if the only thing that matters is the set of functional roles (the syntax), then, generally speaking, the isomorphism Mind–Brain might be extended to other systems, in which the same set is realized with other substrates, e.g., computers. It is the so-called idea of *multiple realizability*, and, evidently, it leads to a generalized interpretation of mind: why not call “mind” any viable realization of the syntax of the human mind? This generalization finds its parallel in theories of autopoiesis and enactivism that develop somewhat similar generalized interpretations of cognition.

All these post-Wittgensteinian conceptions are still in the phase of active discussion and polemics. Many objections to both physicalism and functionalism were propounded, some of them in the form of thought experiments such as the Chinese room by John Searle and the Chinese nation by Ned Block. As Searle argued, mental content cannot be fully expressed in functional terms. Taking into account only functional roles of mental states, we cannot understand semantic and intentional aspects of mind and thinking [13, pp. 417–424]. The validity of his arguments can be illustrated by the words of Lev Vygotsky, whose work will further be discussed: "The meaning of the word is… nothing but a generalization" [14, pp. 297–298]: indeed, the notion of generalization refers to some meta-level and hence is a concrete example of mental content that cannot be fully expressed in functional terms. From a more general point of view, modern reductionist trends in cognitive science are criticized by Noam Chomsky, who notes that the reduction shares the role of a leading paradigm in the history of knowledge with the paradigm of the union and points out that "True reduction is not so common in the history of science, and need not be assumed automatically to be a model for what will happen in the future" [15, p. 71]. Today the paradigm of reduction is dominant, but the paradigm of union did not yet say its last word.

With regards to the problem of thinking, the Soviet psychological tradition that lasted several decades represents a kind of continental counterpart to the Anglo-American school. The comparison of them is instructive; most of their principal typological features are opposite to each other. While the Anglo-American school is strongly inclined to the primacy of logic and synchronistic methodologies of analysis and description, the Soviet tradition is based on the primacy of the historical approach and diachronic methodologies. The work of Lev Vygotsky (1896–1934) represents a real landmark in the history of our problem. Vygotsky's approach called cultural-historical psychology presents a fully-fledged theory of thinking and consciousness that includes empiric studies and uses an original "genetic" methodology relying partly on the ideas of Piaget. According to this methodology, the elaboration of general conceptions usually starts with the empiric discussion of some phenomena of children's psychology so that children's consciousness serves as a kind of a laboratory, in which basic laws and features of human consciousness can be clearly seen in their genesis.

Vygotsky's main contribution to the problem of thinking consists in new treatment and insightful, in-depth analysis of the relation thinking–word/speech presented in his last book published posthumously. He develops a conceptual framework for this analysis, arguing that "the meaning of the word" is the only possible choice for the cornerstone of this framework. "There are all reasons to be sure that the meaning of the word is not only the unity of thinking and speech, but also the unity of the generalization and the intercourse, of communication and thinking" [14, p. 17]. Beginning his analysis, he criticizes two opposite extreme positions in the problem thinking/speech: the identification of these activities, the reduction of the thinking to speech, typical, in particular, of American science, and their separation, the independence of them stated, for example, by Bergson and the Würzburg psychological school. He finds that both fail to present a satisfactory treatment of the relationship in question, but his genetic method makes it possible for him to overcome their binary opposition. He turns to empiric studies and, based on their results, concludes: "We have obtained objective experimental proofs that the thinking of a child goes through a pre-speech stage in its development." After this stage, "at a certain moment, about the age of two, the lines of the development of thinking and speech which went separately cross each other, coincide and give birth to a completely new form of behavior very characteristic of human person" [14, p. 100, 101].

The discovery of the "pre-speech stage" and related Vygotsky's results is significant progress in the problem of thinking. He proves that thinking and speech are two different but closely intertwined processes in consciousness. He discloses intricate mechanisms of their interaction in his studies of higher psychological functions performed with the same genetic method. The main result is the detailed reconstruction of the relationship between thinking and speech as a structured and dynamic process in which the thought changes and matures. Starting stages of this process, at which the thought just goes out of its pre-speech phase and begins its way to the word, being only partly verbal or semi-verbal yet, are of special interest. Describing them, Vygotsky grasps what many scholars, poets, and artists tried to grasp, the *act of the birth of the thought*, when it just emerges as a kind of a not-yet-verbal shoot of the future thought, which will form the inseparable unity with the word. Such not-yet-verbal shoots of thoughts are an important factor in many phenomena, e.g., in creative intellectual work and spiritual practices. Some ancient schools of spiritual practice, like Eastern-Orthodox hesychasm, studied them carefully and worked out sophisticated techniques for monitoring and controlling their development (needed because the uncontrolled flow of arbitrary shoots of thoughts, *logismoi*, threats the holistic man's ascent to the goal, *telos*, of the practice).

In his own plans, Vygotsky considered the study of thinking as a preparatory task for the global problem of the comprehension of human consciousness and even human being as a whole. He introduced a general concept of "psychological system" and stated that a human's characteristic property is the ability to realize the integration and self-management of the psychological system embracing an entire human being. He was also convinced that humans must "rearrange their natural structures" in order to create a "united center" for the management of this all-embracing system. Surely, such a rearrangement must be the mission of the thinking, in the first place, and he started to develop his conception of thinking in this direction. All these ideas of his last period remained in outline, and many of them deserve further development.

In Soviet psychology and philosophy, we find several significant conceptions of thinking belonging to Evald Ilyenkov (dialectical logic of a neo-Marxist type), Sergey Rubinstein (the structural analysis of thinking as a mental process), Pyotr Galperin (the "theory of stages of the formation of mental actions"), e.a. Indisputably, the most well-known and influential of them was Georgy Shchedrovitsky

(1929–1994), the author of the conception of the action-thought and founder of the Methodological movement. The movement was a unique phenomenon in the late-soviet stagnating totalitarianism. Headed by a charismatic leader, it had dozens of centers and thousands of followers all over the USSR, of whom many hold now important positions in Russian politics and business. The main form of its activity was a business game called "Organizational action game" invented by Shchedrovitsky; regular sessions of the game attracted hundreds of participants. This game is a training in "methodology" that is interpreted by Shchedrovitsky as a universal practical-theoretical *ars magna*, both wisdom and know-how, capable of exercising the management of any problem and any situation. As he claims, "Methodology is capable of everything… Methodology undertakes the function of the elaboration of the accomplished worldview replacing philosophy… Methodological thinking is a new kind of thinking that must replace all preceding forms, in particular, scientific thinking… Methodology is ethics of the twentieth century and the next centuries" [16, pp. 552, 550, 566], etc.

Although his teaching was extremely efficient as a set of practices of all sorts, social, cultural, and intellectual, its theoretical basis is eclectic and muddled. It comprises the conception of thinking and the conception of action united in the theory of "system-action-thought methodology." Shchedrovitsky insists that the thinking and the action are two autonomous substances, which "do exist really," and the unity of them, "the world of thinking and action is the primary world, [while] the world of people or people with their psychology is the secondary world, the representation of the world of thinking and action" [16, p. 562]. Thus "we should divide the world into the world of the action-thoughts and the natural world or the world of nature. Moreover, the world of action-thoughts is the primary and principal one, while the natural world cannot have pretensions to the status of reality" [16, p. 563]. This ontology inevitably leads to the view that the human person is of no importance. "What there is, is thinking, and it does not matter on what it realizes itself. In our world, it does it accidentally on people, in another world on penguins… It makes absolutely no difference on what it realizes itself… We should consider the world of thinking and action, but not the world of people, because people are casual epiphenomena of the world of thinking and action… People are just an accidental substrate, on which thinking and action parasitize" [16, p. 561, 562, 585].

Thus, in the core of Shchedrovitsky's teaching, we find a peculiar conception of thinking that includes many seemingly incompatible standings but tries to avoid self-contradictions by means of sophisticated syllogisms. The author claims to adhere to Marxist and materialistic positions, but despite this, denies any dependence of thinking upon the sensory input: "The thinking must be considered separately, in an orthogonal way to the sensory reflection, we should understand that the thinking is formed-up without sensory forms of reflection, but not on the basis of them… Thinking is devoid of images in principle" [16, p. 579]. In our terms, this conception corresponds to ontological thinking. Being eclectic, it imbibes elements of almost all classical philosophies:

- Parmenides (the absolutization of thinking and being, the opposition of *aletheia* and *doxa*, cf.: "What exists actually is essences [that is thinking and action, in the first place], while the phenomenal world is but the world of phantoms-appearances" [16, p. 560]);
- Descartes ("When Descartes said that there are two substances, matter, and thinking, he was right. And he was right even in his dualist standing" [16, p. 562]);
- Hegel (strictly speaking, a human does not think, but the thinking, like Hegel's *Geist*, realizes itself using him as a tool or a substrate);
- Husserl (the anti-psychologism and the demand of the replacement of the natural attitude by an alternative, a bit similar to the phenomenological attitude); and
- Last but not least, modern cognitive science ideas about the possibility of realizing the mind and thinking on non-human carriers

In sum, this conception is hardly a great contribution to the history of thinking, but nevertheless, as the core of the doctrine of the Methodological movement, it played and, to some extent, continues to play a considerable role in Russian philosophy and culture of the last decades. Moreover, at least, some of its ideas, and, first of all, the basic concept of the action-thought, can be used fruitfully in other contexts. Independent of Shchedrovitsky, this concept is studied and exploited today in the works of Andrew Simsky (Okhotsimsky) (see, e.g. [17, in press]). He makes it the basis of a constructive description of both anthropological and sociocultural phenomena: using and extrapolating Nikolai Bernstein's biodynamical scheme of the multilevel hierarchical control of the inner motorics, he constructs hierarchical systems of action thoughts that function on all anthropological and social levels of reality.

Simsky's work is but one example demonstrating that the concept of action-thought has valuable potential for further development and use. In fact, both Shchedrovitsky's and Simsky's work based on this concept can be considered a Russian version of the constructivist trend that predominates today in cognitive science. The idea that thinking, mind, and cognition are not opposed to action, but, on the contrary, are connected inseparably with it, is the cornerstone of a whole group of relatively new theories that are often united under the common title of constructivism or, more precisely, radical constructivism. The message put in this name is that mental activity is considered as having the constructing nature: its elementary units are now not acts, but actions, the making of some constructions, whence it follows that the action-thought is a true constructivist concept. The most well-known in this group is the theory of autopoiesis developed by F. Varela and H. Maturana in the 1970s and the enactivism propounded by Varela, E. Thompson, e. a. in the 1990s.

In constructivist theories, all the set of basic notions related to mind and cognition obtains the cardinal reassessment and generalization. The reassessment goes back to Konrad Lorenz, the founder of ethology, whose studies of animals led him to conclude that the interaction of the living organism with its environment can be interpreted as a kind of cognitive activity or, briefly, that "*life is cognition*."

Evidently, this thesis broke with the age-old tradition that considered cognition as a prerogative of the human mind: now the cognition was conceived as a holistic activity involving all processes of the interaction between the organism and its environment (Cf., e.g., "I shall consider human understanding in the same way as any other phylogenetically evolved function which serves the purposes of survival, that is, as a function of a natural physical system interacting with a physical external world" [18, p. 4]). It might seem that such innovation has nothing in common with the tradition, but one can easily find some intermediate viewpoint uniting both conceptions, e.g., if we define cognition as the development of the ability of the successful orientation in the world by means of constructing actions and concepts that are more and more viable. The Lorentzian reinterpretation of the cognition represented the radical generalization or extension of the old notion. The new conception of *extended cognition* triggered the active process of a similarly extended reinterpretation of all related notions such as mind and consciousness.

It turned out that there are many possible ways to shape corresponding extensions. Basically, the extensions must take into account two principal factors: the dependence on the body and the involvement of the action. The focusing on the structural coupling brain-body world resulted in the emergence of conceptions of *embodied cognition* and *embodied mind*. Here the role of the body is reconstructed in detail: it is shown that the body can function as a *constraint* on cognition, as a *distributor* for cognitive processing, or as a *regulator* of cognitive activity. In these functions, sensomotorics and inner motorics of the body are actively involved, and I should mention that the scrupulous study of them was performed in the mid-20$^{\text{th}}$ century in the USSR by Nikolai Bernstein (1896–1966), who used the formula "cognition through action" and was indisputably a forerunner of today's constructivism. Besides the conceptions of the embodied mind and cognition, a philosophical conception emerged based on the idea that one's mind and cognitive processing are not bound by the limits of brain and body but extend to all the world of human experience (the environment). According to this conception of the externalism or the *extended mind*, a human's mind, body, and the environment form, one interconnected system functioning on holistic principles so that all of it is mind (the extended mind), and all of it is the body (the extended corporality).

Today the constructivist and enactivist conceptions of mind and cognition exist in many competing versions, which did not yet find their definitive form. Evidently, there must be corresponding conceptions of the embodied and/or extended thinking, but now they did not yet appear. Thus, our concise history of thinking comes to its final point here. The final situation is fully in accordance with the words of Edgar Morin: "We are, perhaps, living through a great paradigm shift. … We stand on the threshold of a new beginning. We are not in the last stages of the history of thinking… We are, rather, still in its prehistory" [19, p. 98].

Conclusion

Looking back to all the long way of thinking over thinking, we see it as a double-sided process, the development of the theory of thinking and the evolution of the thinking itself. Surely, it was not a permanent progressive development; the process had both gains and losses. A special question is about the destiny of ontological thinking: modernity has decisively rejected it, but was this a gain or a loss? Today the peak of the reductionist trend is over already, and the new constructivist vision tries to construct a broader perspective taking into account not only the reductionist paradigm but also the paradigm of the union. The externalist conception of the extended mind can be viewed as a turn in the direction of the ontological thinking (and we saw really such a turn in Shchedrovitsky's work), and if it is true, all the way of the thinking will correspond to the ancient symbol of the Uroboros, the serpent swallowing its tail: the symbol of the coincidence of the beginning and the end. Connectionism, another constructivist conception, leads in the same direction. It describes mental phenomena on the basis of artificial neural networks treating the latter on the abstract level as large systems consisting of elements of two kinds, some units and some connections between them. Such an abstract view gives one the idea that connectionist architecture could have a more general interpretation. We notice that it is very close to our conception of the ontological thinking as a universal collecting-and-uniting activity; and we suggest that *thinking as such can be considered as a kind of the connectionist architecture* interpreted in the above mentioned abstract and generalized sense, as a dynamical architecture of changing constructions of connections, not necessarily attached to neural networks.

Accepting such a general interpretation of the connectionist architecture, we notice that the thinking is not the only kind available to us, humans. The other is love, and it is even more powerful: as Dante told us, *Amor muove il sole e altre stelle*. This connectionist architecture also needs its concise history, but I would not dare to write it.

> *"The thinking and speech are all entirely and indissolubly intertwined with being and non-being, and we try to disentangle ourselves out from this tangle, and this is our first and foremost problem."*

[20, p. 436].

> *"Parmenides had more grounds than Nietzsche to say that he is the destiny, and the destiny of the West speaks through him."*

[20, p. 435].

> *"It is not for nothing that Antiquity continues to attract us. But for Plato, on the contrary, our New-European algebra would hardly be interesting; and for Aristotle combing of immense celestial spaces without ontological perspective would be senseless."*

[21, p. 78].

"Being has lost its advantage. It is quite bad with being. ... Epistemology is a result of misunderstanding… In reality, there is no theory, no contemplation, no knowledge. Plato's Sun does not shine in the sky ... It exists inside nets, lamps, electron beams… It is impossible to cognize anything if you are out of nets that organize skills and manipulate them… We have only what is reduced or becomes reduced."

[22, p. 284].

"Thinking exists in Russia like travelers survive at the North Pole or like soldiers live in trenches. It is surprising that it exists nevertheless."

[23, p. 135].

Core Messages

- The chapter presents a synposis of understanding of thinking through all ages of Western culture.
- The analytical presentation identifies principal structures and paradigms inherent in Western thinking over thinking.
- The pre-Socratic matrix is a structure comprising two kinds of thinking: "ontological thinking" and "individual thinking".
- The exposition represents brief descriptions of the set of principal landmarks in the history of thinking.
- The text concludes with a discussion of the present status of the problem of thinking.

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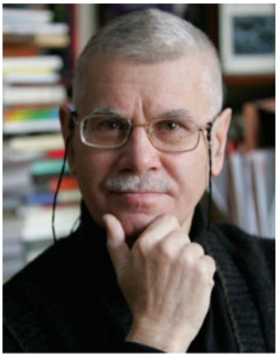
22. Latour B (2011) Pasteur: guerre et paix des microbes. La Découverte, Paris
23. Bibikhin VV (2015) Uznai sebya (Know yourself). Nauka, St.-Petersburg



Sergey S. Horujy b. 05.10.1941, in Skopin, USSR, graduated from the Department of Physics of the Moscow State University, got a Ph.D. and a Doctorate in theoretical and mathematical physics. He worked in the field of relativistic quantum theory (until 2006) and, in parallel, philosophy, and theology (this work was underground until the fall of the communist regime). He developed a general anthropological conception called "synergic anthropology" that includes the reconstruction of anthropology of spiritual practices (in particular, Eastern-Christian Hesychasm, Sufism, and Zen). He founded the Institute of Synergic Anthropologyin Moscow (2005) and the international anthropological journal "Diogenes' Lantern" (2015). He published about 20 books (translations in English, Chinese, and Serbian). He served as the Professor of Philosophy, Institute of Philosophy of the Russian Academy of Sciences (Moscow) and the Honorary Professor of the Russian Christian Academy for Humanities (St.-Petersburg), as well as the Member of the Accademia Sapientia et Scientia (Rome, Italy). Professor Sergey passed away in September 2020. He lives on in our memory with his great contribution to *thinking over thinking*.

How to Think About Human-Animal Differences in Thinking: Two Cases of Marginal Analogy in the Philosophical Explication of Animal Cognition

3

Carlo Brentari

> *"Whenever he heard anyone use the words 'man' and 'animal' as opposites, Oskar Heinroth used to interrupt the speaker politely and ask: 'Forgive me, but when you talk of animal, do you mean an amoeba or a chimpanzee'?"*
>
> Konrad Lorenz *[1, p. 42]*

Summary

This chapter provides some elements for the critical evaluation of a particular philosophical approach to animal behavior: the argumentative strategy of marginal analogy. By marginal analogy, we mean the establishment of analogies between animal behavior in general on the one side and, on the other, some marginal behavioral processes and/or cognitive processes in humans (such as sleepwalking or reflex action), which occur without the aid of reflection or higher symbolic consciousness. In authors such as René Descartes, Ernst Cassirer, and Susanne Langer, the recourse to marginal analogy is essential from the argumentative perspective. It is, in fact, functional to the affirmation of the thesis of the qualitative difference of non-human animals. The critical discussion of marginal analogy, therefore, is a useful tool to overcome this thesis as well, in the direction of consideration of non-human behavior and cognition as a field of

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_3

diffuse discontinuities. After the rejection of any analogy-based approach, much of the non-human experience may remain inaccessible to the human observer; what one can grasp, however, discloses a sphere of astounding biodiversity that calls for preservation.

Apes in the Orange Grove.
[Painting by Henri Rousseau; adapted from Wikimedia Commons https://upload.wikimedia.org/wikipedia/commons/d/da/Henri_Rousseau_-_Apes_in_the_Orange_Grove.jpg.]

Keywords

Analogical approaches · Animal cognition · Ernst Cassirer · Hans Volkelt · Human · Animal studies · Jakob von Uexküll · René Descartes · Susanne Langer · Thomas Nagel

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

The chief aim of the present chapter is to highlight some common problems that arise when, from a philosophical perspective, a scholar tries to think about the difference between human and non-human animals, with particular regard to their ability of *thinking* (Table 3.1). We adopt here, preliminarily, a rather broad concept of thinking: thinking is, to our purposes, every process of spontaneous elaboration of external inputs that leads (or can eventually lead) to an adaptive line of action. There can be no claim to exhaustiveness in our presentation, neither about the philosophers we will consider, nor about the animal behaviors we will examine. The focus of the paper will be, instead, on some strategies of the analogical kind that philosophers adopt to analyze animal actions and their cognitive background (and, secondarily, in exposing their analyses to their readers). One of the most significant examples of these strategies, as we shall see, is the recourse to the analogy with marginal human behaviors in order to explain non-human perceptive and operative modalities. We will call it, briefly, *marginal analogy*, in order to distinguish it from all cases of explicit anthropomorphism or direct analogy (i.e., the naïve ascription to non-human animals of the same mental process, or of the same kind of consciousness, as human animals have). This second kind of analogy, which has been criticized countless times by philosophers, ethologists, and scientists, will remain outside of our consideration.

Before tackling the marginal analogy issue, however, some brief considerations are needed about how non-human animals enter the philosophers' attention span. For much of the history of Western philosophy, non-human animals are scarcely an

Table 3.1 Summary of models of the difference between non-human and human animals

Model of the difference between non-human and human animals	Quantitative difference	Qualitative difference		Diffuse differences
Mentioned authors	Michel de Montaigne, Charles Darwin, Neo-Darwinism	René Descartes	Ernst Cassirer, Susanne Langer	Thomas Nagel, Jakob von Uexküll, Hans Volkelt
Kind of the difference(s)	*Adaptive* Gradual enhancement of evolutionary traits already present in non-human animals (communication, reason, moral behavior)	*Ontological* Res cogitans (rational soul) as monopoly of human animals	*Semiotic* Symbol-based cognition as the monopoly of human animals	*Qualitative differentiation inside a common domain* Interspecific variability of conscious subjectivity, leading to qualitative differences running through the entire field of animal life forms
Number of relevant differences in the entire (non-human/human) field of animal life forms	Plural	Singular	Singular	Plural
Argumentative strategy	*Analogy* Gradualism allows for unrestricted use of analogical interpretations of animal behavior and cognitive processes	*Marginal analogy* Non-human cognition appears understandable in analogy to marginal human behaviors (reflex actions, sleepwalking, other actions performed in the absence of reason)	*Marginal analogy* Non-human cognition appears understandable in analogy to marginal human behaviors (sign-based semiosis, pre-linguistic cognition)	*Renounce to analogy* Reconstruction of the cognitive sphere starting from observable behavior An effort to think of animal cognition as phenomenological and categorical otherness (with consequent admission of the partial unknowability of the inner sphere of non-human animals)

object of autonomous interest. With the great exception of Aristotle's biological works, the attention devoted to animal life forms in ancient and modern philosophy is usually functional for other purposes. In classical Greek thought, for example, the reflection on the cognitive abilities of animals—which, however, starts to highlight some significant elements also from a scientific perspective—is frequently conducted inside the discussion of vegetarianism (seen as a practice aimed at improving the human being from the moral point of view). Arguments that favor vegetarianism relying not only on the possibility of soul transmigration but also on the statement that non-human animals possess a minimal degree of rationality are representative of the Pythagorean and Neoplatonic repertoire. Particularly clear is, in this regard, the incipit of Plutarch's *The Cleverness of Animals* [2, pp. 321–325; 3, pp. 540, 550]. Functional to other purposes are also all those philosophical works in which non-human animals provide a term of comparison in order to illustrate, by contrast, some human features. This kind of comparison is a recurring strategy when a philosopher wants to affirm the ontological, moral, or religious superiority of humans. Even the extensive and detailed review of non-human animals' skills in Montaigne's *Apology of Raymond Sebond* provides cues ultimately oriented at an ethical aim concerning the human being: to lower human presumption [4, p. 505].

Even if their interest in non-human animals is for other purposes, the passages that ancient and modern philosophers devote to them allow us to identify the methodological and logical problem that lies at the heart of this contribution. Whether they want to affirm the essential superiority of humans over animals, or (on the contrary), they aim at highlighting the affinities between the two forms of life, each of their arguments suffers from the same limitation: the tendency to reason by analogy, searching the observable behavior of non-humans for cases that appeared explainable in terms of known human cognition and experience. Now, the analogical nature of the inferences from the behavioral to the cognitive level is explicit in those philosophers who want to affirm the closeness and affinity between human and non-human animals and is hidden and implicit (but equally important) in the ones who support the view of the qualitative alterity of human cognition. This is the thesis that, through the analysis of two emblematic cases, we will try to demonstrate in the following pages: even authors who support strong versions of the qualitative difference of non-human animals, such as René Descartes, Ernst Cassirer, and Susanne Langer, rely on marginal forms of human experience to gain an analogical access key to the interior world of animals.

On Reflexes and Instincts

A paradigmatic case of marginal analogy occurs in Descartes' discussion of the difference between human and non-human animals. Descartes links consciousness and thought to the soul's possession (understood as *res cogitans*) and, therefore, makes them an exclusive patrimony of humans. His position does not imply that non-human animals have no sensitivity, but their sensitivity lies in the transmission of movement: perceptive stimuli impact the sensory organs and provoke a chain of sub-processes that finally leads to action [5, p. 366]. The stimuli, however, are not re-perceived on a conscious level since (in the absence of the rational soul) there is no perceptive center playing the role of a subject. This mechanistic view of animal behavior, universally known as the 'animal machine' theory, poses many problems, especially in complex behaviors carried out by higher animals (it poses much fewer difficulties when one observes a frog catching a fly). In front of complex behaviors, is it no longer rational to assume in non-human animals a limited capacity for cognitive processing of stimuli, a small degree of judgment (if we want to use the terms of the time)? Descartes' answer is negative. His theory of perception seems sufficient to him to explain the whole animal behavior; a position, moreover, which is supported by the belief that, if the possession of the *res cogitans* is limited to humans, then the field of the remaining animal behavior must be homogeneous [6, pp. 546–649].

To our ends, however, what matters most is the argumentative strategy Descartes brings into play to support this position. This strategy is clear in Descartes' letters, perhaps because, here, the philosopher has to answer direct questions regarding animal behavior. His correspondence, and in particular the letter to the Marquess of Newcastle of November 23, 1646, will therefore constitute our reference text (together with some passages of the *Meditations on First Philosophy*) (Fig. 3.1). Descartes' argument starts from the exclusion of the hypothesis, associated with the name of Montaigne that animals have a certain degree of reason: *"I cannot share the opinion of Montaigne and others who attribute understanding or thought to animals"* [5, pp. 302]. According to Descartes, this view is the result of incorrect analogical reasoning: *"I see no argument for animals having thoughts except this one: since they have eyes, ears, tongues and other sense-organs like us, it seems likely that they have sensation like us; and since thought is included in our mode of sensation, similar thought seems to be attributable to them"* [5, p. 364]. The adverse arguments, which Descartes qualifies as *"stronger and more numerous,"* include various lines of reasoning. Some of them sound weak to the contemporary mindset: *"it is more probable than worms, flies, caterpillars and other animals move like machines than that they have immortal souls"* [5, p. 364]. The most convincing among them, however, is the following one. Faced with the task of understanding animal behavior in the absence of reason, Descartes proposes to think as follows: *"I consider that they [non-human animals] imitate or surpass us only in those of our actions which are not guided by our thought. It often happens that we walk or eat without thinking at all about what we are doing; and similarly, without using our reason, we reject things which are harmful for us [...]. Indeed, even if we expressly willed not to put our hands in front of our head when we fall, we could not prevent ourselves. I consider also that if we had no thought we would walk, as the animals do, without having learnt to; and it is said that those who walk in their sleep sometimes swim across streams in which they would drown if they were awake"* [5, pp. 302–303]. By the way, a similar passage can be found also in the *Fourth Set of Replies* in the *Meditations on First Philosophy*: *"a very large number of the motions occurring inside us do not depend in any way on the mind*

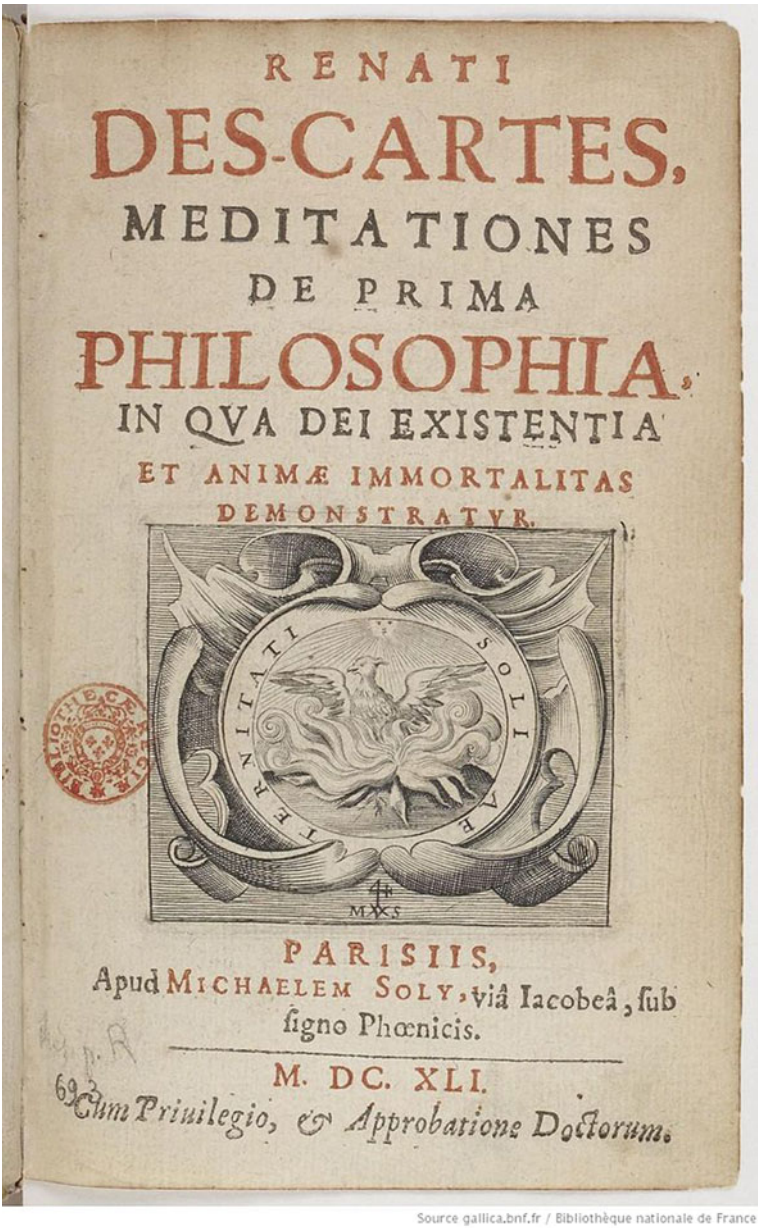

Fig. 3.1 The title page of the 1641 edition of Descartes' meditations on First philosophy. Adapted from Wikimedia Commons, the free media repository https://upload.wikimedia.org/wikipedia/commons/7/77/Meditationes_de_prima_philosophia_1641.jpg

[…]. When people take a fall, and stick out their hands so as to protect their head, it is not reason that instruct them to do this"; they act according to a physiological process occurring *"without any mental volition, just as it would be produced in a machine"* [7, p. 161].

Descartes includes three types of actions in this set of non-rational behavioral modalities: reflex reactions, movements carried out in sleepwalking, and, more generically, instincts (*"they [animals] act only by instinct and without thinking"*) [5, pp. 302–304]. This choice is not without consequences: reflex motions and instincts, in particular, will become in modern times the key tools of the mechanistic interpretation of animal behavior. In the form of the reflex arc (as, among others, in the works by Thomas Henry Huxley, William James, John Dewey; for an introduction to this issue, see [8]), of Pavlovian conditioning, and of tropisms [9, p. 23; 10], immediate and involuntary reactions to the external stimuli will become the paradigm of animal action itself. At the same time, instinct, originally used by Thomas Aquinas to underline the hetero-direction of animal action within a moral comparison with human autonomy [11], *quaestio* 64, *quaestio* 95; [12], will become the typology *par excellence* of the behavior of non-human animals. This concept applies to some traits that, though seemingly positive (such as safety, if not alleged infallibility), in reality, convey the idea of the rigidity of animals' repertoire of action. The mechanistic model takes on its most complete form in authors who, like Hugo von Buttel-Reepen and Heinrich Ernst Ziegler, unify the two key concepts (reflex and instinct) in the idea of the instinct as a chain of reflexes [13, p. 296; 14, p. 62; 15, pp. 136–137]. We cannot reconstruct here the whole history of the mechanistic toolkit, limiting ourselves to pointing out that its importance is now reduced. As far as the notion of instinct is concerned, Konrad Lorenz's work has shown that innate behavioral sequences are only a part of the behavioral repertoire of animals (which also includes different varieties of learned behavior, exploratory behavior, etc. [15, pp. 259–262, pp. 325–326]). Moreover, innate behavior now appears as far from being immutable or perfect as in Descartes' clockwork model. We know, in fact, that it has been subjected to Darwinian adaptation processes to a changing environment. As a good evolutionist, Lorenz was aware that innate motor modules are inserted, like any other phenotypic trait, in an incessant adaptation process to the environment, determining its usefulness in a contingent and context-related way [15, p. 24–32]. Furthermore, in contemporary research, the study of behavioral processes is mainly conducted by neurobiology and other cognitive sciences, whose approach is not necessarily mechanistic (even when the focus is the behavioral repertoire of insects [16]). The mechanistic model is still alive in common sense, where 'instinct' often remains the most common pseudo-explanation for complex animal behaviors.

Let us come back now to Descartes' letter to the Marquise of Newcastle to understand the complex strategy the philosopher deploys to convince his correspondent of the validity of the thesis that animals are a machine. Descartes' first move is to awake in the reader a strong sense of participation through the usage of the first plural person, "we:" "*It often happens that we walk or eat without thinking….*" The next step is to generalize some marginal human behaviors carried out in the absence of any self-conscious thinking activity, such as sleepwalking or the reflex of self-protection in case of a fall. This step is extremely relevant. Descartes proposes to use our imagination to set up a thought experiment on a great scale: what if all animal behavior is equal to some human actions conducted in the absence of reason, which we know by direct experience? The last step is to show which advantages this hypothesis brings in. We limit ourselves to the two advantages Descartes highlights in the examined letters:

i. first, the hypothesis explains the impression of perfection and completeness conveyed by many animal behaviors: *“I know that animals do many things better than we do, but this does not surprise me. It can even be used to prove that they act naturally and mechanically, like a clock which tells the time better than our judgement does”* [5, p. 304]. Incidentally said, Descartes is among the first philosophers to affirm the infallibility of instinct, a myth that (as we have seen) will be definitively dispelled by Lorenz’s evolutionistic approach to instinctive behavioral modes. Also, animal visual perception, in Descartes, loses any possibility of contact with conscious reflection: *“Animals”*—writes Descartes—*“do not see as we do when we are aware that we see, but only as we do when our mind is elsewhere”* [5, pp. 61–62]; and
ii. the second advantage (from Descartes’ viewpoint, obviously) is that, after being accepted by marginal analogy, the hypothesis of the mechanical or instinctive nature of animal behavior provides a background to highlight, by contrast, the qualitative differences of humans. In Descartes’ thought, the peculiarity of humans pivots on two elements: on the metaphysical level, the possession of an immortal and substantial soul; on the anthropologic and pragmatic one, the use of language and other semiotic systems with denotative (and not merely expressive) function. *“None of our external actions”*—writes Descartes—*“can show anyone who examines them that our body is not just a self-moving machine but contains a soul with thoughts, with the exception of spoken words, or other signs that have reference to particular topics without expressing any passion”* [5, p. 303].

We will return in the next section to the question of the semiotic capacities of human and non-human animals; the second case of marginal analogy I want to discuss belongs, indeed, to the disciplinary domain of zoosemiotics. Before addressing this new field, however, I would like to take stock of what the analyses of Descartes’ writings have allowed us to understand about how humans can try to think animal otherness. The line of reasoning that I have chosen to call *“marginal analogy”* is useful because it opposes analogy to analogy. Descartes is opposing in the first place Montaigne, who in his *Apology of Raymond Sebond* had presented the reader with a wide range of examples in which animal action appears organized by cognitive processes that are similar to those of humans. Let us see a famous example: *“Consider the fox which Thracians employ when they want to cross the ice of a frozen river […]. Were we to see it stopping at the river’s edge, bringing its ear close to the ice to judge from the noise how near to the surface the current is* *running; darting forward or pulling back according to its estimate of the thickness or thinness of the ice, would be not be right to conclude that the same reasoning passes to its head as would pass through ours and that its ratiocinates and draws consequences by its natural intelligence like this: 'That which makes a noise is moving; that which moves is not frozen; that which is not frozen is liquid; that which is liquid bends under weight'?"* [4, p. 515]. As has been said, Montaigne's intent in the *Apology of Raymond Sebond* is to break down human presumption by showing the closeness of humans to non-human nature, especially animals. In Descartes's eyes, in doing this, Montaigne reinforces a dangerous habit of thought: the tendency to consider animal behavior as arising from the exercise of reason, i.e., in the same way, it arises in humans [5, p. 303]. Descartes explicitly addresses the tenacity of direct analogical thinking in a passage of the *Meditations on First Philosophy* that immediately follows the denunciation of the false inference, on whose basis we attribute "mind or thought" to non-human animals. This passage sounds: *"things which we have become convinced of since our earliest years, even though they have subsequently been shown by rational arguments to be false, cannot easily be eradicated from our beliefs unless we give the relevant arguments our long and frequent attention"* [7, p. 162].

On Signs and Symbols

As we have seen, Descartes's argumentative strategy aimed to establish a strong version of the thesis of humans' qualitative difference. This difference is based, on the metaphysical level, on the possession of a substantial and immortal soul (the *res cogitans*), and, on the behavioral and pragmatic level, on the denotative (and not merely expressive) usage of signs, especially of verbal signs (*"spoken words, or other signs that have reference to particular topics without expressing any passion"*). We will not dwell on the first point. From Kant onwards, the soul issue has been declared inaccessible to the empirical inquiry, and therefore as inevitably destined to produce nothing more than confusing speculations. Instead, we will deal extensively with the second point, the usage of signs by human and non-human animals. This issue is still at the center of a fruitful debate. Without pretending to exhaust the theme, we would like to highlight that modern and contemporary research inclines to attribute some semiotic abilities also to non-human animals. At the same time, as we will see through the analysis of some texts by Ernst Cassirer and Susanne Langer, this does not prevent many scholars from equally supporting the thesis of humans' qualitative difference. This difference, however, necessarily takes a different form as in Descartes's thought, where only humans had the monopoly of the denotative usage of signs. In a similar way to what we have seen happen with Descartes, also in the works by Cassirer and Langer, the thesis of the qualitative difference of human animals requires, in a different version, the argumentative tool of marginal analogy.

Before starting with the exposition of this issue, it is appropriate to specify our reasons for choosing these two authors among the many contemporary philosophers supporting the view of the qualitative otherness of humans. Ernst Cassirer represents that part of German (and continental) philosophy that considers the reflection on science as an integral part of philosophy itself. It is true both for:

i. the neo-Kantian phase of Cassirer's writings, in which epistemological and methodological interests prevail; and
ii. the anthropological phase, in which a particular scientific theme, the definition of the human being, moves to the fore.

The second phase is the most important for us because it shows that (even in German philosophy, traditionally rooted in idealism) the twentieth century brings with it the urge to seek a definition of the human being that does not rely on the attribution of some remote metaphysical entity – like Descartes' res *cogitans* or the Hegelian spirit. Also, by the influence of the classical philosophical anthropology by Max Scheler, Helmuth Plessner, and Arnold Gehlen [17, p. 27; 18, pp. 215–17, pp. 261–2], in Cassirer's and Langer's works, the metaphysical consideration of human beings is increasingly replaced by the comparison with non-human animals. In some cases, as in Cassirer's work, the term *Geist* can also be maintained, but with a new meaning that makes it a synonym of the vital (biological, instinctual, and semiotic-cognitive) organization of the human being. In the case of Cassirer's American pupil Susanne Langer, the distance—also geographical—from the classical German philosophy and the influence of other philosophical currents (the Vienna circle, American pragmatism) lead to a composite approach, in which symbolic logic, individual psychology, studies on the nervous system and dreams, ethology, and primatology coexist.

The following quotation by Langer can make us understand how the characterization of the qualitative difference of humans has changed in contemporary time: *"We need not assume the presence of a transcendental 'human spirit', if we recognize, for instance, the function of symbolic transformation as a natural activity, a high form of nervous response, characteristic of man among the animals"* [19, p. ii]. With the passage from modern to contemporary philosophy, in short, the qualitative difference of humans is no longer metaphysical but empirical, often related to communicative and semiotic behavior. Previously, even where the semiotic dimension was not neglected (as in Descartes), the use of signs was seen as a consequence of the metaphysical difference separating humans from non-human animals.

We now come to expose the form that the thesis of the qualitative difference of humans assumes in Cassirer and Langer (for this contribution, it is possible to present this thesis by referring indifferently to the two authors, leaving aside the terminological and, in a few cases, even conceptual differences between them). For both authors, this difference lies in the human faculty of the symbolic transformation. The easiest way to introduce this concept is to start from the distinction, introduced by Cassirer and taken up by his American pupil, between signs (or signals) on the one side and symbols on the other. Both signs/signals and symbols are semiotic ways of referring to the objects of experience; in other terms, both can absolve the semiotically basilar function of *staying for* other elements to a perceiving agency. The difference between the two categories of semiotic elements lies in the way they stay for their referent. Signs, which are spontaneously used by animals, function as mere substitutes for the denoted element. In *An Essay on Man*, Cassirer states that non-human animals naturally develop signs systems—*"that we find rather complex systems of signs and signals in animal behaviour seems to be an ascertained fact"* [17, p. 36]—and also that humans can instruct them so that they grasp new semiotic relationships: *"the famous experiments of Pavlov prove only that animals can easily be trained to react not merely to direct stimuli [i.e., the perceptive qualities naturally linked to the object] but to all sorts of mediate or representative stimuli"* [17, p. 37]. It should be pointed out, here, that the term *"representative"* does not refer to any kind of mental representations or conceptions through which the denoted object would be signified—a process which, for Cassirer, is peculiar to humans as symbolic animals. At the animals' semiotic level, representation is nothing more than the function of signs to *replace* the denoted object at the behavioral level (the Scholastic *stare pro*). According to Cassirer, animals can only *"respond to tokens [signs/signals] as substitute for food rewards in the same way in which they respond to food itself"* [17, p. 37].

Here we begin to glimpse the logical core of the distinction between animal signs (or signals) and human symbols. The former denote their object without any mediation through mental representations or concepts, by the merely associative and substitutive way; the latter denote their object through the mental conception they convey. The difference between the two categories of semiotic elements is substantial. *"Signals and symbols belong to two different universes of discourse"*—writes Cassirer—*"a signal is part of the physical world of being; a symbol is part of the human world of meaning. Signal are 'operators'; symbols are 'designators' [and] have only a functional value"* [17, p. 37]. The same distinction is summed up by Langer as follows: *"Symbols are not proxy for their objects but are* vehicles for the conception of objects*"* (emphasis by Langer) [19, p. 49]. Symbols, in short, denote their object through mental conceptions; this applies not only to verbal symbols, which remain for Cassirer and Langer the examples *par excellence* of human symbolic activity, but also to artistic, mathematical, religious symbols, and so on. The sole presence of mental conceptions inside the symbolic denotative process can justify the thesis that Cassirer and Langer fall within the authors who affirm the qualitative otherness of humans. This thesis is supported by a detailed analysis of the cognitive opportunities that, according to Cassirer and Langer, open up to human beings thanks to the availability of mental conceptions:

- the possibility of disengaging from direct perceptual experience and to denote absent or abstract objects, past or future events, etcetera; and
- the possibility of using mental conceptions regardless of any immediate biological, pragmatic, or behavioral need; and

- the possibility of denoting other symbols, which makes possible (among other things) the phenomenon of the recursion of human language, etc.

Even if Cassirer and Langer support the view of the full naturalness of human animals (and of their higher faculties), the fact that they ascribe to humans the monopoly in the use of symbols includes, at least implicitly, the belief in their qualitative difference. Non-human animals remain confined to the immediate perceptive level, dominated by semiotic elements having *"a sort of physical or substantial value"* [17, p. 37]. To humans, on the contrary, the sphere of meaning discloses—a sphere that Cassirer continues to define as *Geist* and Langer names, instead, *symbolic mentality* or *mind.*[1]

For Cassirer and Langer, the distinction between signs and symbols is the logical-semiotic basis of the qualitative difference between non-human and human animals. As in the case of Descartes, this difference has universal validity; it applies to every animal species and every behavioral modality. It has the side effect, in other terms, to homogenize the field of non-human animal behavior and cognition, eliminating every species-specific peculiarity. Again, as in Descartes, this operation is not without problems. The adversaries can identify cases in which non-human animal behavior is more easily explained by assuming the existence of complex mental contents (for instance of mental maps or expectations about the conspecifics' behavior) and not by merely associative processes. That is what happens, typically, in the research on primates—which, therefore, both Cassirer and Langer have to discuss in detail (the latter also making some timid opening towards the possibility that a rudimentary symbolic mentality begins to emerge in primates [19, pp. 90–91]).

Moreover, the radicalism of the semiotic separation of non-human from human experience pushes both Cassirer and Langer to resort to the strategy of marginal analogy. In other terms, they make their position more solid by offering the reader the possibility to "enter" the cognitive and behavioral modality of non-human animals (that is based, as we know, on the use of signs alone). The semiotic version of the recourse to marginal analogy takes over this form:

[1] From the ontological point of view, Cassirer and Langer's version of the body/mind dualism (which has the form, as we have seen, of the dualism between a sign-based and a symbol-based semiosis) is not a form of Cartesianism. Cassirer's reflection on Kantian epistemology leads him to affirm the functional rather than substantial nature of the mind; for her part, Langer, influenced by Whitehead, elaborates in *Mind. An Essay on Human Feeling* a complex ontology in which, especially in the determination of organic matter, the category of substance is replaced by those of act and process (see [20, 18]). This ontology of organic matter leads to an articulated theory of hominization, in which the phylogenetic passage from primates to humans is read in terms of the acquisition of symbolic consciousness (or symbolic mentality). This thesis is not abstractly stated, but developed through a steady confrontation with authors who conduct first-hand research on animals, such as Wolfgang Koehler, Jakob von Uexküll, Konrad Lorenz and many others [18, pp. 55–56, pp. 65–66, pp. 142–148, pp. 164–165, pp. 193].

i. if non-human animals lack superior symbolic systems, how can we understand their semiotic interactions with the environment? and
ii. we can do this because, in marginal cases, even human beings make use of non-symbolic semiotic systems.

In the concrete development of the strategy, the choice of the marginal cases to be discussed falls on cases of missing or incomplete mastery of verbal language. Both Cassirer and Langer rely on the case studies (frequently discussed in the psychological literature of the late 19th and early twentieth centuries) of Helen Keller and Laura Bridgman, two deaf-mute girls who could learn language thanks to the use of a manual alphabet. What our authors are interested in is not only the process of acquisition of higher (linguistic) symbolic skills but the fact that, even before this step, both girls were able to act in the world with relative success thanks to associative semiotic tools. The passage from the associative phase to symbol-based experience is described in terms of a cognitive revolution: *"[Helen Keller] had previously learned to combine a certain thing or event with a certain sign. A fixed association had been established between these things and certain tactile impressions. But a series of such associations […] still does not implies an understanding of what human speech is and means. […] Then, suddenly, the crucial development takes place. It works like an intellectual revolution. The child begins to see the world in a new light. It has learned the use of words not merely as mechanical signs or signals but as an entirely new instrument of thought [the symbol]"* [17, p. 40]. Equally relevant, in the logic of marginal analogy, are the cases where the acquisition of language fails. Langer dwells extensively on the cases of the so-called wild boys, children who grew up in the wild without relevant human contact. Particularly significant is her discussion of the account left by the Enlightenment physician Jean Itard of the case of Victor, a boy growing up in solitude (it is said, aided by animals) in the French province of Aveyron [21].

In the exposition given by Langer, despite Itard's best efforts, Victor never learns the verbal language. His experience remains limited to the use of signs; such signs could even be commonly used words, but he uses them in an associative modality and with merely expressive functions. For example, he associates the French phoneme [lɛ] with a glass of milk (*lait*) but uses it only as a sign of joy: *"Victor picked up a few spoken words […]; but as he merely said them when he contemplated their objects with joy or sorrow, not when he lacked anything"* [19, p. 98]. For his part, Cassirer refers to people who, like Langer's wild boys, manage to reach only the associative level of human semiotic and cognitive faculties. This limitation allows them to acquire only a low level of behavioral competence: *"patients suffering from aphasia or other kindred diseases […] can perform the task of everyday life; some of them even develop considerable skill in all test of this sort. But they are a complete loss as soon as the solution of the problem requires any specific theoretical or reflective activity. They are no longer able to think in general concepts or categories. Having lost their grip to universals, they stick to immediate facts, to concrete situations. […] Without symbolism the life of man would be like that of the prisoners in the cave of Plato's famous simile"*

[17, pp. 46–47]. If the last statement is true, however, then non-human animals are regular guests of that cave that human animals visit only under particular conditions.

Finally, the recourse to marginal analogy is particularly evident where, in order to show how signs-based cognition can work in non-human and human animals, Langer refers to habits and repeated actions that we can easily track in the human repertoire: *"The interpretation of signs is the basis of animal intelligence. Animals presumably do not distinguish between natural signs and artificial or fortuitous signs; but they use both kinds to guide their practical activities. We do the same thing all day long. We answer bells, watch the clock, obey warning signals, follow arrows, take off the kettle when it whistles, come at the baby's cry, close the windows when we hear thunder. The logical basis of all these interpretations, the mere correlation of trivial events with important ones, is really very simple and common […]. It is the most elementary and most tangible sort of intellection; the kind of knowledge that we share with animals […]. Its mechanism may be conceived as an elaboration of the conditioned-reflex arc"* [19, pp. 47–48]. This clear passage contains some unsolved issues:

i. firstly, it questions the sense in which human signs-based conduct can be called marginal. Langer's statement that *"we do it all day long"* tells us that this behavioral modality is, indeed, marginal for the definition of what is properly human (which remains linked to the use of symbols and representations) but is very frequent at the behavioral level. Signs-based experience seems to be a lower functional system, always active (or ready to act) when conscious symbols-based reflection is not required. Human beings, as it were, continuously oscillate between these two functional systems. Let us assume we are in front of the STOP road sign: if we are in *sign mode,* we limit ourselves to stopping (without any need to think about the *meaning* of the English word 'to stop,' so much so that the sign can also be learned and used by people who do not know this language). If we are in *symbolic mode,* instead, the meaning of the verbal sign makes its way into our mind, looking for points of contact with the rest of our conscious life—let us imagine, a little poetically, a person who is about to commit suicide and reads a symbolic message in the STOP road sign (s)he meets on her/his way. If this is the case, however, then the peculiarity of humans is not only the possibility of having recourse to the symbol but the constant switch between two semiotic worlds of experience. This thesis, which we do not have the possibility of deepening here, should be considered the core of possible philosophical anthropology: the human being would not be the symbolic animal but an animal endowed with semiotic plasticity; and
ii. secondly, the closing of the quotation allows us to highlight the conceptual continuity that runs through all theories of the qualitative difference of humans (a point that we will resume in the concluding remarks). Langer qualifies sign-based behavior as reducible to reflex reactions; reflex arc, so to speak, seems to be the hidden mechanism governing animal action. In addition to bringing us back to the Cartesian idea of the animal as a machine, this statement

by Langer seems to contradict many of the efforts that, in other points of her works [18, p. 108], she makes in order to recognize higher cognitive abilities (exploratory behaviors, rudiments of symbolic mentality in apes, etc.) at least to some non-human animal species. It, however, should not be surprising. As we have already pointed out, a thesis as strong as that of the qualitative otherness of humans brings with it, as a hardly controllable side effect, a whole series of simplifications and potential devaluations of animal experience.

Conclusion: How to Depart from Marginal Analogy—Animal Cognition as a Field of Diffuse Discontinuities

In a hypothetical general overview of the theories on animal cognition proposed by philosophers throughout Western thought history, the theories based on the qualitative difference of humans and defended through the argumentative strategy of marginal analogy would turn out to be the majority. Their logical core, which we have tried to highlight in this chapter, affirms a radical discontinuity between human and non-human animals, based on the possession by the former of ontologically and/or cognitively unique faculties. As a side effect, non-human perception, behavior, and cognition appear as a domain run by lower functional systems (reflexes, associative semiotics, instincts).

To be sustainable, this thesis needs to convince the opponent of the effectiveness for practical purposes of the lower functional system. To this end, the recourse to marginal analogy is very opportune: if, in marginal cases, human animals can act even in the absence of the higher faculties that distinguish them, why not read the entire animal behavior as a generalization of these cases, as an uninterrupted permanence in a condition of missing or scarce rationality, reflection, verbal skills, symbolic mentality, and so on?

As we have seen, the Cartesian analogy between animal behavior and reflex actions in humans (later strengthened in the idea of animal instinct as chains of reflexes) runs like a red thread through many modern and contemporary theories of humans' qualitative difference. We have seen it reappear in Cassirer and Langer, in a semiotic version that links reflex behavior to the associative usage of signs. However, we could have analyzed, with equal legitimacy, Heidegger's theory of the animal Umwelt as a *disinhibiting ring* [22, pp. 253–257]. Heidegger makes no secret of moving from a robust version of the qualitative otherness of the human being. According to him, openness to being makes humans an ontological *unicum*, whereas non-human animals dwell in a condition of "captivation," in which external entities are inaccessible as such and interact with animal life form only as a "ring" of disinhibiting stimuli [22, pp. 136–246]. Heidegger's idea of non-human animals as "captivated" beings is reminiscent of Descartes' sleepwalker condition (and of the Platonic cave evoked by Cassirer); similarly, his view of the animal's condition of steady inhibition, interrupted only by the impact of the disinhibiting stimuli, appears to our eyes as an upgrade of the view of the animal as a machine.[2] Finally, we could have found clear cases of marginal analogy, functional (as usual) to the thesis of the qualitative difference of humans, in that group of theories that (relying on Frans de Waal) we can define as "veneer theories" [23, p. 19]. Frequent in moral research and well represented in common sense and popularized science, these theories aim at explaining the outbursts of human aggressive and destructive behavior as the re-emergence of an original layer of animality, which the subsequent "patina" of civilization can only hidden. Again, we meet here the idea of the double functional system; and, again, the possibility opens up of considering the whole animal behavior in analogy with those of human actions that seem entirely *instinctive*, spontaneous, and natural (in analogy, in short, with the way we would act *etsi cultura non daretur*).

The aim I pursue in these conclusive remarks, however, is not to provide a review of all theories of the qualitative difference of humans that can be found in Western thought but to indicate some guidelines for their critical evaluation. The first one is the (already expressed) recommendation to unveil the hidden analogies that contribute so much to our acceptance of the "poor" descriptions of non-human animals' behavior and experience (on the possibility to give, for the same animal behavior, both "rich" and "poor" descriptions [24]). The second critical guideline consists in showing some advantages of the theories that reject the model of animal life as a homogeneous field, in which only humans stand out for their otherness. We are not referring here to gradualist theories of the Darwinian or neo-Darwinian matrix (according to which the higher faculties of humans are nothing but a quantitative enhancement of animal faculties) but to a much smaller but up-and-coming group of theories. These views of animal life can be named as theories of diffuse discontinuities [25]. Without rejecting *in toto* the thesis of the qualitative otherness of humans, such theories argue that the discontinuity that separates humans from other forms of life is not the discontinuity *par excellence* but rather one of the many qualitative differences widespread in the realm of the living being. If considered in this way, we can investigate the discontinuity between human and non-human animals without producing the deleterious side effect of making the entire field of animal behavior and cognition homogeneous. Furthermore, this perspective is entirely compatible with evolutionism, insofar as contemporary evolutionism admits the limits of gradualism and the need to admit discontinuities and level jumps in the course of evolution itself.

The theories pivoting on the idea of diffuse discontinuities are often diverging from each other in other respects. Examples include contemporary authors belonging to different disciplinary fields: a neovitalist in biology (Jakob von Uexküll), a Gestalt psychologist (Hans Volkelt), and a philosopher of the mind

[2] Heidegger does not resort explicitly to the strategy of marginal analogy, maybe because he is aware of its risks and disadvantages. In any case, his recurrent juxtaposition between the animal condition of captivation and the ontological state of the profound boredom in humans (even if accompanied by the philosopher's warning that it is not the same phenomenon) leaves the reader with the impression that, from a philosophical point of view, it is perfectly justifiable to speak of animal cognition inside a discussion of the ontologically defective modalities of the *Dasein* [22, pp 160–180, pp 279–282].

(Thomas Nagel). Despite the diversity of their general approaches, they share as a basic coordinate the idea that each animal species builds up a world of subjective experience that is qualitatively different from that of other species. Their refusal of the analogical procedure rests on a basic assumption that can, at first sight, sound paradoxical: the analogy is not only misleading but ultimately superfluous because it is possible to define a unitary field of experience *inside which* there can be discontinuities. For Nagel, Uexküll, and Volkelt, this unitary field that has to be preliminarily delimited is conscious subjectivity. They understand it differently, but (and this is what counts most) all three give of subjectivity a minimal and flexible definition so that the resulting field of inquiry remains open to the greatest possible number of internal differences—among which, without any privilege, that between *homo sapiens* and the other species. It is useful to provide here at least two examples of their minimal definitions: for Nagel, there is subjectivity whenever we face a form of life for which the question makes sense: *"what is* like *to be that organism?"* (emphasis by Nagel) [26, p. 436]. For Uexküll, subjectivity spikes in the presence of any transcendental (i.e., a priori) tool used in the construction of a species-specific world of experience (or Umwelt) [27, p. 3; 28, pp. 107–114].

As anticipated above, in this group of theories, animal cognition appears as a field of discontinuities but also as a domain that is sufficiently well defined to allow for a non-analogic study approach. In this approach, the inner aspects of animal behavior are accessed in an indirect way, through the animals' physiology and observable behavior: *"We cannot deny"*—writes Uexküll—*"that [in biology] we may come across completely unknown stimuli, which we become aware of only through the animals' reactions"* [29, p. 12]. With the caveat, however, that an underlying extraneousness will remain, that animal life can be *"a fundamentally* alien *form of life"* (emphasis by Nagel) [26, p. 438; 30]. The species-specific otherness of animal experience does not consist only in the presence of different sensory fields, as seen in bats when echolocating or in some migratory birds sensitive to the earth's electromagnetic fields. Discontinuities can rely on a cognitive or (to use a Kantian concept) "categorial" organization of the mental contents radically different from ours. For Volkelt, for instance, the observation of the predatory behavior of the crusader spider (*Araneus diadematus*) leads to the hypothesis that its experience relies on a different categorization of the perceived data. In particular, its lived experience would lack the "thingness [*Dinghaftigkeit*]" [31, p. 41]—that is, as happens in conscious human life, the structuring of perception into stable and discrete entities and according to the substrate-quality categorical pair. We cannot here reproduce the arguments with which Volkelt comes to clarify his view. However, we can enunciate their key result: the conscious experience of the crusader spider is devoid of "thing-constants" and, instead, organized by "overall situations [*Komplexqualität*]," in which "only the whole, and not the particular, is phenomenologically present" [31, p. 69]. The animal would orient its action not based on the change in the qualities of well-limited things but the alteration of the "atmospheres," "colorations," or nuances of the overall perceptive situation [31, p. 90]. A similar, non-analogical conceptual effort to enter the alien worlds of animal experience is also characteristic of Jakob von Uexküll's approach. His reconstruction of the subjective Umwelt of the tick guides the reader into an alien silent universe, empty of unitary things and in which, alternatively, rare tactile and olfactory stimuli ignite [32, pp. 44–50].

These theories, based as they are on the model of the diffuse discontinuities, renounce any (direct or marginal) analogical arguments; in doing so, they succeed in opening phenomenologically new worlds. We can indeed transpose ourselves only partially into these dimensions; as Nagel writes, *"my realism about the subjective domain in all its forms implies a belief in the existence of facts beyond the reach of human concepts"* [26, p. 3]. At the same time, however, these alien worlds of experience challenge us to grasp *Erlebnisse* that has no analog in our conscious experience. Indeed, both Volkelt and Uexküll use metaphors to qualify the animal way to organize perception, for instance, comparing it to a "melody" of perceptive contents [27, pp. 77; 31, pp. 190–191; 32, p. 126]. A metaphor, however, is not an analogy: it conveys otherness but without flattening it on what is already known. Analogy, including the cases of marginal analogy we have discussed above, tends to suppress our wonder for animal cognition diversity. On the contrary, if coupled with rigorous observation, metaphors make it grow and allow us an insight into the rich otherness of other species' subjective point of view on reality, an otherness we should consider and preserve as an integral part of the biodiversity of our living planet.

Core Messages

- Analogical approaches can be misleading not only when they concede too much to non-human animals but also when they give them too few.
- Animal life is a field of discontinuities crossed by a plurality of qualitative differences.
- That between human and non-human animals is one qualitative difference among many others.
- The wonder we feel about non-human life forms should never disappear from our theories on animal behavior and cognition.

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Homo Pictor: A Philosophical Enquiry into the Origins of Human Thinking

4

Roberto Franzini Tibaldeo

> *"A word devoid of thought is a dead thing, and a thought unembodied in words remains a shadow"*
>
> Lev S. Vygotsky

Summary

The chapter inquires into the human condition from a philosophical-anthropological perspective to clarify the human being's distinctive faculties and qualities. It shall be argued that the capacity to think plays an essential role in this regard. Hans Jonas' reflections are of great help to achieve this goal since his account of the human specificity is pivoted on the eidetic and symbolic experience, which equips the human being with a unique degree of freedom and with capabilities like imagination, reflection, and speech, which are connected to thinking. Indeed, these capabilities exhibit the multidimensionality of the experience of thinking, which can be fruitfully clarified thanks to philosophy's critical and meta-reflective approach.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_4

Imaginative thinking: inherent sight.
[Adapted with permission from the Health and Art (HEART), Universal Scientific Education and Research Network (USERN); Painting by Arshida Karami.]

Keywords

Hans Jonas · Human being · Image · Imagination · Philosophical anthropology · Reason · Reflection · Speech · Thinking · Understanding

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's

keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

This chapter aims to inquire into human uniqueness, whose most prominent signs are imagination, reflection, and speech. Indeed, these capabilities exhibit the multidimensionality of the experience of thinking. The approach I adopt is philosophical and relies on a perspective generally understood as "philosophical anthropology"—or better "philosophische Anthropologie," since it has its origins in Germany in the first half of the twentieth century thanks to scholars like M. Scheler, A. Gehlen, H. Plessner and A. Portmann [1]. Philosophical anthropology is a "discipline within philosophy that seeks to unify the several empirical investigations of human nature in an effort to understand individuals as both creatures of their environment and creators of their own values" [2]. These scholars deal with controversial biological-philosophical issues, like the difference between living and inanimate beings, the relationship between life and matter, the place of the human being in the material world, etc., in an epoch of scientific crisis dominated by two opposed—albeit unsatisfactory—viewpoints, namely evolutionism and neovitalism. According to the first, life (including human life) can be explained in purely materialistic and mechanical terms; on the contrary, according to the second view, life is ontologically different from matter and essentially transcends it. Philosophical anthropologists generally strive to find a third way or "the golden mean" [3, p. 77] between monistic reductionism and ontological dualism. They strive for an overall reinterpretation of the living beings and their behavior capable of overcoming mechanic reductionism and for a more comprehensive idea of life, organism, and human being. They also aim to overcome various types of dualisms regarding the human experience (internal and external, mind and body, *psyche* and *soma*) thanks to a different method of inquiry, namely understanding the human being through the analysis of his/her bodily experience and through a comparative approach with other living beings.

Also, the German-born philosopher of Jewish origins Hans Jonas (1903–1993) contributes to this joint effort. Indeed, the "philosophical biology" [4, 5, p. 105] he develops in the second half of the twentieth century shows that the phenomenon of life is thoroughly misunderstood by both dualistic and monistic reductionistic perspectives. And yet, life is the most eminent feature of being. What is required to understand it thoroughly—states thus Jonas—is a change of paradigm and a renewed way of understanding life. Jonas refers to this rediscovery as an "ontological revolution" [6, p. 222, 226; 4, p. 81; 7] capable of changing our idea of life radically from its simplest form—namely, organic metabolism. Its "ontological" feature depends on the fact that renewed research starting with the organic metabolism may lead to understand the ontological characteristics of life, and to the renewal of science.

Now, in Jonas' inquiry into life, the role played by the human being is indeed central, since it is the human being who carries out this inquiry and at the same time is part of and involved in the research, because he/she inevitably has, or better, *is* a living body. And, according to Jonas, the organic and living body "is the memento of the still unsolved question of ontology, 'What is being?' and must be the canon of coming attempts to solve it" [4, p. 19]. Thus dualism is programmatically rejected.

On the other hand, the human being is a result of evolution, which is a process that cannot be denied, but whose interpretation requires to go beyond a mere Darwinian viz. materialistic-mechanistic and instrumental account [3, p. 76]. Providing a comprehensive portrait of evolution and of the human specificity—i.e., neither in simply monistic nor dualistic terms, but explained in the light of "a new, integral, […] philosophical monism" [4, pp. 16–17]—is indeed Jonas' main aim. As we shall see, this entails achieving a renewed view of how human features like imagination, reflection, and speech—in a word, thinking—rely on the evolutive adventure of life.

Jonas' Philosophical Account of the Human Specificity

It must be said that Jonas does not wish to carry out a biological inquiry but a philosophical interpretation of biological facts. Therefore his philosophical account of the human specificity does not lay claim to being a genealogical account of how organic life gave birth to the human being. Quite the contrary, Jonas begins with a historical phenomenon (the prehistoric appearance of 'human' artifacts). He inquires into its prerequisites (the existence of living beings endowed with the capability to produce such artifacts), which ultimately rely on a specialization of the basic dynamic of life. So, to fully understand Jonas' position, it is necessary to contextualize Jonas' anthropology briefly in his overall philosophy of life.

In various passages of his work, when it comes to stressing the distinctive feature of human beings, Jonas uses the expression "imago Dei."[1] This expression is interesting for two reasons: first, the "imago Dei" is traditionally invoked to contrast humanity with the rest of nature, namely to underline the human being's uniqueness and irreducible metaphysic specificity [see esp. p. 269–274 in 4]—and this is indeed what Jonas endeavors to achieve [4, p. 175], although not in the dualistic

[1] This reference does not at all imply that Jonas' philosophical reflection ultimately relies on religion [see for instance 8]. Jonas cannot be classified as a religious thinker, although he reappraises tradition by making a philosophical use of religious concepts.

sense of ontological separability and independence of the human essence from matter; second, the "imago Dei" refers to the human being's "appearance" or "form" [4, pp. 167, 185–186]. Indeed *form* is a core aspect of Jonas' phenomenology of perception and anthropology, as related to the overall "philosophical biology," where the dynamism of the "living form" plays a role of paramount importance. In what sense?

Basically, according to Jonas, any living being is characterized by an "organic form," which stands in a "dialectical relation of *needful freedom* to matter" [4, p. 80]. This "basic situation of freedom" [4, p. 83] relies on the following features:

i. dependence and, at the same time, "a certain independence of organic form with respect to its own matter" [4, p. 81];
ii. the organism's "emancipation from the type of fixed self-identity that is matter's, to give scope to a different, viz., mediate and functional, kind of identity" [4, p. 81], namely an identity "which from moment to moment reasserts itself, achieves itself and defies the equalizing forces of physical sameness all around," and which "is truly pitted against the rest of things" [4, p. 83];
iii. the organism's need of the world in order to exist, persist, and renew itself—this means that the organism's being and selfhood, "suspended in possibility, is to be actualized by the *use* of the world" [9, p. 196]; and
iv. the organism's need to develop "means of survival" to bridge the spatial–temporal gap between itself and the world [9, p. 196, 204].

As a result, the "basic situation of freedom" characterizing organic form reveals a "polarity of self and world, of internal and external, complementing that of form and matter" [4, p. 83], which cannot be successfully understood neither in monistic nor in dualistic terms. In a word, organic freedom is characterized by an opposing and dialectical dynamic, which reveals the organism's tendency to *transcend* itself by going "constantly *beyond* the given state of things" and "beyond the given condition" [9, p. 197]. At the same time, this outward dynamic is complemented by an interior one, namely "inwardness or subjectivity," which imbues "all the encounters occasioned in its horizon with the quality of felt selfhood, however, faint its voice" [4, p. 84]. In this sense, the organism's self-concern and self-centeredness "at the same time bridges the qualitative gulf to the rest of things by selective modes of *relation*" [4, p. 84]. The result of this dual continuous process is "organic form," whose meaning cannot be simply reduced to dependence, although its existence certainly relies on this feature [4, p. 80]. Life thus depends on a deep change and a revolution in the relationship between form and matter, since "form becomes the essence, matter the accident" [4, p. 80].

Moreover, according to Jonas, the organism's "opening into an environment" and "having a world" carries the evolutive "promise of higher and more comprehensive stages" of life [4, p. 83, 106]. What is envisaged here is that thanks to self-transcendence, the organism's striving for self-preservation somehow leads beyond itself by opening to the broad phenomenon of evolution, which ultimately culminates in the human being. In other words, the revolutionized, dynamic, and dialectical attributes related to the primary level of life, defined by metabolism and organic form, also characterize the more complex levels of life, including the human. Jonas achieves this result by extending the organic dynamics of self-transcendence to the overall phenomenon of life. In this sense, Jonas' innovative anthropological reflections are the key to understanding both the human being's integral belonging to the living world and his/her irreducible difference.

Let me briefly recall how Jonas describes the 'progress' within the evolutive dynamic of life. On the one hand, different species share the same basic biological pattern, while, on the other hand, they are characterized by a thorough discontinuity. So, in addition to the basic discontinuity of the organic individual as regards inorganic matter, life manifests a discontinuity of a different kind *within* its own domain, which is related to the fact that individuality admits of a "more-or-less" and is thus a matter of degree [9, p. 204]. The discontinuity within organic life relies on dissimilarities in *mediacy* and *distance*; this is to say that living beings need to bridge the gap between self and world to survive [9, p. 204]. According to Jonas, the disparate degrees of individuality rely on the specific means of survival developed by organic individuals in order to exist and cope with the dialectic of mediacy and distance. For instance, as regards animal life, Jonas states that:

> The spatial gap between subject and object, which is provisionally spanned by perception, is at the same time the temporary gap between need and satisfaction that is provisionally spanned by emotion (desire) and practically overcome by motion. All three modes [perception, emotion, motion] express the mediacy of animal being, or the split between self and world—a qualitative widening of the split which metabolism opened first, and which is thus at the root of life. The lesser integration of the animal into its environment as compared to the plant, of which these modes of mediacy bear witness, is a measure of its greater individuality [9, p. 204].

This evolutionary plurality of means of survival developed by life is but another essential feature of life's own essence [9, p. 196; 4, pp. 90–91, 106]. "Freedom" and correlated "desire" are the concepts Jonas employs to clarify this evolutionary dialectic, which—as we shall see shortly—characterizes, although with a radical discontinuity, the human being too.

According to Jonas, human specificity in contradistinction to other living beings resides in a "more-than-animal" and "symbolical" feature [4, p. 158]. However, it is also true that between animal and human capabilities, there are "fluid boundaries" [3, p. 79]. To be sure, the possibility of distance-taking from the biological level must, to certain degrees, "be credited even to some higher animals" [4, p. 170]. According to Jonas, these capabilities arise "with higher sense-perception as such (i.e., prior to man)" [4, p. 178], and especially thanks to *sight*, the "noblest" of all senses, due to the unique role played by sight "in the higher mental performances […] in the case of man" [4, p. 136].[2] However, what guides animals is a fixed behavior pattern, something automatic and entirely confined within the "realm of

[2] Indeed, sight "contains trans-animal potentialities of beholding and attitude which a higher mental faculty can actualize" [4, p. 184].

animal necessity" [3, p. 79] that human beings can invoke no more. Why not? Because the human being "is one that indulges in the making of useless objects, or has ends in addition to the biological ones, or can serve the latter in ways remote from the direct usefulness of instrumental things" [4, p. 158]—in a word, the human being has enhanced in a unique way organic freedom and the related potential to transcend the given state of things.

How does Jonas justify this statement? He focuses on three specifically human features:

i. the capacity to produce and use artificial "tools" [3, pp. 78–79];
ii. the "image faculty" as a "further degree of mediacy" distinguishing humans from animals [4, p. 184]; and
iii. finally, a "threshold to a further mediation," which is achieved thanks to "reflection" [4, p. 185].

First, *tool creation*: although it is still "very closely connected with the realm of animal necessity," tool creation is indeed something new viz. human, since "it serves animal needs in a supra-animal manner" [3, p. 79]. Second, the *image faculty*, namely the specifically human capacity to make and behold images, which are different from tools. But what is an image, and why is it so important to Jonas' account of the human specificity? An image is both an internal and an external entity characterized by a series of properties such as likeness, intentionality, incompleteness, selection, alteration, visibility, symbolic detachment, and ontological difference [4, pp. 159–165], which are fully developed by human beings only. Images rely on sight, a sense organ that the human being shares with other animals. But there is also an important difference: although all animals endowed with movement and sight are somehow capable of image perceiving [4, pp. 135–156], only human beings are capable of perceiving images "in a certain way" [4, p. 165]—namely *as images*. What does this mean exactly? By actualizing the evolutionary potentials related to sight [4, p. 152], human perception evidences the achievement of a new capability, namely the faculty "of separating *eidos* from concrete reality, or form from matter" [4, p. 167]: "The image becomes detached from the object, that is, the presence of the *eidos* is made independent of that of the thing" [4, p. 170; see also 10]. So, what truly distinguishes the human being is the capacity to cope with the challenges of survival and bridge the gap with the world by developing "eidetic freedom," namely the capacity to produce internal and external images. This twofold possibility relies on the "eidetic control of imagination" and the "eidetic control of motility," respectively:

> What we here have is a trans-animal, uniquely human fact: eidetic control of motility, that is, muscular action governed not by set stimulus-response pattern but by freely chosen, internally represented and purposely projected *form*. The eidetic control of motility, with its freedom of external execution, complements the eidetic control of imagination, with its freedom of internal drafting. Without the latter, there would be no rational faculty, but without the former, its possession would be futile [4, pp. 172–173].

From the moment the *homo* develops the image faculty, he/she quits the kind of freedom and mediacy characterizing animality and initiates a qualitatively different viz. *symbolic* experience, in which new capabilities are developed:

> Imaging and speaking man ceases to see things directly: he sees them through the screen of representations of which he has become possessed by his own previous dealings with objects […]. Their greatest role, however, lies in between experiences, when the actual object is not present for direct perception: then the abstracted images that are at the command of the subject provide in themselves the material for an 'experience' at a remove —symbolic experience, in which the world is taken hold of without imposing its presence [4, pp. 184–185].

However, "true man" viz. the very human peculiarity fully appears only thanks to a further step in the dynamic of human mediacy involving the relationship between image faculty and *reflection*, which generates a further radical turn in the basic dynamic of life:

> The fateful freedom of objectification, which confronts the self with the potential sum total of the "other," the "world," as an indefinite realm for possible understanding and action, can and eventually must turn back, with its burden of mediacy, upon the subject itself and make *it* in turn the object of a relation which again takes the detour via the *eidos*. The "form" here involved is different in kind from those of the whole realm of outwardness, for it concerns the self's *relation* to all outwardness. The new dimension of *reflection* unfolds, where the *subject* of all objectification appears *as such* to itself and becomes objectified for a new and ever more self-mediating kind of relation. With the first asking of the question, What is man's, what is my place and part in the scheme of things?, the self becomes engulfed in the distantness in which all things are kept by man and from which they have to be retrieved in acts of eidetic intentionality [4, p. 185].

According to Jonas, the human artifact embodying reflection is the *grave*, which evidences the human being's social and interpersonal trait (Jonas stresses the social act of commemorating the dead—[3, p. 83]), as well as the capacity to transcend the state of given things thanks to the belief and open resistance to the world: indeed, common to the cult of the grave and the related beliefs "is that they somehow defy our apparent mortality, pointing beyond what is visible to the invisible, from the material to the immaterial. The grave bears visible testimony to this defiance" [3, p. 83]. As a result, image faculty and reflection play a core role in human life, since "Man models, experiences, and judges his own inner state and outward conduct after the image of what is man's. Willingly or not he lives the idea of man —in agreement or in conflict, in acceptance or in defiance, in compliance or in repudiation, with good or with bad conscience. The image of man never leaves him, however much he may wish at times to revert to the bliss of animality" [4, pp. 185–186].

Implications of Jonas' Account for the Clarification of 'Thinking'

What I find interesting in these reflections by Jonas is firstly that if the human being had not integrally belonged to life and had not been connected to the world through bodily experience, he/she would not have become human at all [see also p. 246 in 9]. Secondly, being human entails preserving this peculiar bodily and worldly-connected experience [see also 11]. Thirdly, if the "homo" had not been primarily "faber," but especially "pictor" viz. "symbolicum," he/she would not have developed into "sapiens" [3, p. 79, 82; see also 12].[3] Finally, Jonas' reflections shed light on the mutual connections between human faculties and qualities—like imagination, reflection, and speech –, which characterize thinking.

I would like to add something in this last regard. What is thinking? Instead of beginning with an abstract definition of 'thinking' equipped with certain features to be examined,[4] I choose a different path, which is more coherent with Jonas' philosophical-anthropological approach. Namely, I assume that thinking is the human being's distinctive trait, and I endeavor to show how it relies on the previously analyzed qualities of the human phenomenon. For this purpose, Jonas' reflections prove once again to be quite useful.

Let me briefly return to the three human artifacts mentioned by Jonas: tool, image, and grave. They reveal something about the being that produces and uses them, and they show how he/she copes with and understands the world—in a word, they exhibit the kind of freedom enjoyed by that being: "These are basic forms in which man, in uniquely human fashion, answers and transcends what is an unconditional given for man and animal alike. With the tool he surpasses physical necessity through invention; with the image, passive perception through representation and imagination; with the tomb, inescapable death through faith and piety" [9, p. 252]. May not invention, representation, imagination, and even faith and piety be but understood as potential dimensions of thinking, and this is especially in the light of the disciplines and the related practices that actually stem from them—namely technology and physics, art, metaphysics, and history [3, p. 84–85]? What is more, in his study in the phenomenology of the senses, Jonas details the role played by bodily sight in the higher mental performances as follows: there are "virtues inherent in sight" which provide "the ground for some basic concept of philosophy. *Simultaneity of presentation* furnishes the idea of enduring present, the contrast between change and the unchanging, between time and eternity. *Dynamic neutralization* furnishes form as distinct from matter, essence as distinct from existence, and the difference of theory and practice. *Distance* furnishes the idea of infinity. Thus the mind has gone where vision pointed" [4, p. 152]. That is to say, a

[3] By the way, this statement has been recently validated thanks to the archaeologic discovery in South Africa of a 73,000-year-old "abstract drawing" [13].

[4] Indeed, the very definition of 'thinking' is contested, also because there are many recognised types of thinking, like critical thinking, problem solving, decision-making, higher-order thinking, creative thinking, caring thinking etc. [see for instance 11, 14–16].

thinking-related effort like philosophy and the concepts it uses, like time, eternity, duality, and infinity, rely on capacities provided by bodily sight and then actualized by the human being.

I would like to spend a few more words on the centrality of the *homo pictor* to thinking and then on the relationship between thinking and speech. As previously mentioned, Jonas states that without the image-making ability, entailing "the eidetic control of imagination, with its freedom of internal drafting," the human being would not have developed any "rational faculty" [4, pp. 172–173]. However, he also warns not to overlook the "real qualitative *novelty*" [17, pp. 67–69] and the difference between image-making and thinking, since "man's image-making ability […] is not simply synonymous with 'thinking' but rather supports and enhances it through playful imagination" [3, p. 78]. On the other hand, Jonas' philosophical inquiry highlights that thinking relies on a *qualitatively* peculiar kind of freedom (i. e., eidetic freedom), which provides the human being with the unique capacity to recreate and "ponder things in the imagination" [3, p. 81] and thus transcend the world. At the same time, the *homo pictor* is still connected to the world, not only because he/she is a living, perceiving body, but also because his/her 'eidetic' capability submits to the criterion of truth: "An image can be more or less true, i.e., faithful to the original. The intention to depict an object acknowledges it as it is and accepts its verdict on the adequacy of the pictorial homage thus expressed" [3, p. 81]. By the way, in this sense, the *homo pictor*'s 'eidetic' capability is the precursor of both "verbally descriptive truth" and "scientific truth" [3, p. 81].

The reference to "verbally descriptive truth" alludes to speech—undeniably, "man's most outstanding trait" [3, p. 77]—, whose meaning and relationship to thinking is now time to investigate further. As we shall see, the inquiry into speech furnishes the *homo pictor* with additional thinking capacities enabling him/her to flourish as a human being. In brief, speech reveals the human being's capacity to transcend actual reality by means of communication, interpersonal recognition, and understanding. Let us follow once more Jonas' meditations, which reaffirm the belonging of the human being to organic life, and especially to the domain of animality, which is characterized by perception, emotion, and motion:

> *Animal life is expressive*, even eager for expression. It displays itself; it has its sign codes, its language; it communicates itself. Whole rituals of posture and gesture and expressive movement serve the role of signals before the action or take its place, making the action itself unnecessary, if warning was to be conveyed. Such spontaneous but strictly fixed symbolism counts on its being understood; untaught, animals do understand the mimics of aggression, anger, and sexual courtship. It would be foolish to except man from all this [9, pp. 245–246].[5]

Like the animal, the human being is an expressive being who communicates, although in a more mediated and spontaneous way, relying on the previously analyzed eidetic freedom. What is more, the human being seems to develop this expressive and communicative trait in two specific directions: the first is the *homo*

[5] As regards the animal's expressive nature and behaviour, see the wonderful and detailed account provided by Adolf Portmann [18].

pictor's intention to express him/herself in his/her paintings; the second is the human being's interpersonal intentionality and willingness to communicate with someone else to achieve a certain goal. Recent findings in developmental and comparative psychology seem to confirm the centrality of this kind of intentionality to mutualistic cooperation and the related development of humans' species-forms of cooperation, as well as their unique forms of cognition, communication, and social life [19, 20]. What is more, according to this line of research, shared intentionality relies on the specifically human configuration of gaze, eyes, and sight, which gave birth to the so-called "cooperative eye" [21]. It is thus true that—to paraphrase Jonas—mind, thinking, and human behavior have gone where vision pointed.

But what about speech in particular? To some extent, language is already encapsulated in the previously mentioned human features since understanding, imagination, and speech are closely connected in that they rely on the human capacity to deal with possibilities and potentialities mediated by symbols rather than with sheer actualities [9, p. 247]. However, what *reveals* this human capability is precisely language: "the very use of *language* for the generation of psychological novelty—an actual enlargement of the soul's estate—depends on this transcending trait of our nature by which we are always indefinably more than our present being" [9, p. 247]. That is to say that speech sheds light on the human being's "self-transcending feat" [9, p. 257], while simultaneously recalling that being human "takes place on the base and within the bounds of that abiding common humanity which is somehow always at our call" [9, p. 257]. Indeed, as significantly pointed out almost a century ago by Lev Vygotsky, not only human development and interpersonal-linguistic communication are structurally and dynamically intertwined, but the first somehow relies on the second [22, 23]. In this regard, Jonas' philosophical inquiry includes a further caveat about reductive interpretations of language and thinking, like the one proposed by the German-born art theorist and perceptual psychologist Rudolf Arnheim, according to whom human thinking cannot go beyond the patterns supplied by the human senses, since it takes place in the realm of the senses exclusively [24, p. 233; 9, pp. 224–236, and esp. 230]. To be sure, we know that according to Jonas, "true man" relies on the *homo pictor* and that thought and speech rely on the image faculty. However, as soon as the thinking and speaking human being makes his/her evolutive appearance, it is absolutely clear that he/she has somehow gone 'beyond' the *homo pictor*, just like thought and speech have somehow gone 'beyond' perception and sight. This is how Jonas summarises the meaning of this specifically human capacity to 'transcend' actual reality: "language […] superimposes on it [= perception] a realm of pure signification, non-pictorial, free from the bonds of likeness, and therefore the genuine vehicle for intellectual, suprasensible thought" [9, p. 231]. Consequently, those who overlook the meaningful difference between language and perception encounter a serious problem: what do they "make of so simple a statement as 'You shouldn't have done this'? And what of the sentence I once heard, to my unforgettable delight, a four-year-old girl just back from an errand to the grocer's address to her mother: 'If you had given me a larger basket, I could have brought more things'? I still remember the dazzling light this shed for me on the human mind: its transcendence and freedom, distinct from animal mentality not by degrees but by a qualitative leap" [9, p. 232].

A final remark is on the dynamic of transcendence and freedom, which has proved to be central to developing the human being's capacity to think. For sure, thinking is synonymous with rationality. But what about reason's "dark side" [25], namely irrationality? Is it synonymous with a lack of thinking? Surely not, unless we want to relapse into a dualistic and unsatisfactory account of human affairs. An effective way to deal with this delicate issue is to recall Jonas' dialectical and dynamic account of life and see how it applies to the *homo pictor*: thanks to the development of the image faculty, the *homo pictor* achieves a qualitatively new viz. eidetic way of transcending reality and dealing freely with it. Now, the point is that this distantiation from actual reality thanks to the qualitative enhancement of the *homo pictor*'s freedom is precisely where the basic dialectic of life gives finally rise to the *ambiguity* of the human condition—which is open to either hope or despair, truthfulness or deceit, good or evil, etc.[6] –, and to the related need of *ethical inquiry* and *education* [15, 19, 27–33]. As a result, all human traits and capacities, including thinking, evidence an intrinsically twofold and ambiguous nature, and human beings ought to carry the weight of this burden.

Conclusion

In this article, with the help of Hans Jonas, I carried out a philosophical-anthropological inquiry into the human condition to clarify distinctive features, like imagination, reflection, and speech, which exhibit the multidimensionality of human thinking. Despite its transcendent and abstract appearance, the capacity to think relies on a dual dynamic of freedom and necessity, distance and mediacy, and transcendence and dependence, which characterizes life as a whole. Moreover, human thinking stems from the evolution of life and depends on the human being's bodily experience. On the other hand, what sheds light on the peculiarity of the human experience of thinking is precisely a qualitative discontinuity in the phenomenon of life. Especially the *homo pictor*'s capacity to perceive and make images is the prerequisite to understanding the kind of imaginative freedom enabling him/her to actualize the potentialities related to his/her biological condition. And then it is thanks to a reflective turn in the *homo pictor*'s eidetic freedom that we can understand his/her becoming fully human, namely capable of reflecting, speaking, recognizing and being related with others, and thinking. Rather than focusing on these capabilities separately, I tried to show their mutual and dynamic connections, to shed light on the multidimensionality of human thinking: the image faculty provides a basic bodily connection to the world and supports and enhances

[6] It is worth noting that more or less in the same years as Jonas, the American literary theorist Kenneth Burke proposes a similar definition of the human being as a "symbol-using, symbol-making, and symbol-misusing animal" [26, p. 6], with the aim to develop a view of art and literature as *symbolic action*.

thinking through playful and symbolic imagination; reflection and speech provide thinking with a profound interiority and a powerful capacity to transcend the world respectively; the ability to recognize and care about other beings evidences the interpersonal and social intentionality related to human thinking.

Core Messages

- Imagination, reflection, and speech exhibit the multidimensional experience of thinking.
- Thanks to bodily experience, the *homo* was able to develop image-making and image-perceiving capabilities and thus became "sapiens."
- Speech reveals the human being's capacity to transcend actual reality by means of interpersonal recognition and thinking.
- The *homo pictor*'s freedom is at the origins of the *ambiguity* of the human condition and of the need for *ethical inquiry* and *education*.

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5 Idealism and Science of Life: An Intersection Between Philosophy and Biology

Stefania Achella

"Do you see this egg? With this you can topple every theological theory, every church or temple in the world."

[1]

Summary

While scrutinizing the interchange between philosophy and the sciences in the eighteenth and nineteenth centuries about the origins of life, this paper shows how the commonality of research among different disciplines can lead to moments of great discovery and theoretical advancement. In those years, in fact, a new scientific form of knowledge is born under the name of biology, while also one of the most important philosophical movements of modern history, German idealism, flourishes. The general aim of this paper is to emphasize the richness of the dialogue between different kinds of knowledge, namely between the so-called sciences of nature and the sciences of the mind (*Geist*).

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_5

Rembrandt van Rijn, The Anatomy Lesson of Dr Nicolaes Tulp, 1632.
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Keywords

Epigenetics · Hegel · Jacobi · Kant · Organism · Preformationism · Reason · Schelling · Teleology

QR code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

Taken from an imaginary conversation between Diderot and d'Alembert, the opening quote clearly expresses the epochal transition produced in the eighteenth century by discoveries in the life sciences and, in particular, in embryology. To preformationism, according to which future life would already be included in small format in the ovum or spermatozoon, one could oppose epigenetics, which takes the living being to be the result of a development originating from natural matter and driven by an internal force. This latter claim questions the idea that human beings have been created by God: a real earthquake even within a centuries-old culture. As Diderot also points out, this is not just a scientific question. Discussing embryology involves questioning a worldview that has determined the idea of nature, human beings, and the role of God for centuries. This transformation can only really be understood as a phenomenon that involves religious, philosophical, and anthropological standpoints.

While choosing to advocate the theory of *generatio aequivoca* rather than the *univocal* one,[1] to support the claims of epigenesis rather than those of preformationism, to argue in favor of a relationship of mutual dependence between human beings and their environment, scholars take sides for a certain way of interpreting the world. Scientific discoveries in the eighteenth and nineteenth centuries involved then a repositioning with respect to religion, philosophy, and so on; however, the reverse is also true: these scientific discoveries were possible thanks to the progress urged in more general epistemological terms by humanities, particularly within philosophy. This explicit link between the science of life and humanities was, however, later rejected if not repressed.

[1] Based on the notion of *generatio aequivoca* the derivation of life from non-life is supposed to be possible. This position was untenable even according to Kant, who instead leaned towards the *generatio homonyma*, that is the idea that the organic can derive only from the organic.

As a clear sign of the victory of reductionist positivism, the subsequent history of biology dismissed, sometimes hastily, the richness and theoretical scope of the dialogue between *Naturphilosophie*, romantic science,[2] and German idealism. The scientific reasoning developed since the mid-nineteenth century rigorously separates the objective study of the living from what subjectively the living is—i.e., a dynamic and alive bond. The romantic debate has thus been consigned to the prehistory of biology with "metaphysical" inclinations and, as such, banned. As a result, the ground-breaking contributions of the so-called *Goethezeit* have been lost, among these, in particular, the common effort to articulate a new common research domain that looks at life in a different, organic way; the attempt to find a place for life in the order of the physical world; the birth of a new role in the world of research, namely that of the *médecin philosophe*, the *philosophischer Arzt*, who embodies the insufficiency of any single disciplinary field to account for the living being. A scrutiny of the debates of those years can therefore not only help us retrieve a historical period that has been mystified but also offers a different model for today's discussions between sciences and philosophy. One can notably learn how philosophy has intervened with its questions and methodological instances in the formation of science—e.g., biology[3]—and how a new scientific paradigm can prompt philosophy to rethink its categories and concepts—e.g., the notion of *ratio* in German idealism (Table 5.1).

Life and Its Origins: A Controversial Story

For centuries creationism had remained uncontested. Although attempts had been made to identify theories that could scientifically explain the origins of living beings, no open conflict with theology had been triggered; scientists would merely investigate the 'how' and not the 'why' of life, that is to say, the way in which the phenomena of the living manifested and not the causes that had determined their origins. In the eighteenth century, thanks, among other things, to the scientific

[2] At the end of the last century historiography distinguished between *Naturphilosophie* and romantic science. In this regard, according to Richards, "Naturphilosophie specifically focused on the organic core of nature, its archetypal structure, and its relationship to mind, while Romanticism added aesthetic and moral features to this conception of nature" [2]. Differently, Stefano Poggi draws attention to the fact that the appellation *Naturphilosophie*, as *pars pro toto*, does not bear testimony to the complexity and scientific acumen of the research of these years. He therefore suggests using the broader expression of "romantic science". On the contrary, the term *Naturphilosophie* lays emphasis on the aspiration to a speculative physics, and therefore on an idea of science that would soon be rejected as an insufficiently rigorous model of knowledge [3].

[3] This view is stated very clearly in the well-known book by John H. Zammito: "It is well-past time to put this prejudice to rest along with all the other complacent dogmas of the positivist epoch. The effort to consolidate biology found positive reinforcement in German Idealist philosophy, and instead of viewing *Naturphilosophie* as a contamination, we might view it as historical evidence that something essential to the character of biology as a special science was at stake, and thus, this episode in the history of biology might reopen issues in our own philosophy of biology" [4].

Table 5.1 Major differences between Newtonianism and Romantic Science

Newtonianism	Romantic science
The origin of phenomena explained by reference to God	God not included in explanations of the living being
Science investigates the "how" of life	Science investigates the "why" of life
World viewed as "non-organic" and purposeless	World viewed as "organic" and purposive
Fundamentally mathematical	Mainly qualitative
Physics can explain the functioning of the living	Living being needs an organic explanation

reworking of the Montpellier school,[4] vitalism introduced the concept of vital force, no longer in terms of a merely metaphysical force, but as a natural one. As a result, life was no longer made to depend on a creator but rather understood as a self-organized system generated by material and natural causes. The vitalistic hypothesis accompanied then the resurgence of the epigenesis (from Greek: ἐπί "after" and γένεσις "generation").[5]

Epigenesis was first elaborated by Aristotle [9], who argued that the agent of the genesis process could be found in the male seminal fluid. The latter would indeed be the efficient cause of the process; in other words, what triggers the change and deploys its action by activating the process of formation of the new being. The seminal fluid is supposed to act on the matter provided by the mother by transmitting a series of successive impulses to it. The new organism then becomes independent of the parents. Its formation happens step by step: some parts appear at an early stage, others later. Therefore, no external cause is required, as each organism possesses the cause of its own development, which Aristotle calls soul (*psyche*) or, at an early stage, the nutritive soul.

[4] Since the Middle Ages an important medical training centre was based in Montpellier. In the seventeenth century, an inflamed clash between mechanists and animists took place there: while the iatrophysicians—led by Fizes (1690–1765)—claimed that the data of physics could fully explain the functioning of the living, based on Descartes' animal-machine model, on the opposite front, scholars, among which Stahl (1659-1734), supported animism and saw the soul as the true cause of vital phenomena. From this clash an original position emerged, namely that of the autonomy of the science of life, which will seep through the vitalist current, in which Montpellier played an absolutely decisive role. Cf. [5, 6]. The importance of Montpellier's *médicins-philosophes* is due to two main achievements: they take up the idea of an "échelle commune des êtres vivants", as to integrate human being into nature and among other animal species; they reject the separation between body and soul, as outlined in the medical treatises of the seventeenth century, and develop a monist and global theory of the living and of human beings. Cf. [7].

[5] As Paul S. Agutter and Denys N. Wheatley explain, "His 'physics' was in that sense organic, in sharp contrast to modern physics. During embryo development, the uterus (formal cause) shapes the growing seed (material cause) towards the goal-state of the mature organism (final cause). Aristotle's accounts of all-natural processes broadly conform to this account of embryogenesis. As a result, his worldview was entirely naturalistic but teleological rather than mechanistic. Every process must have a final cause, a 'goal,' just as embryo development does" [8].

In modern times, epigenesis is retrieved by the famous English physician William Harvey (1578–1657), who, in a text from 1651, *Exercitationes de generatione animalium*, introduces the idea of the generation *per epigenesin*, the idea, that is, that in some animals the formation of organs derives from a process of differentiation and subsequent formation of the individual parts. Other animals, such as insects, for example, instead, do this "*per metamorphosis*," in other words, "they are formed from ready-made material and only acquire a new figure"[6] (Fig. 5.1). While reviving the epigenetic claim, through his ideas on ready-made material, Harvey also opens the door to preformationism, which, contrary to epigenetics, is based on the assumption that all embryos already exist in the first individual of each species that appeared on earth. In the case of human beings, this amounts to saying that there is a homunculus already present in the sperm, and thereby we are "preformed"[7] (Fig. 5.1).

Precisely thanks to its compatibility with Christian dogmas, preformationism widely spread. According to this new standard theory, the entire human species—as the preformationist Swammerdam writes in his *Historia insectorum generalis* (1669)—already existed in Adam and Eve, and this would also explain why the whole of humanity is condemned to their sin [11].[8] The most radical ideas about preformationism and the encapsulation of embryos in *animalculi* were expressed in 1694 by Nicolas Hartsoeker. In the *Essay de dioptrique*, he applies preformationist assumptions to human beings and suggests that the entire fetus is a "homunculus" that microscopically replicates the being in gestation, which is housed in the sperm (Fig. 5.2).

At the heart of preformationism lies the wish to decouple life sciences from the Aristotelian finalistic approach, as well as from vitalism, which proves weak at the experimental level. The vision that guides these scientists fits into the mechanistic Cartesian scheme. But despite the efforts to dismiss all finalism, these theories keep referring to a primary cause or higher intelligence. Preformationism, therefore, avoids confronting the issue of the origins and limits itself to analyzing vital phenomena. As Charles Bonnet writes: "the production [of an individual] is not a true generation but the simple development of what was already formed, […] the simple evolution of what was already generated" [12].[9] Starting from the

[6] As William Harvey states, in some animals the origin has to be thought *potius per epigenesin quam per metamorphosin*. Cf. [10].

[7] Preformationism is based at an early stage on the hypothesis that first there was an egg (*ovism*); subsequently, on the idea that first there was a spermatozoon (*animalculism*), with more convincing outcomes at experimental level.

[8] Animated by deep religious spirituality, the Dutch Swammerdam, who was among the first to use the microscope to dissect living bodies—especially insect bodies—sided against the idea of metamorphosis and spontaneous generation, supporting preformationism instead.

[9] And later on, accusing the defenders of epigenetics: "what amazes us is to see the naturalists [*Physiciens*] who, in a century as enlightened as ours, take up these errors and deploy all the strength of their genius to persuade us that an animal is formed like a crystal […]. They revive the occult qualities that a good philosophy banned from natural philosophy [*la Physique*]. They resort to instincts, forces of attraction [*forces de rapports*], chemical affinities, organic molecules that are neither vegetable nor animal and form from their combination [*réunion*] vegetables and animals" [13].

Fig. 5.1 W. Harvey, Exercitationes de generatione animalium. Quibus accedunt quaedam de partu: de membranis ac humoribus uteri: & de conceptione, Amstelædami: Apud I. (Exercises on the Generation of Animals. To which are added the essays on parturition, on the membranes, fluids of the uterus, and conception, published in the Engraved frontispiece, 1651 by Ravesteynium). (Adapted from Europeana Collections under CC BY 4.0 https://classic.europeana.eu/portal/en/record/9200579/q9a6g97d.html?q=W.+Harvey%2C+Exercitationes+de+generatione+animalium#dcId=1615948483190&p=1)

mid-eighteenth century, a series of discoveries relaunches the vitalistic approach and the epigenetic solution, namely exposing the failure of the great mechanistic project, underpinning the theories of preformationism and the pre-existence of

Fig. 5.2 Sketch of a homunculus enclosed in a human spermatozoon, 1694, from Essai de Dioptrique (Nicolas Hatsoeker). (Adapted from Wikimedia Commons, the free media repository https://en.wikipedia.org/wiki/Nicolaas_Hartsoeker#/media/File:Preformation.GIF)

germs. Among these experiments, one could mention that of the English biologist Needham (1713–1781) published in his *Nouvelles observations microscopiques*, in 1750, which allegedly demonstrated spontaneous generation—even though the experiment was later denied.[10] Needham comes to support the existence of an "expansive internal force," or of a "generative faculty," even in the brute matter, and insists on its "producing force"[14]. It is worth remarking here that the epigenetic hypotheses develop along different lines in France and Germany. While in France, based on Newton's theory and the idea of mechanical force reinforced by Maupertius' research, scholars move in a materialistic direction in terms of physical-chemical forces, a revival of Leibniz's ideas occurs in Germany. Along Needham's line, epigenetics is there strongly qualified by the postulate on the existence of specific vital forces.

[10] It is the Italian Lazzaro Spallanzani who conclusively refuted the epigenetic theses of *generatio aequivoca* (*Saggio di osservazioni microscopiche relative al sistema della generazione dei signori Needham e Buffon*, 1765). Epigenetics will regain ground only a few years later, and only for a short time, thanks to the support of Goethe who, with his idea of *morphology*, introduced the concept of metamorphosis as a solution to the issues epigenetics faced once the continuity between organic and inorganic world was established.

Within this second tradition, the major exponent is Caspar Friedrich Wolff, who, in his *Theoria generationis* (1759), advocates the idea of a life force (*Lebenskraft*[11]) endowed with material and natural features. Wolff calls this force *vis essentialis* and does not understand it in Newtonian terms as a mechanical force but rather as a vital drive. He thus goes as far as to postulate the existence of a vital principle that operates before the appearance of any vital function and that presides to the entire embryonic development by associating itself with other forces of physical–chemical type, which are responsible for the formation of organs and tissues. This *vis*, like the Aristotelian nutritive soul, is the capacity to distribute the nourishment, organize the parts to make the whole work, and promote what will later be identified as the instinct of self-preservation.[12] The Wolffian hypothesis restores then to an empirical and observable dimension the still metaphysical reference of the first theorists of vitalism (for example, Georg Ernst Stahl). The embryo presents itself initially as a shapeless mass, and then gradually, thanks to this *vis*, it becomes more articulated until the parts slowly assume a definitive structure. An original force or instinct would develop over time, determining completely new formations, not present from the beginning, thus determining an evolution in "layers" of materials. This vital force would be able to guide the emergence of the form within the organism. In this way, Wolff grafts epigenetics into vitalism.[13]

Behind these different "embryo epistemologies" lie different worldviews. As Farley also puts it, in the eighteenth century, a materialistic mechanist could only be a good Christian if they adhered to preformationism [18].[14] Centuries of doctrinal teachings were indeed at stake. And hardly unexpected is the hostility, in Christian circles, towards vitalistic theories. The case of Albrecht von Haller is in this respect emblematic.

Initially close to epigenetics, Haller appreciated Buffon's work and promoted the German translation of his *Histoire Naturelle*—for which he also wrote the preface to the second volume. Upon his return to Switzerland, probably also in consequence of the condemnation issued by the creationist theologian Reimarus—who considered materialism as a form of naturalistic Epicureanism as well as atheism—and the influence of Bonnet—a strenuous defender of preformationism and creationist mechanism and an opponent of the theory of spontaneous generation—Haller decided once and for all to close any dialogue with the supporters of epigenesis and to advocate preformationism openly.[15]

[11] The concept of *Lebenskraft* or "life force" was introduced by the famous botanist Friedrich Casimir Medicus in 1774. He uses this term for those chemical phenomena related to living matter that could not be explained by the chemistry of inanimate objects and, in this respect, the use of the term is not far from the idea of Newtonian force.

[12] «*Quaecumque vero sit haec vis […] modo praestet enarratos effectus, et ponatur, posita planta et humoribus nutritiis applicatis* […]: *sufficiet ea praesenti scopo et vocabitur a me vis vegetabilium essentialis*», [15]. Cf. [16]

[13] For an accurate account on the whole debate, cf. [17].

[14] Roe calls this: "science within the limits of religion". [19].

[15] On the different perspectives embraced by Haller, initially close to epigenetics and then completely converted to preformationism, see [20].

While it is clear how much religious discourse intervenes in scientific research of the time, it is not the only factor influencing scientific choices. In accepting one theory or another, one's ideological approach to experiments also plays a fundamental role. The use of microscopes and the possibility to closely observe "the facts" pave the way to conflict between those who understand the role of the naturalist as aimed at collecting positive results from observations—since, according to the Newtonian motto, *Hypoteses non fingo*, hypotheses could only lead to unfounded and dangerous generalizations—and those who see science in different terms: facts are only facts, bricks of science; the essence of science are ideas. Two opposite fronts confront then each other: on the one side, a "fideistic" experimental approach; on the other, a holistic approach aimed at understanding "scientific evidence" in a wider system context—an example of this approach is provided by the *philosophical anatomy,* also known as *transcendental anatomy* presented in those years by Étienne Geoffroy de Saint-Hilaire and even earlier by Goethe. What's more, also political factors have their bearing. While in Germany, scientists are mostly linked to universities, the French government centralizes scientific institutions. Access to careers is often filtered through mechanisms that do not exclusively rely on the reliability of scientific criteria. Aspiring naturalists were well aware that their position on certain issues could affect their careers. One example is provided by George Cuvier—permanent secretary of the *Academie des Sciences*, professor at the *Collège de France*, member of the *Conseil de l'Université* and friend of powerful politicians—who used his role to gather allies in the fight against the morphological approach to anatomy, as developed by Geoffroy de Saint Hilaire and his people, giving rise to a heated dispute.[16]

Behind the debate on life and its origins, therefore, there is a much more complex world that reaches well beyond scientific connotations and implies not only a wide range of historiographical elements but also epistemological ones. It is precisely with respect to this point that the role played by philosophy within this constellation is particularly interesting.

Knowing Life

Whereas religious beliefs and political institutions affect the evolution of claims in biology from the outside, philosophy has a different status. There is, in fact, a strong philosophical component at the origins of the discourse of biology. The term "biology" as an autonomous discipline was introduced at the beginning of the nineteenth century.[17] Both Jean-Baptiste de Lamarck and Gottfried Reinhold Treviranus assess the essence of biology against its philosophical background. According to Lamark, unlike physiology which takes life for granted, biology, while querying itself concerning "what life is," poses "philosophically" the problem of its own

[16] About this debate see below.
[17] Cf. [21–24].

foundation; for Treviranus, biology is not limited to describing events but rather tries to elaborate theories and systems. For the scientists of these years, that is, biology is a philosophy of living nature, *Philosophie der lebenden Natur*, as the subtitle of Treviranus' work reads. Biology is then an inquiry that, far from pivoting on the mere observation of the results of experiments, is aimed at understanding life as a system within a system. With its assessments, philosophy deeply influences the structure of the new science. It underlines in particular:

- the need to move from a static vision to a dynamic one;
- the need for an organicistic and not only analytical approach;
- the resumption of a finalistic conception.

These philosophical contributions play a key role in the constitution of the epistemology of biology, which, on their ground, can take distance from Newtonian physics.

The Dynamic of the Living

In the course of the eighteenth century, Linnaeus' abstract and static classifying intent is replaced by the idea that nature as a living being is subject to a process of transformation, not only external but also internal [25]. This dynamic component also provides rehabilitation of the role of time, in reaction to the prevalence of the spatial perspective typical of the early modern period. Unlike the bodies of Newtonian physics, life is linked to a temporal process of development and formation. The laws of its knowledge need to take into account a dynamic component. As a result, the *Naturbeschreibung*—a description of nature framed by an affinity-based system—is flanked by the *Naturgeschichte*—a narration of the history of nature. What is at stake here is not only a question of historical knowledge but also a dynamic vision of reality. Nature is recognized as an *agency*. Logic's artificial regularities and the human definition of a set of categories schematically ordering the world are believed to fail to accurately map the prolific dispersion achieved by nature. Classification systems can certainly be employed as helpful artificial sign systems, but it is a totally different matter if one accounts for the truth of these processes. This is basically the contrast between the fixism at the basis of preformationism and the dynamism at the basis of epigenetics.

The Organism as a Model

The second aspect based on which philosophy is recognized as *criterium* of knowledge in the realm of living beings concerns the organism and the idea of internal organization. Granted that nature is living, it does not follow a linear and mechanical development, but it organizes itself in such a way as to preserve and reproduce itself, following a sort of internal project. Mechanism appears to be a necessary but not sufficient interpretation of this process, and, in this respect, the organism model has the upper hand [26].

The living being can no longer be understood as an aggregate of parts but must be considered as a unity made up of limbs, and it is this unity that gives meaning to the parts. The internal configuration of this unity, together with its *ratio essendi* (reason for being), determines its *ratio cognoscendi* (ground of knowledge). As they elaborate and react to drives, even mechanical ones, according to their own constitution and to a *conatus* to self-preservation, living beings cannot be read based on external causes only. The organism requires a new understanding of the relationship between the whole and the parts, as non-linear and chronological, based on which the whole is always more than the sum of its parts. This introduces a further epistemological shift with respect to classical physics: the parts are not like wheels in a machine, which can be assessed separately from the whole; they rather define themselves in reference to the whole, just as the whole can be identified only as counter-effect of the aggregation of the parts. The famous dispute between Cuvier and Geoffroy is compelling proof of the sudden importance of the notion of organism in understanding the living. The main object of debate is, in fact, the relationship between the functions of the organs and the organism. As he supports a teleologically oriented position, Cuvier insists on the priority of function over structure; Geoffroy instead supports the morphological position, hence the priority of structure over function. Cuvier gives precedence to holistic and functional considerations rather than strictly morphological ones. Geoffroy, on the contrary, seeks to create a science of pure morphology. The failure of his theory might be taken as the sign of its being too ahead of its time. The debate nevertheless features the culmination of a struggle in biology, which can ultimately be traced back to the idealistic attitude of the Platonic tradition. In the philosophical scenario of the time, this tradition finds expression in the transcendental Kantian-Fichtian positions, which clash against the Aristotelian teleological approach embraced by all the *Naturphilosophen*.[18] This ultimately fuels the contrast between comparative anatomy and morphology, as well as between teleology and transcendental abstraction.

For Cuvier, each part of an animal is designed to contribute to the functional integrity of the animal or to adapt it to its environment. Whenever a new part is needed for functional purposes, the creator can create a new and appropriate organ. The function is of primary importance: the animal's needs are considered sufficient to determine its structure. Clashing with the functionalist vision of nature, Geoffroy outlines a theory of anatomy in philosophical or transcendental terms. Whereas Cuvier argues that the animal structure is determined by the functional needs of an organism, Geoffroy maintains that all animal structures are modified forms of a

[18] As Appel states: "A closer study of the debate, however, shows that both Cuvier and Geoffroy defended extreme positions. The significance of the debate for the future of biology is that it laid bare the untenability of both Cuvier's and Geoffroy's views, and challenged naturalists to come to a creative resolution of them. While Geoffroy's more speculative doctrine of the "unity of composition" in the animal kingdom may have been rejected in 1830, his morphological program, known as "philosophical anatomy," eventually became an integral part of biological science in both France and Britain" [27].

single unified plan. Cuvier reflects the systematic and organistic position of idealism; Goeffroy, on the other hand, embodies the attitude of the *Naturphilosophen*. The dispute between the two scientists is the fallout of divergent philosophical orientations. Beyond the empirical evidence of those years, such a slippery subject as the relationship between organs and organisms has to be built necessarily upon the basis of a worldview.

A New Teleology

A third element can be added to this picture, namely Kant's reintroduction of finalism. At twenty-three years of age, in his 1747 dissertation, *Thoughts on the True Estimation of Living Forces* (German: *Gedanken von der wahren Schätzung der lebendigen Kräfte*), Kant tackles the issue of the insufficiency of mechanism in the explanation of the living and looks for a principle of explanation for those forces —what Leibniz inspires him to call living forces—which cannot be traced back to the mechanical forces. Several years later, a much more mature Kant (Fig. 5.3), while drafting the *Critique of Judgement* (1790), tries to solve this problem by introducing the idea of a *telos*. He indeed admits that even if one aims to explain everything in nature in mechanical terms through scientific inquiry, some objects cannot be explained mechanically. These objects can be explained in teleological terms.[19] The end expresses here a dynamic model of relationship that connects everything to the parts. There is, therefore, something more than the bipolar relationship that recalls the Newtonian-type tension between the forces. For Kant, however, this idea of totality remains unattainable to the finite intellect and therefore retains only an "ideal" status [29].[20] It can serve to guide our thinking, but it provides no access to truth. As Lenoir argues [31, 32], Kant is at the origin of an attitude, teleomechanism, that becomes typical of the sciences of the living, which takes center stage in the discourses of the main naturalists of those years, from Blumenbach, to the Göttingen school, to Reil, and which lays the ground of both vitalistic materialism and epigenetic embryology.

Kantian instances push science to acknowledge that, with respect to the use of the Newtonian method (i.e., the derivation of laws from an observational-experimental investigation; the mathematical deductive explanation of phenomena in the light of the same laws), the study of the living requires a more holistic approach.

This philosophical standpoint urges scientific thinking to come to terms not only with qualitative differences in addition to quantitative differences but also with the need for an analytical account of phenomena in their entirety; this implies a progressive questioning of the primacy of mathematics and the analytical method and draws attention to the need to develop—with the support of philosophy—new tools for analysis. It is therefore clear, as Huneman states in reference to those years, that

[19] See [28].
[20] On the normative feature of the teleological judgement, see: [30].

Fig. 5.3 Portrait of Immanuel Kant. (Adapted from Europeana Collections, Public Domain Marked https://classic.europeana.eu/portal/en/record/90402/RP_P_1886_A_10329.html?q=Immanuel+kant#dcId=1600197000531&p=2)

"the line we are prompted to draw between science and philosophy appears quite blurred, or more complicated than we thought, since people at those times would spontaneously elaborate their explanatory strategy within both science and philosophy" [33]. In conclusion, in the years between the eighteenth and nineteenth centuries, change in how living beings are scrutinized goes hand in hand with philosophical accounts.

Thinking Life

The relation of influence between philosophy and sciences is clearly reciprocal. The science of living with its problems and answers also plays an important role in formulating a new idea of reason. In this respect, historiography has wrongly identified the philosophical contributions of these years, especially in Germany, as a mere relapse into a metaphysical and anti-scientific attitude.[21] It should be clear, instead, that being confronted with a dynamic and self-regulating object such as life produces significant effects on the philosophical discourse around the models of rationality, as clearly shown by idealism. In other words, one could say that the model of rationality elaborated in these years is also a reflection of the influences of the new sciences of life.[22]

The starting point is, once again, Immanuel Kant. As is well known, while embracing the critical stance brought forward by Hume's empiricism—which had awakened him from dogmatic sleep—and sharing Newtonian positions and the mechanistic approach, Kant initiated a fundamental investigation in the epistemological field, which aimed to overcome classical metaphysics. The main aim of Kant's critique was to overcome Hume's skepticism through a radical examination of the assumptions that underpin our conscious experience of the natural world, effectively delimiting the scope of human knowledge. If, as Kant recognizes, humans can only know what they posit, the outcome could be either skepticism—which is Hume's conclusion—or self-limitation. This second solution, which is the one chosen by Kant, however, opens up a deep rift between the plane of knowledge and that of life: philosophy, like science, must build its knowledge by following a rigorously mathematical method based on a priori principles. The outcome of Kant's operation, which has the merit of freeing philosophy from elements still linked to the metaphysical tradition, leads to the distinction between a cognizable sphere—what Kant defines as the phenomenon—and an unknowable sphere—the space of the noumenon. Whereas on the epistemological level, Kant contributes to clarifying the concept of truth and knowledge, on the level of the new sciences, his distinction leads to an aporetic outcome. What happens then when this analysis is applied to the living? Kant's perspective leaves a deep mark on German idealism, which seeks to overcome the separation between a *homo phaenomenon* and a *homo noumenon*, that is to say, between finite and infinite.

[21] Zammito suggests "to link the gestation of biology in Germany with that most despised phenomenon in the history and philosophy of science, Idealist *Naturphilosophie*" [34].
[22] Richards finds the roots of nineteenth-century biology in the Romantic movement [35].

How to heal the fracture between man and nature? Can the human intellect know nature and think life? These questions brought about in those years a redefinition of the idea of philosophy and its system. As previously seen, science shows that certain aspects of living cannot be reduced to mechanical explanations. This issue is clearly a product of the model of reason and knowledge born within the scientific revolution. The effort made by post-Kantian idealism is, therefore, to go beyond the separation between the mechanical dimension and the organic dimension. And it is on this point that nascent biology has a strong influence.

The first obvious influence concerns the *imagery*. The metaphorical reference to scientific theories in describing the phenomena pertaining to the realm of mind is certainly not a novelty of those years. It may suffice to mention in this respect Kant's famous reference to the Copernican revolution to describe the different relationships of knowledge between the subject and the world. But in German idealism, the metaphorical use of biological images takes on remarkable proportions.

Beyond the metaphorical turning to the living, however, science has an essential bearing on how idealism rethinks rational thinking itself. Schelling provides here a good example. Among the first advocates of *Naturphilosophie*, he explicitly theorizes the necessary link between philosophy and science and devotes himself to speculative physics or natural philosophy. In his early writings, drafted at the end of the eighteenth century, the concept of life takes center stage.

Life stands there for a unitary horizon, including the world and the subject. Schelling is in this respect committed to showing the isomorphism between the principles objectively given in nature and the acts subjectively deliberated by the self. Based on the perspective adopted by the young Schelling, while exploring nature, the scientist finds but the other realm of the self, that is to say, rationality. Science and philosophy ultimately work on the same object. Only one reason is assumed to govern both humans and nature, thought and world, and subjectivity and objectivity [36]. Just as nature does not differ from the subject, in the same way, no longer valid is the Kantian distinction between subjective representation and objective world. Based on the ability to act and self-organize, which identifies both nature and the subject, thought and life are no longer seen as irreconcilable, and a form of thought capable of grasping life, that is to say, the world is deemed possible. Consistently, Schelling's efforts can be described as looking for a system of knowledge that follows the model of organization identifying living organisms.

The same effort also appears in Friedrich Heinrich Jacobi's contributions. In the well-known dispute with Fichte, Jacobi blames his interlocutor's transcendental idealism for resorting to a form of rationality separate from life. In some of his remarks, Fichte does not deny believing that thought could be at most *speculum* of life. To this standpoint, Jacobi contrasts his anti-dualistic idea of philosophy and life, which clearly incorporates a cognitive scheme derived from the biology of those years.

Jacobi supports the superiority of a comprehension that goes beyond the conceptual rigidities of the intellect and investigates the living nature of human beings beyond their mere *bios*. Jacobi ultimately performs a turnaround that sets life as a model for thought. As already stated in the *Doctrine of Spinoza*: "The principle of all cognition is living being; living being proceeds from itself, it is progressive and productive. The stirring of a worm, its sluggish pleasure or displeasure, could not arise without an imagination holding [such stirrings] together according to the laws of the worm's principle of life, and producing a representation of its state. The more manifold the felt existence that a being generates in this way, the more *alive* is such a being" [37]. The form of knowledge is consequently seen as deriving from the form of life that produces it: knowledge-reason expresses the life that is at its origin. According to Jacobi, the distinctive autonomy of life is the opposite of the heteronomy of the legality of physics.

A final example of the effects of biology on philosophy is provided by Hegel. In his work, the metaphorical use of scientific models developed by the biology of his time is overwhelming. One could mention here not only the reference to the functioning of digestion while describing the way knowledge proceeds,[23] but also the famous *Preface* to *The Phenomenology of Spirit*—drafted just a few days before the delivery of the work to the printer while worrying that the manuscript would be burnt by Napoleon's army marching on Jena. Hegel' work was studded with the metaphorical use of examples taken from biology:

- the image of the seed that disappears into bloom like the negative movement of dialectics;
- the description of the passage to a new era, as equivalent to the "troubled" period in which the child is about to be born and which arrives at the "first breath" that "shatters the gradualness of only quantitative growth—it makes a qualitative leap and is born" [38];
- the equation between the abstractive capacity of the intellect and "death;"
- "the bacchanalian revel where not a member is sober" [39], to understand the pervasiveness of the truth that touches every element of knowledge.

Alongside this metaphorical repertoire, what is surprising in Hegel's philosophy is how biology is employed to grasp how thought works. The clearest example in this respect is precisely the use of the concept of life. Whereas Newtonian physics, relying on a Cartesian, analytical understanding of intellect, builds itself around the idea of the force field and therefore seeks a principle of explanation that remains extrinsic to the analyzed objects, biology offers a more dynamic and articulated type of knowledge that develops precisely within the living organism. Life is a system of relationships that has the principle of its own knowledge within it. Even death, previously understood according to the Epicurean definition as an alternative to life,

[23] It should be remarked that at the end of the 1700s, the Italian scientist Lazzaro Spallanzani conducted important research on digestion (see: *Dissertations of animal and vegetative physics*, 1780), based on which he was able to demonstrate the digestive action of gastric juice, independently of any mechanical action of the walls of the digestive tract, and how digestive processes differ from fermentation; he also succeeded in obtaining in vitro digestion, thus providing a new, valuable means of analysis of the chemistry of digestion. Digestion was a key scientific topic of the time.

now, thanks to Xavier Bichat's inquiries, falls within its orbit. Granted that life is not primarily individual life, but rather the life of the species, it also incorporates death. And, as Bichat makes clear in his studies of anatomopathology, death is essential to the understanding of life. This is also how Hegel thinks about contradiction: a process that, like death, denies thought (life) but is essential to its understanding. And there is yet another enlightening example, which is also quoted by Foucault in *The Birth of the Clinic* and which concerns Bichat's invitation to open up corpses and look at the dead body to understand life[24]; similarly, in a famous passage from the *Phenomenology*, Hegel invites us to look at the negative in the eyes: "spirit is not this power which, as the positive, avoids looking at the negative, as is the case when we say of something that it is nothing, or that it is false, and then, being done with it, go off on our own way on to something else. No, spirit is this power only by looking the negative in the face and lingering with it" [41].

The relationship between thought and life is even more explicit in Hegel's philosophy at an epistemological level (Graphical Abstract). Hegel tries to build a system of thought that does not just break down concepts into isolated and abstract determinations. As biology exceeds the limits of physics in the understanding of the living, in the same way, Hegel's speculative philosophy is aimed at overcoming the internal limits of knowledge which, instead of addressing processes in their entirety, prefers to decompose knowledge into individual prepositions. In short, Hegel shares the same problem of the doctors, physiologists, scientists of his time: how to develop a new form of understanding which can capture the whole movement in its organicity [42]. In this respect, the model of the relationship between life and the living offers a viable way to understand the type of relationship that must be established at a logical level between the universal and the particular. This is also the model for a new idea of reason. Given that this new model of reason is dialectics, one should then claim, as Hegel does, that at the heart of dialectics is the pounding beat of life.[25] These examples of the influence of biology on the structure of thought in German philosophy ultimately help us to clearly understand how much the dialogue between different disciplines is capable of producing new paradigms of knowledge and understanding.

[24] As Bichat writes: "the more diseases are observed and the more corpses are opened up, the more we are convinced of the need to consider local diseases not from the point of view of compound organs, which are rarely affected in their entirety, but from the point of view of their different tissues, which are almost always affected in isolation" [40].

[25] Numerous studies have appeared in recent years on the importance of life in Hegel's speculative philosophy [43–45].

Conclusion

As I have tried to show, the reciprocal influences between biology and German idealism in the nineteenth century provide an example of the rich possibilities of dialogue between science and philosophy. The subsequent reinterpretation of this historical period as anti-scientific, resulting from a reductionist mindset, ended up missing some essential elements for the understanding of the origins of the epistemological discourse in both biology and philosophy. A full understanding of the "paradigm shift" in biology requires taking into account the principles on which philosophy is working at about the same time. Similarly incomplete would be an understanding of the philosophical project of German idealism, which does not take into account the changes in mindset produced by the science of life. The "case of German idealism" shows to what extent the ideas of rationality and knowledge are historically determined and to what extent the way of proceeding of humanities and sciences is parallel and not antagonistic. Recovering this example of dialogue can be key to avoiding today's impoverishment of both levels of research. As Hans Jonas puts it: philosophy "obsessed with man alone, is in the habit of claiming as his unique privilege and predicament much of what is rooted in organic existence as such: in so doing, it withholds from the organic word the insight to be learned from awareness of self. On its part, scientific biology, by its rules confined to the physical, outward facts, must ignore the dimension of inwardness that belongs to life;" however, "in the mystery of living body, both poles (philosophy and sciences, SA) are in fact integrated" [46].

Core Messages

- The relationship between philosophy and biology in the nineteenth century makes an excellent case for integrating different disciplines.
- The intertwining of scientific and philosophical inquiries led to a new idea of reason in those years.
- The dialogue between philosophy and biology in the nineteenth century can provide a model for their interaction today.

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6 Embodied Creativity and Symbolic Variation in the Evolution of Life

Mirko Di Bernardo

"Once productive, art has become creative."

Naum Gabo

Summary

The chapter is based on recent research in complexity theory to deepen, in an interdisciplinary way, the emergence of creativity in biological processes in an evolutionary and epigenetic perspective with particular attention to the problem of variation, growth, and co-evolution of symbolic forms in living systems. This level of analysis explores the hypothesis, in genealogical terms, to identify some characteristics based on the possible outline of a metabiology of symbolic forms that closely relate the artistic language with that of the biological sciences. In this perspective, the creative dimension of nature is interpreted as an emerging reality unpredictable and irreducible to the laws of classical physics.

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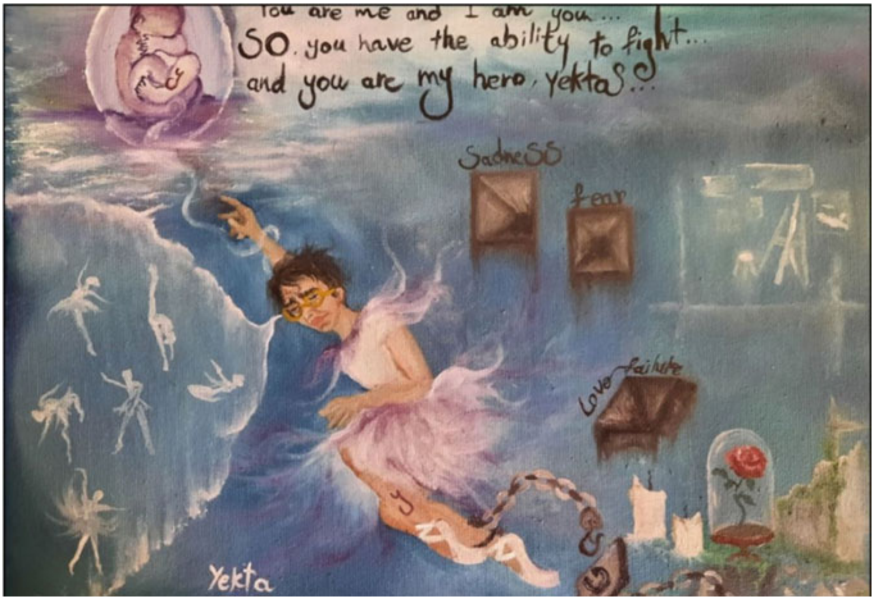
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_6



Evolution of life in symbolic language.
[Adapted with permission from the Health and Art (HEART), Universal Scientific Education and Research Network (USERN); Painting by Yekta Esmaeili.]

Keywords

Autopoiesis · Creativity of nature · Epigenetics · Metabiology · Natural evolution · Symbolic forms

QR code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's

keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

The present work maintains as a theoretical frame of reference on the cultural context that, starting from the second half of the twentieth century, has seen the international research and studies on the complexity of the living world ranging from the theory of autopoiesis to the doctrine of complex systems, from studies on autonomous morphogenesis to the theory of computability, from the epistemology of systems to that of the mind, and from neurophenomenology to the theory of semantic information and post-neo-Darwinian evolutionary doctrines. In this perspective, an important theoretical synthesis able to probe the very roots of the creativity of cellular life comes in the second half of the seventies with the concept of autopoiesis to merge themes and methods from the most disparate sciences in an admirable way [1]. This notion makes it possible to reconstitute the secret design of the organic unity of the living at the level of the model, according to what were the "dreams" of some philosophers of the classical age. In this perspective, biological life is configured as "a cyclic process that produces the components that in turn self-organize in the process itself" within a certain differential threshold of realization [2]. In agreement with South American scholars, it is possible to define an autopoietic as a unit that works in a self-maintaining manner through the self-generation of components. This process is triggered by an intricate plot driven by a specific internal teleology of molecular interactions [3]. This doctrine, in deep harmony with the insights of Prigogine and Nicolis [4] on the thermodynamics of irreversible processes and with the most recent studies of Kauffman [5–6] on the elaboration of a theory of embodied information for greater intelligibility of biological processes, still offers an appropriate holistic anchorage for the generalization of the definition of biological life [7]. Therefore, enaction and reflexivity appear as two sides of the same coin, i.e., as two complementary aspects of the creative and organismic dimension of every biological system. Suppose enaction is understood as that process of extrapolation of meanings and of a world in the course of a sensory-motor interaction with the environment and with others. In that case, reflexivity represents, on the other hand, the inseparable dimension of the living agent from the world with which it is united in a relationship of mutual specification and co-emergence. Therefore, this contribution aims to review the most recent research and accordingly provide the main conceptual coordinates required to understand embodied creativity better. This understanding can help investigate, at a theoretical level, how the fundamental characteristics of autonomous living agents contribute to changing the image of nature and the very concept of symbolic form in the light of a possible new relationship between art and natural sciences. This new relationship is inspired by a multidimensional and autopoietic evolutionary approach capable of sounding out the preconditions of the possible outlining of a metabiology of artistic forms shaped by the epigenetic shift.

Art and Biology in Comparison with Nature

Among the first attempts to delineate the biology of art capable of tackling the philosophical problem of form by closely linking artistic production with scientific research is the work of D'Arcy W. Thompson (1917) *On Growth and Form*. This study embraces a framework of knowledge anchored to the reductionist approach of classical biology, where form and growth are examined with reference to the physics and mathematics of time, eliminating any final cause and reducing the importance of natural selection considered exclusively in its action aimed at discarding unsuitable forms. According to this perspective, living structures are portions of matter, and it is in obedience to the laws of physics that the particles that compose them have been settled and shaped [8]. This perspective considers the living form deprived of its individual character and investigated according to a mathematical-geometric and mechanical theory that reduces the different expressions to common generation models [9]. The forms are not analyzed in their presentation as individual events but are considered in relation to the process of growth in which the forces acting on matter turn out to be the causes both of their origin and their respective changes. Thompson can therefore say that the shape of an object coincides with a diagram of forces, at least in the sense that it is possible to deduce from it which forces act or have acted on it [8, pp. 11–15]. Starting from general heuristic tools such as the laws of physics, mathematical formulas, and geometry figures, Thompson's investigation arrives at reconstructing the multiplicity of forms of nature by finding general rules universally applicable to both the organic and inorganic world. Therefore, the Scottish scholar is deeply convinced that an organism can be represented as a mathematical function that has to do with the spatial and temporal order.

The biological sciences, with particular regard to physiology, seemed to be initiated in the direction of a progressive approach to the concept of "true science" by virtue of which the application of mathematics could be interpreted, as much as that of an artistic technique, as a creative act, understood as an activity through which man comes to codify the world around him by means of a language he understands. This interpretation of Thompson's work brings the discourse on the generativity of nature back to an extensible and objective level where the creative dimension is reduced to mere productivity according to the linear and mechanistic models of classical biology. But "creating" implies something greater because creativity in its actual artistic or biological dimension achieves a further step that must always be based on cognition, and that is nevertheless beyond cognition itself because the games that life can create are infinite [10]. In fact, today, we know that systems that involve the coding of ribonucleic acid (RNA)-deoxyribonucleic acid (DNA), for example, the molded replication of real cells, more than a hundred years after the Scottish naturalist's considerations, no longer appear as the only possible molecular mechanisms underlying the emergence of life on Earth. The important idea here is that the activity that leads to life understood in metabiological terms as the emergence of cognition and reflexivity, is a self-catalytic and organismic process, i.e., dictated by the autonomous and self-constructive biochemical organization of the entire system in play [11]. This "creative activity from within" is expressed in all autopoiesis-related concepts, such as the notions of evolutionary bricolage, enaction, and adaptation, intelligible through the use of a theoretical framework inspired by rules of internal closure able to generate deep processes of self-organization, stratified, and hierarchical in constant evolution and co-evolution (reflexivity as *forma formans* or unpredictable reorganization of the structure), also able to offer, in informational terms, an objective measure of the complexity, i.e., the continuous biological growth (cognition understood as assimilation) of the autopoietic system in relation to a precise meaning of the environment [12]. In the light of these considerations, therefore, according to the contemporary theory of biological complexity, life appears as a transaction phenomenon, i.e., the result of "a series of bi-directional transfers, independent of each other and at the same time interconnected." "Independence implies that each transfer is voluntary in itself, i.e., free; in other words, no transfer constitutes a prerequisite for putting the other into action, since there is no external obligation" to act on the dynamics of the process. The latter is a logic of molecular reciprocity. This logic is neither conditional nor purely unconditional because if it is true that the molecular processes of a cell are free, at the same time, without the response of some macromolecules, the system does not realize its internal *telos* [13]. However, to these two characteristics (conditionality/unconditionality and bi-directionality of transfers), a third one must be added: transitivity. In highly complex systems such as living organisms, at a molecular level, we have that the response of a molecule to a signal of another molecule may not be directed towards that molecule that triggered the reciprocal reaction but also towards a third element. In other words, A, which puts in place a process towards B, triggers a process of chemical reciprocity not only if B responds towards it but also if it acts reciprocally towards C (think, for example, to the auto-catalytic closure of prebiotic systems). Therefore, this is what makes the reciprocity of the bios something different from a crossed selfishness, also giving it openness. In fact, these are the internal dynamics of the processes of self-organization of life. At the molecular level in living systems, the structure of reciprocity that spontaneously emerges is normally triadic and therefore open, that is a structure in which it is possible to trace not only phenomena of molecular association but phenomena of cooperation in which each part, as there is only through all the others, "it is also thought of as existing in view of the others and of the whole, that is, as a tool only then and for this reason such a product can be called, as being organized and self-organizing, a natural purpose" [14, p. 207].

Right here, we can precisely recognize the mysterious mechanisms of what Kant defines as an ethical life force about two hundred years before Maturana and Varela, that is the particular interweaving of self-organization, complexity, emergency, assimilation, and cognition that allows us to "read" life as a cognitive, co-evolutive, and relational phenomenon, that is a phenomenon governed by a mysterious creative logic of molecular reciprocity. This logic of the concrete, which transcends the extensional models conceived by Thompson's classical biology and geometry of nature, presents deep analogies with the concept of artistic creation elaborated by Gabo. According to the artist, creativity is precisely the way in which man accepting the principles that underlie nature, emancipates himself from it, becoming "the further cause of its accretion" [15, p. 8].

In its implementation, Gabo's eclectic use of methods of constructing mathematical models, concepts such as curved space or images borrowed from morphological research openly suggest that his constructions are, first of all, the expression of an aesthetic vision motivated by the desire to make his art accessible on an intuitive level to the largest possible number of people. However, it is matured first of all in the awareness, typical of every artist, that nothing that is exclusively correct from a mathematical perspective can show either the characteristics of life or the attractiveness of beauty [10, p. 22]. The works of art are for Gabo refractory to the simple formulas of mathematics, as are the phenomena of organic life. Despite the apparent accuracy of lines, the precision of curves, and intersections of planes, there is no formula that governs, for example, the structure of linear construction in space [16]. The nylon thread draws a different profile at each successive step, and the sequence generated in this way, despite the undoubted regularity, is composed of shapes that are never identical. This is the result of a knowledge that cannot be reduced to any form of gnoseological reductionism; in these forms, intuition plays a fundamental role that is expressed not only in the ability to synthesize the characters of individual natural facts but in that more general condition of man that consists in the awareness of sharing with those same facts its root. For this, art is in turn not only creation but also growth in an effective and autopoietic sense: it produces autonomous forms and images, generates an accretion in the infinite number of things surpassing its own object of investigation, and becoming, in turn, a fascinating enigma for man as a self-conscious being endowed with symbolic language. However, if for Gabo this creative dimension could not be associated with the language and methods of classical biology, at that time susceptible to mechanistic and deterministic demands, today instead we know that a new alliance between art and science is possible based on an effective evolution of the codes and principles within biology itself that have gradually abandoned the ancient diatribe between structuralism and functionalism by virtue of a systemic approach inspired by the anti-reductionist and anti-deterministic turn of epigenetics [17]. Thus, once in opposition to Thompson's formalism, Gabo's constructions can now be interpreted as prophetic insights into the history and development of the biological sciences. Gabo's work, as well as the works of Arp and other artists today, more than in the past, stimulate interpretation, research, and perhaps the creation of specific biology of art that probes its appearance and structures [16]. However, it is a new science that is inherent in its destiny that checkmate that was common to those who preceded it because we can analyze forms and phenomena, but we remain astonished to contemplate their intrinsic and harmonious organization of process [18].

Epigenetics and Metabiology

Recent findings in molecular biology and cognitive biology have led some scholars to recover the centrality of development in evolutionary dynamics, thus giving new emphasis to the processes of epigenesis and individual genotype modulation [19]. Such research opens the door to a more in-depth study of the relationship between cultural evolution and natural evolution, going beyond the "genocentric" version of the modern synthesis, according to which adaptation occurs exclusively by the natural selection of random DNA modifications. In this perspective, therefore, the role played by cultural evolution in genetic variation acquires a precise meaning, in so far as hereditariness at this point involves not only DNA but also the information (epigenetic instructions) that regulate its expression. Recent studies on the fruit gnat confirm that a DNA marker is transmitted from parents to their children, becoming essential for embryo development [20]. This documents once again that DNA is not the only biological information transmitted from parents to their children: epigenetic instructions regulate gene expression without affecting the DNA sequence and are transmitted to the offspring [21]. It means that "epigenetic memory is essential for the development and survival of the new generation" because what we learn and know affects, in ontogenetic terms, the growth of what we are. In reproduction, therefore, "epigenetic information is not only inherited from one generation to another but also important for the development of the embryo itself." This process leads to a review of the classical perspectives of identity and biological growth presented, for example, by Thompson and Neodarwinian theorists, bringing out an extremely more plastic configuration of the living, pushing to the elaboration of a new ontological reflection on the dynamic processes pertinent of the creative dimension of the living state of matter. Thus, these analyses make it possible to revisit the relationship between growth and form, highlighted in the comparison between Thompson and Gabo's different perspectives, overcoming the ancient hiatus existing between the mechanistic and repetitive dimension of scientific language and the authentically creative dimension of artistic language. The epigenetic paradigm shows that even the development can be selective so that part of the innovations introduced in the genetic heritage of a species is screened and expressed in the embryonic period. Intergenerational continuity is not maintained only through gene transfer. There is an entire cell, including cytoplasm and nuclear genome, which is transferred from one generation to another. With it, an organism inherits not only a copy of the parental gene heritage but also a set of organelles and membranes that assimilate the history of life experiences that are transformed from a plane of acquired knowledge to innate ontological realities inscribed and transferred in phylogenetic terms to subsequent generations [17]. A fertilized egg is therefore not only a gene transmission vehicle but also a place of expression of coded information and a place where the recombinatory potential of nucleotide sequences is endowed with meaning because it is placed in a position to express itself in the form of new transcripts and proteins [22]. In other words, the egg acts as a context in which the gene message can become meaningful because it embodies infinite expressive creativity. At this level, the form is no longer a simple order or structure but can rightly be defined as a "dynamic growth process," thus transcending structuralism and functionalism [23]. In this sense, following the lines of research traced in the epistemology of complexity and the fundamental hypothesis of Maturana and Varela, we can infer that living beings are autopoietic systems, i.e., able to produce their own identity by constantly building themselves; consequently, even if they are concretely modified, autopoietic systems are autonomous in the sense that they subordinate any change to the maintenance of their own organization [1]. This progressive flowering of the idea of autonomy and organizational closure by the biological sciences is an exciting aspect of the contemporary scientific paradigm that, at present, shifts the reflections on form towards approaches that go from the world of given structures (syntactic level of bios) to the world of the unpredictable functional and systemic capacities of DNA (semantic level of bios) [24]. In this way, a behavior that takes shape is always linked to a biological characteristic (synaptic plasticity), but it just occurs in the function of an experience in contact with the environment and, however, is not determined by the "genetic program" [22]. In this sense, the optimal organization of a biological system, in deep relationship with the surrounding "environmental significance," should be considered an effective compromise between maximum variability, on the one hand, and the highest degree of specificity, on the other. Therefore, the epistemological discourse can refer to different ways of connection with the variability of the information principles. The invariance that must be protected in a development situation is that relating to the unitary coordination of deep growth patterns. In fact, within this dynamic relationship between surface and depth, we can find the *telos* capable of making us understand how it is possible to maintain an analytical identity even in the progressive and synthetic transformation of information structures [11]. In such a framework, the epigenetic structures that live at the sensorial level then appear to be filtered in the making whose growth is indirectly guided by the intellect through successive changes in the design of the measures at a probabilistic and relational level obtained through the use of specific reflection procedures [7]. In this sense, we can hypothesize that it is this intricate path that allows, at least in part, to achieve a sort of assimilation, indirectly, of the external message, assimilation that strengthens the coupling between the environment and internal self-organizing processes [25]. This opens a new, but at the same time ancient, chapter of research. This chapter currently represents one of the fulcrums of the ongoing investigation in epigenetics and metabiology. No longer understood as a catalog of forms to be reproduced, nature is therefore considered in its constant becoming and presents itself as an analog of the creative process, a process that is embodied in the biochemical fibers of living systems and that today both the sciences of nature and art are able to study. Therefore, revisiting artists such as Gabo, Arp, and Moor, it is possible to examine under a new light the parallelism between biology and art, specifically considering the formative dynamics through which to create autonomous and meaningful images in the conviction that works must be the result and witness of a process of growth and change just like the forms of nature. Therefore, the renewed reflection on nature in the epigenetic field makes it possible to reread in a new way the relationship between Gabo's works and scientific thought. In both investigation fields, the organic concept finds its definition in the gradual shift from the sphere of appearance to the systemic/organismic one. Morphology understood as the "doctrine of the form" emerges as a possible "unifying natural philosophy of the age to come," since in it, form is considered in its characteristics of "disposition, configuration, organization, ordering," no longer understood exclusively in the static sense but analyzed in their production overtime in an a priori unpredictable way [26, p. 20]. For this, Gabo and Arp rejected the denomination of "abstract" for their art, preferring that of "concrete." Even if abstraction for some of them had represented the means to reach a non-figurative art, they shared the opinion that to refer to their works, the word abstract has no meaning since every form that has taken shape is already concrete; "Every work of art in its real existence, being a sensation perceived by any of our five senses, is concrete" [27, p. 109].

How concrete are the epigenetic mechanisms[1] that can include enzymatic modifications of DNA or histones or altered processing, editing, and expression of small non-coding RNAs that can cover the chromatin? Such overlapping and interdependent processes change the accessibility of complexes and proteins that regulate transcription to DNA, influencing their translation and disproving any deterministic hypothesis [28]. This investigation on the evolution of symbolic forms at the level of systems biology has highlighted in recent years the fact that genetic variations can be transmitted from one generation of cells to others in alternative ways to the directional flow of information through the genome. Epigenetic inheritance systems force us to review the gene as the only hereditary transmission unit [17].

These results allow the development of a series of philosophical considerations about the opportunity to elaborate an ontology of symbolic forms adapted to the evolution of biological processes. This new research field, the so-called metabiology, can be summarized in the following essential points. First, this field is a branch of the increased attention given to the environment by biologists, and consequently, a sudden worldwide wave of action that boosted research over the impact of

[1] The most relevant mechanisms that cause epigenetic effects through the activation or deactivation of genes consist of: a) chromatin remodeling due to both DNA methylation processes and histones modification; b) gene silencing due to pathway alteration of small non-coding RNA (microRNA). These processes alter the physical accessibility to the regions of the genome on which proteins and enzymes are bound. These last ones are devoted to gene expression and therefore alter the expression of the gene.

environmental factors on the determination of phenotypes. This led to identifying epigenetic factors that introduce the effects of environmental and genetic factors into the system through *random noise* to generate phenotypic changes while modifications into the genetic code are hidden. Secondly, the investigation attempts to reflect on the ontological fallout of biological data on the centrality of the concept of plasticity in the recovery of the field perspective, that is, a perspective open to elaborating the semantics of biological processes. It can offer first possible solutions different from those of classical formal ontology: an ontology of the living adequate to the fact that the functions (and uses) of organisms are not mappable, definable, predictable, or inserted in a predefined system of alternatives, but are associated with history imbued with meanings understood as symbolic living structures [12, 13]. These epistemological investigations also shed new light on the nature of biological complexity, the flexibility and reversibility of cellular destiny, and the methodological limits of some models inspired by reductionist approaches followed since discovering the DNA Double Helix by Watson and Crick in 1953. For example, Waddington [29, 30] understood more than a decade earlier that life is a systemic phenomenon where matter is constantly oriented by significant, independent, and hierarchical informational flows; life is, therefore, a code that becomes a process, a language that is expressed infinitely through the bricolage of biochemical fibers in constant evolution. Living systems, then, producing what they mean, are deeply connected with the emergence of a specific selective *telos* within their own self-organization; in other words, they do not follow the Darwinian natural selection principle exclusively, and their genome is not a tout-court DNA sequence but a complex network of factors, functions, and memories, i.e., it is the set of DNA and epigenetic factors whose codes have not yet had a complete formalization. The thought emerges in history and results from cultural evolution in continuous relationship with the natural one; therefore, it is necessary to rethink a new metaphysics and a new philosophical realism inspired by new scenarios opened by studies in biology and the evolution of dynamic systems. The metabiology or semantics of biological processes seems to provide the appropriate tools to study those systems whose emerging properties need to be described by identifying the underlying main actors and their mutual interactions. Some issues require explanations different from those we are used to in physics and chemistry:

- "the large number of dense interactivity of parts;
- the hierarchical (and multi-scale) organization of biological systems;
- the dependence of the identity of the parts and the interactions among them on higher-order effects; and
- the robustness and adaptability of biological structures" [31].

The mechanistic paradigm where man and the living are seen as mechanical aggregates on which one can intervene artificially to change their behavior gives way to a metabiological vision that sees the living as a systemic information network that must be regulated in a physiological way [28]. Epigenetics has allowed us to follow the imprints that the environment leaves on our DNA, trying to study the mechanisms that are used by cells to change, to adapt to the environment. It has allowed us to read the signs of time and space on our bodies. The dimension of time and history then comes to be considered as the alternative to the Monodian "genetic program" and to the idea of predefined and immutable atemporal symbolic forms.

In the works of Arp, Gabo, and Moore, as in those of the many other artists with whom they shared the experimentation of new visual codes the search for forms was the main common element. These forms did not refer to a referent, but that they were able to exhaust in themselves their own meaning and their own content. The forms they tried to create were not abstract but absolute [27]. This turning point finds in the autopoietic approach to contemporary living systems and metabiology a deep reverberation that allows us to rethink the methods and languages of science in the light of a possible new paradigm of knowledge able to recover the strength and semantic significance of mythical narratives for deeper intelligibility of the creativity of nature and the human being.

Observing, however, is not enough for us; it leads us to want to touch, experiment, and interact as creative beings who live both inside and outside evolution as autopoietic (and therefore cognitive) generative systems of ever new symbolic variation. All this allows us to read with new eyes the enlightening words of Gabo, who in the first issue of *Abstraction-Création* expressed himself as follows: "art once reproductive has become creator" [32, p. 14]. His words today revisited, allow us to look at the possibility of a deep union between art and science, a union that can generate a new and at the same time ancient strand of scientific research in the field of biology of form whose foundations were laid in the systemic approach of the first half of the twentieth century by Waddington himself [30], who was a pioneer of the epigenetic aspects of development. Gabo's position has been shared by many artists, albeit animated by different sensibilities. In particular, the works of Arp, Gabo, and Moore can be analyzed together, starting from a common attitude towards nature which was outlined in their production at the same time as a reflection on the form. In their sculptures, this one appears freed from every link with the notion of the image that implies the representation of an object and, above all, with that of sign [9, 16]. The sign means (it refers to another), while the form means itself (it produces what it means and does not refer to anything else).

Adjacent Possible and Creativity of Nature Beyond the Entailing Laws of Physics

Within this complex framework of the revision of the doctrines of Thomson's geometry of nature and molecular biology of the mid-twentieth century, the recent studies of Kauffman [18] on the self-organization of natural systems and the integration of Neodarwinian theory stand out. The evolution of the biosphere, in fact, is interpreted according to a completely new vision of the world in which its becoming cannot be established in advance because it does not appear "governed" by laws of implication where everything that becomes constitutes Actual always New [5].

Looking at history, Hegel says, in short, that there is a continuous and creative dialectical process. We could find in this conception of history, understood in a broad sense, an expression of the antientropic process of the universe. What we think of it as "the most complex system in the universe" has become an unpredictable historical unfolding. We are the living children of nature; we are not superior to it. We must not pretend to tear it away from us. Still, according to this new metabiological paradigm, we must treat it with a sense of sacredness to rediscover, revisiting ancient myths. Kauffman, in his book *Humanity in a creative universe* [33], considers the hypothesis that the universe produces "all possible proteins with the length of 200 amino acids," with 20 types of amino acids bound in peptide bonds during its lifetime. Please, remember that with 20 types of amino acids, there are 20^{200} "possible proteins with the length of 200 amino acids." It is equivalent to about 10^{260} possibilities. Now, the shortest time in the life of the universe is 10^{-43} s on the Planck scale. The "universe is 13.7 billion years old and has about 10^{80} particles." It is easy then, according to the American scientist, to calculate that even if all these particles would only form proteins of the length of 200 amino acids in every moment of Planck, it would take 10^{39} times the life of the universe to make all the possible proteins of this length only once. Actually, the universe will not give rise to all the possible proteins composed of 200 amino acids in 10^{39} repetitions of its life. At a higher level than atoms, the universe is mostly non-ergodic.[2] This has a physical meaning: the story begins when the space of the possible is much wider than what actually happens. The universe will not realize all possible proteins, cell types, organs, and organisms, as well as the indefinite hierarchy of levels of increasing complexity at levels higher than the atomic one. In this way, the space of possibilities becomes scarcer and scarcer, and it will become wider as peptides and proteins increase. In Kauffman's eyes, this phenomenon is at the basis of the antientropic process that encloses a part of why the universe has become complex. In a profound sense, the biosphere has become complex and different because it could, that is, because it has transformed itself into the multiple possibilities, it has created and continues to create [33, pp. 64–66]. From this point of view, we can revisit the notion of organization or integers deepened by Kant in the *Critique of judgment* [14], not conceivable without an end that identifies with life, an end that is no longer imposed from the outside, but which, on the contrary, finds its origin precisely within the processes of self-organization. The reference is to living organisms. One way to reach existence "in the non-ergodic universe above the level of atoms" is to be an entire Kantian, "in which the function of the part is its causal consequences" that allow keeping the whole alive. Therefore, given an entire Kantian that exists "in the non-ergodic universe above the level of atoms, we can define the function of a part as a subset of its causal consequences" and, in particular, those consequences that allow keeping alive the whole Kantian [33, p. 67]. Specific examples of Kantian wholes are autopoietic systems, i.e., systems that "build themselves" as autocatalytic [1]. Therefore, "an organized being is not a mere machine. For a machine has only

[2] In standard statistical mechanics the meaning of "ergodic" is that the system will pass through all the small volumes of the spatial state at a given time.

motive force," while the organism contains within itself a forming and regulating force that, as we have seen previously, "shapes" its own constituent materials. According to Kauffman, following the theoretical groove traced by Kant, there exists in living beings a particular force that determines a change of form and movement of matter. This force alters and destroys the state of chemical rest that holds together the constituent elements of food substances on which the organism feeds. G. Ashkenasy has recently developed a similar system composed of nine polypeptides, each of which "catalyzes the formation of a second copy of the next peptide" in a cycle of nine peptides. This collective set is reproduced in the laboratory [34]. Therefore, we can observe the following results:

i. "no peptide catalyzes its own formation;"
ii. the set of nine peptides "collectively" catalyzes its formation from the exogenous starting block, i.e., the fragments of the nine peptides supplied from outside;
iii. this autocatalytic system is a Kantian whole, or autopoietic system, in which the whole exists for and by virtue of its parts, i.e., nine peptides;
iv. the function of each peptide is defined in terms of its role in catalyzing the formation of the next peptide. On the other hand, if a peptide causes water to swing in the Petri dish that contains the nine-peptide system, the latter is not a function but a "side effect." We have thus distinguished the function of the peptide, i.e., its causal role in forming other peptides, from other possible causal consequences, which are side effects;
v. thanks to the evolution of such a set, the functions of peptides can sometimes improve;
vi. this ability "to define a function as a subset of causal consequences that can be improved in evolution further separates biology from physics, which cannot make the distinction among all causal consequences into a subset which are functions." Therefore, as we will see later, Biology is beyond physics because it cannot predict the evolution of new functions, i.e., it does not provide implying "laws for the evolution of the biosphere;"
vii. if we define "catalytic reaction" as the functional "catalytic task," the nine-peptide system reaches a functional task closure in its world, which allows it to survive in this universe that is not ergodic above the atomic level. "The functional task closure in his world" is a metabiological concept that is fundamental not only in the living realm but also in the artistic production of conscious autopoietic systems like us humans. According to Kauffman, the organisms exist as *functional wholes* that support functional closure, or more generally, a functional "sufficiency" in an actual sense yet to be defined, in their worlds that may include other organisms with which they are functionally coupled in a fruitful way.

In this sense, the entire biosphere reaches a wave of functional sufficiency that propagates together with the events of speciation and extinction whose intricate intertwining of interconnected functionalities goes beyond our narrative, as Darwin also said. The evolution of the biosphere is the unfolding of always functional sufficiency, wave after wave, for 3.7 billion years, with small and large extinction events and now, a myriad of species and even more interconnected structures and processes in a continuous infinitely creative DIY [5, 6]. “These ever-new functions constitute the ever-changing phase space of biological evolution.” If we cannot know which functions will emerge in the future, “we cannot write differential equations of motion” for natural evolution either. Therefore, we have no implied laws for evolution. Moreover, we cannot predict in a non-circulatory way the niche of every organism in its world: we, therefore, lack both the laws of motion and the boundary conditions, i.e., the niche that would allow the integration of implying laws [31]. In light of all this, we can infer that, in accordance with the theses of Kauffman and Ashkenasy, we have that:

i. the number of uses of a function in biology is indefinite; and
ii. the hypothetical list of uses is a “nominal scale,” since they are all “different uses.” “Thus, there is no ordering among these uses,” i.e., which one can be “larger than.”

Suppose to accept statements i and ii. In that case, “no effective procedure or algorithm can list all the uses of a screwdriver or find new uses of screwdrivers. Further no effective, propositional, procedure can find a new, unordered, use of a screwdriver” [33, p. 71]. Significant examples of such dynamics in biology are the Darwinian preadaptations. The feathers needed for flight evolved in birds as a thermoregulation tool were then co-opted for flight. The little bones of the middle ear that “transmit sound from the eardrum to the inner ear” were preadaptations of a vibration-sensitive jaw with which a primitive fish was equipped. In both cases, new functions were born in the biosphere, such as hearing and flying. Evolution itself, therefore, creates the future evolutionary possibilities of the biosphere. As for the unpredictability of the evolution of the universe since the preadaptations, we have overcome Darwin; it is the evolution of the biosphere itself that creates the future evolutionary possibilities. “Life is a miracle of largely unprestatable becoming.” New Actuals arise and do not cause, but enable new Adjacent Possibles, new pathways or opportunities for evolution to “explore” in the antientropic process” [33, p. 73]. In an even broader sense, in reductive materialism, Weinberg dreamed of a unifying theory [35], which would include everything that must, can, or could happen in the universe. The same was true for Thomson’s geometry of nature which reduced the creativity of nature to mere objective and measurable productivity according to universal parameters of an extensive nature. But the evolving biosphere, which is part of the universe, is not involved by any law in its becoming, so the dream of reductionism is broken. There could not be similar implying laws for the becoming of the whole universe. We can still send probes to Mars thanks to Newton’s laws, general relativity is widely confirmed, and quantum mechanics is verified up to the eleventh decimal place. Yet, no law implies the specific evolution of the biosphere. Reductionism and determinism as a vision of reality seem destined to failure. This metabiology or semantics of biological, anti-reductionist, post-Newtonian, and post-neo-Darwinian processes, outlined so far, is based on a model of post-nomothetic science and can be summarized in Kauffman's words as follows: "New Actuals are enabling constraints that create new, typically unprestatable, Adjacent Possibles in which New Actuals may arise, creating yet more new Adjacent Possibles" [33, p. 76]. This, being the case, there is a continuous becoming in the unpredictable Adjacent Possibles that evolution itself creates in an emergency that goes beyond any implying law. Science, therefore, also consists of historical forms that allow establishing a new alliance between biology and art. Artistic innovation, in fact, in this new metabiological paradigm is like innovation in the biosphere, i.e., mostly unpredictable because it creates new Adjacent Possibles that we inevitably evolve in epigenetic terms (by behavioral and symbolic variation), without being able to predict the Adjacent possible that we ourselves realize. We human autopoietic systems are radically free, radically emerging, and radically creative. In fact, in human life, we are "sucked" into the "Adjacent Possibles" that we ourselves, without knowing it, contribute to creating. This new perspective can undoubtedly find an artistic and symbolic reference in Jan Vermeer's 1669 work *The Lacemaker* [36], in which the kingdom of the Lacemaker is depicted and whose freely conceived work of art allows the continuous emergence of new possible forms of vision and life. The image of the Lacemaker can therefore be a sort of icon symbolizing the evolution of symbolic forms in the evolutionary evolution of the biosphere, which continuously favors the emergence of new functions in Darwinian preadaptations and in many other types of adaptation, for example, cultural niches [19]. In conclusion, we can infer that it is impossible to establish in a way that is not vitiated by circularity the conditions around the niche of an organism (meaning environment), separating it from the organism itself. Once again, no law implies the becoming of the biosphere and the evolution of symbolic forms of culture and art become life, i.e., embodied information (self-organizing form in action) + meaning (selective response).[3] *Embodied creativity*, in this sense, is the autopoietic process of incarnation, reconstruction, assimilation, and reduction of information in the biochemical fibers of every living organism (and therefore cognitive) realized under the conditions of double selection and in accordance with sophisticated procedures of biological self-organization (enaction and reflexivity). In other words, it appears necessarily modeled by the symbolic forms and mathematical modules of non-linearity that, domesticating chaos, determine and shape it.

[3] It should be specified that the concept of meaning used here does not refer to consciousness, but to the ability of each living system to respond selectively (by changing its behavior and the environment around it) to the stimuli that determine significant internal changes of state to achieve a precise telos: the maintenance of its autonomy. The concept of meaning, therefore, within the theory of complexity, is understood as a profound process (potentially infinite capacity) of "production of forms" (in the sense that it "cuts" forms creatively) and, in accordance with Carsetti [12], Atlan and Louzoun [37], is applied in several disciplinary areas. In this sense creativity coincides with maximum selectivity.

Conclusion

"We cannot prestate the evolution of new functions in the biosphere, hence cannot prestate the ever-changing phase space of biological evolution which includes precisely the functions of organisms and their myriad parts and processes evolving in their worlds" (process semantics). In this new metabiological and epigenetic perspective, the evolution of the biosphere, but also of art and culture, are all "stories" of the new current ones that create new "Adjacent Possibles" where the evolution of the biosphere and our becoming flows. Usually, we do not know the Adjacent Possibles that we create and in which we flow. These stories about atomic levels in which the universe is non-ergodic are not something that happens, willingly or not: it is an unfolding, mostly unpredictable, in which what is Actual creates the possibilities of becoming ours and of the biosphere. Therefore, the article highlighted the limits of reductionism (eliminative materialism) and genetic determinism, laying the foundations for the elaboration of a metabiology of form inspired by a naturalistic and autopoietic approach where the concept of meaning as a selective response (whose creativity coincides with maximum selectivity) allows a holistic anchorage for the study, in informational terms, of the relationship between growth and form beyond the functionalism vs. structuralism dichotomy of classical biology. At this level, embodied creativity coincides with the emergence of life itself.

Core Messages

- This chapter identifies the characteristics of the living from the perspective of the epistemology of biology.
- It clarifies meaning as a selective response internal to biological self-organization processes.
- It delineates the metabiological and epigenetic aspects of the biological shapes interpreted as a gradual potential for growth.
- It includes a prolegomenon to an evolutionary metabiology of the creativity of symbolic and artistic forms.
- It analyzes selective aspects of biological information with reference to the relationship between form, function, and meaning.

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Within the Box: Captives of Our Own Mind

7

Christopher A. Haines

> *"If I ever find a problem I cannot solve, I make it bigger. I will never solve it by trying to make it smaller, but if I make it big enough, I will eventually find the outline of its solution."*
>
> Dwight D. Eisenhower

Summary

This chapter discusses how our thinking becomes trapped "within the box" because we do not understand how the two hemispheres of our brain operate. This ignorance leads to a strong tendency to steer with our "rational mind," and society as a whole has gone that way. Our rational mind would appear to be a wise choice, but it comes with baggage that has led to our society's current problems. It is only by understanding the breadth and systemic nature of what our brain offers that we can recognize the wisdom of a balanced path. This discussion is largely based on the work of Iain McGilchrist, *The Master and his Emissary: The Divided Brain and the Making of the Western World*.

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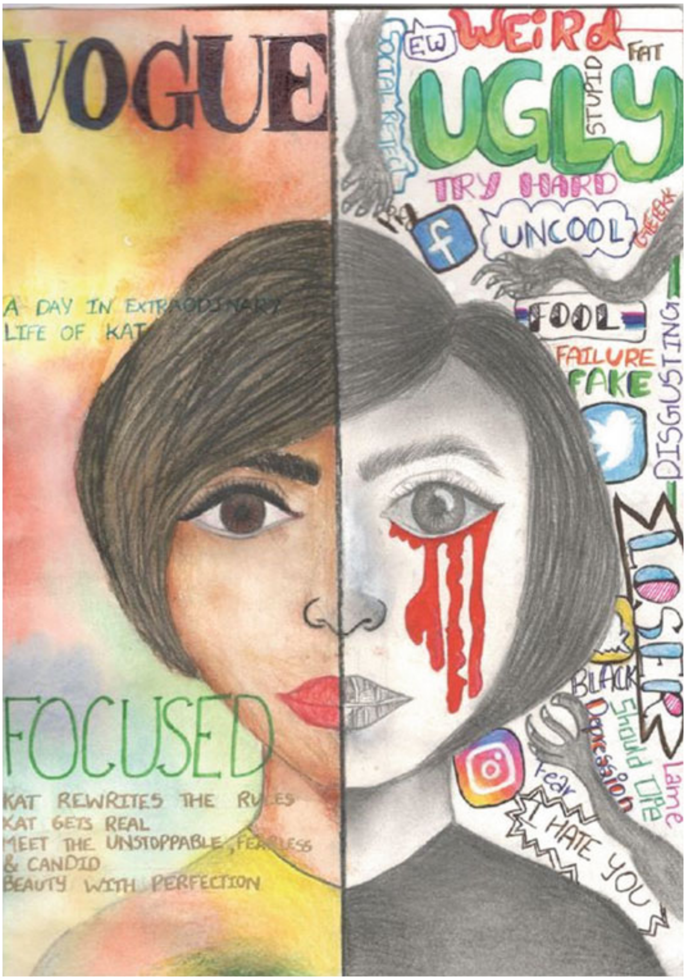
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_7



Thinking within the captives of our mind
(Adapted with permission from the Health and Art (HEART), Universal Scientific Education and Research Network (USERN); Painting by Jiyanshee Shah)

Keywords

Bureaucratic · Closed · Intuitive and wise · Left hemisphere · Open · Overoptimistic · Realistic · Relationships · Right hemisphere · Utility

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

> for us as human beings there are two fundamentally opposed realities, two different modes of experience; that each is of ultimate importance in bringing about the recognizable human world; and that their differences is rooted in the bi-hemispheric structure of the brain. It follows that the hemispheres need to cooperate, but I believe that they are in fact involved in a sort of power struggle, and that explains many aspects of contemporary Western culture.
>
> Dr. Iain McGilchrist [1]

Engineers are fond of saying, "you cannot manage what you do not measure." In the case of the human brain, "we are captives of what we do not understand." It is only by learning how our brains work that we can start recognizing its operations and learn to control them. While individuals have intuited much of this for millennium, the full story was not revealed until recently. Furthermore, due to the nature of the power struggle noted above, many critical aspects have been neglected.

"I am not a psychologist or neurologist, but *an architect and student of climate disruption* who recognized that our thinking is at the heart of our problems. While I have read extensively on the subject, I do not claim to be an expert. An expert would require more space to explain the nuances and dangers of the over-simplifications that I am forced to make than the entire length of this *chapter*" [2].

I will primarily stick to key points on how our lack of understanding of our mind's operations traps us, increasing our likelihood of thinking in a left hemisphere mode, and how that impacts ourselves and society as a whole. This tour encompasses a wide variety of information that I will mention only briefly as it impacts the main story. Further details are available in the references. All errors and misrepresentations of the work of others are my own.

While I have read many books on brain science and the workings of the human mind, most of them said little of importance. It was not until I read *Iain McGilchrist, The Master and his Emissary: The Divided Brain and the Making of the Western World*, that I found an author writing about critical material. McGilchrist spends nearly 250 pages on clinical findings of the workings of the split-brain, followed by over 200 pages of western history demonstrating how these different thinking patterns played out in society. It is a tome that I expect has gotten far less attention than it deserves, probably because it is a tome, and it is not in the dominant thinking pattern of our time.

McGilchrist was an English professor before he went back to school for his medical degrees as a clinical psychologist and psychiatrist. He spent time at John Hopkins in Baltimore, working on brain imaging. He may be fluent in five languages, appearing completely comfortable describing the nuances of word meanings from historical and philosophical treatises in English and German but also Greek, Latin, and French.

Humans have the advantage of the neocortex, but the split-brain structure is shared with the entire animal kingdom. Thus, these characteristics are developed to a limited degree in the simplest animals, through reptiles and rodents, to the more complex mammals.

In an evolutionary context, the right hemisphere is responsible for not getting eaten for dinner. It had to be conscious of its environment and alert to dangers. It gathers information through the senses and rapidly processes that material for all possible contexts and meanings. Failure could be fatal. Survival also required building relationships with everything else out there. The left hemisphere, on the other hand, was responsible for finding dinner. It had to understand and manage the obstacles it faced in achieving that goal. It achieved this by generalizing its environment to recognize qualities that could assist in success. Table 7.1 briefly summarizes the primary findings from the first part of the book as the basis for discussing the remainder of this chapter.

The book title comes from a Nietzsche story about a wise and well-loved master with a small but prosperous and happy domain. The master was unable to do everything demanded of him, so he enlisted emissaries to represent his interests with neighboring realms. His most intelligent and capable emissary realized his position and manipulated circumstances that enabled him to overthrow the master and take over his position. He successfully deposed the master, but the result was the demise of the domain and his own ruin.

As you have probably guessed, the master is represented by the right hemisphere and the emissary by the left. What qualities make a master loved and respected? Also, what qualities, when lacking, make a highly intelligent, but ambitious

Table 7.1 Characteristics of the two brain hemispheres

Left hemisphere	Right hemisphere
It knows but does not believe: "A closed system which cannot reach outside itself to whatever it is that exists apart from itself" [1]: • It manipulates fixed, re-presented abstractions, ignoring context, and living qualities • It dislikes change • It craves certainty and makes the implicit explicit • It mistrusts that which is not clear and direct • It values that which can be measured but is more concerned with precision than accuracy	It believes but does not know: an open system grounded in its environment, receptive to informational stimuli, with context: • It is concerned with living individuals and their unique, messy, imprecise, and limited realities • It accepts change, movement and the unknown • It embraces implicitness and duality • It is the source of metaphor, poetry, humor, and artistic creations • It is open to wonder and awe
It is primarily concerned with utility: • It sees the world as a resource to be exploited • It seeks power and control • It is goal-focused and competitive • It is unconcerned about others and their feelings	It is primarily concerned with relationships: • It lives in implicitness and betweenness • It seeks life and relationships • It is the source of empathy, sympathy, and morality
It divides and sub-divides elements and organizes them into categories: • Vocal, the source of language and logic • It sees the whole as the sum of the parts • It builds systems and arguments logically and linearly, with bifurcate choices	It is intuitive and wise, operating almost subconsciously from experience and moral concerns: • Non-vocal, yet plays some part in language • It sees the whole as a dynamic, living system
It is arrogant of its abilities and overly optimistic about its prospects. It is not only blind to its weaknesses but willfully denies them: • It is dismissive of anything it does not control or understand • It is unable/unwilling to admit ignorance and perfectly willing to fabricate stories even in the face of overwhelming evidence to the contrary • It is not keen on taking responsibility: "Evidence of failure does not mean we are going in the wrong direction, only that we have not gone far enough in the direction we are already headed" [1]	It is realistic, maybe melancholy due to mortality and empathy: • It re-integrates and humanizes the creations of the left hemisphere back into the living world

emissary dangerous? McGilchrist sums this up clearly: [all italics are mine] "We need the ability to make fine discriminations, and to use reason appropriately. But these contributions need to be made in the service of something else, that only the right hemisphere can bring. *Alone they are destructive*. And right now they may be bringing us close to forfeiting the civilization they helped to create" [1].

The story amply shows that the left hemisphere is a valuable tool necessary to fulfill many human endeavors. However, personally ambitious and without morals, empathy, or a sense of justice, it is dangerous on its own. It is ill-equipped to address personal realities and utterly befuddled by complexity, leaving it poor at best in addressing ecological systems. McGilchrist devotes a chapter on whether the left hemisphere could be successful by itself, even by its own criteria, and the conclusion was that it could not.

While we can find many faults with left hemisphere thinking, McGilchrist documents the parallels between pure left hemisphere thought and schizophrenia, indicating just how anti-social it can become. Biology did not design it to be used exclusively. The purpose of having two parts of our brain is to use them synergistically. The peak of human attainment is a world with an integrated balance that brings out the best of both hemispheres, exemplified by the flowering of the Renaissance.

However, the left hemisphere's qualities make this a hard balance to obtain, particularly if we do not understand our own mind. Platonic philosophers put us on the road to left hemisphere dominance with the idea of the perfection of the invisible. Western society has ever since shown an increasing tendency to justify itself with the thinking patterns of the left hemisphere, and society as a whole has accepted those arguments. The arguments are seductive, and it becomes hard to be confident that there is something wrong with a plea for consistency, or a dismissal of something that is framed as too far-fetched to take seriously. Both of these are calls of the left hemisphere. That does not mean they are wrong. They may be wise, but without a full understanding of the circumstances, we have no way to know. Neither hemisphere is inherently better or worse, only different, and that is the reason that a synergy between them is so important.

We will proceed by considering the characteristics of the left hemisphere and how it can lead us astray and then look at how the right hemisphere can balance those qualities. We are only captives of our own mind if we allow ourselves to be thus. With an understanding of how our brain works, we can become its master, to reduce the errant paths it can lead us onto, and explore the horizons it offers.

The Left Hemisphere: *"It Knows, But It Does Not Believe"*

A Closed System

The first characteristic of the left hemisphere that is critical to understand is that it is a closed and entirely self-contained system. It is fed information by the right hemisphere, but strips that information of context and living qualities. It thus deals exclusively in represented, static abstractions. Portraying that as 'represented' is intentional. Everything the left hemisphere knows is of its own creation.

Because left hemisphere images are 'static,' they are also 'dead,' unable to convey living qualities. As life is a process of change, the left hemisphere is poorly suited to comprehend the ecological environment. Math and physics are more suited to left hemisphere thinking, and they are, in fact, the more popular sciences. The more we know about biology, the more it can be abstracted into 'ideals,' the more amenable it is to left hemisphere manipulations. However, the 'down in the muck' of biology is not a left hemisphere exercise.

In the line between faith and knowledge, the left hemisphere falls clearly into the knowledge camp. However, that camp is less tidy than hoped, with implications for the search for 'knowledge.' Firstly, the left hemisphere dislikes change as it requires reworking its images, like redoing a jigsaw puzzle. It needs to bolster its positions with 'proof' to assure certainty and avoid the need for change. However, it is unable to trust, meaning there is never 'enough' proof. I have joked that the last three words of research papers are "more research required." Generally true.

This plays out in a variety of ways. For example, hiring managers are frequently so scared of getting the wrong candidate they add job requirements until no one has them all, and they then complain that there are no qualified candidates. Years ago, I knew a colleague with an architectural degree and some work experience seeking a low-level position in an architectural firm. He found a listing that looked promising until he got to the end of the add. In addition to architectural requirements, the position required fluency in English, Mandarin, Swedish, and Portuguese. If there is anyone in the world who speaks those four languages, I seriously doubt they have any architectural credentials. This is pure left hemisphere gone mad!

The left hemisphere is, as we might expect, concerned with measurement. However, consistent with its internal focus, it is more concerned with precision, that can be generated internally, than with accuracy. Thus, engineers can generate several decimal points of precision based on a premise that is only within perhaps 30%. Home weather stations that I have investigated offer precision of one-tenth of a degree, but an accuracy of plus or minus four degrees. What good is a tenth of a degree, if it cannot confirm if it froze or not?

Case Study: Planetary Area

As a more significant example, did you know that the Earth's land surface may be twice what has been measured by satellite imagery? Dr. Rob Blakemore has pointed out that even with satellites doing the photographing, the measuring of those images assumes that the area within any set of coordinates is two-dimensional (2D), perfectly flat. A reasonable estimate of the planet's flat land surface area is 12 billion ha or 29.65 billion acres. Stucco textures, with hills and valleys, have actual surface areas from 40 to 100% greater than the underlying flat projection. Thus, the irregularities on Earth's surface, from small to large, could account for an additional 12 billion ha of soil surface available for photosynthesis and carbon sequestration [3]. Sophisticated technology is nothing more than an extension of the left hemisphere thinking that created it. While it takes on a grander image, it does not always deserve it.

Utility

The left hemisphere's primary purpose is to obtain resources, like dinner, for the benefit of self, and it views its environment as the source of those resources, there for the taking. In these pursuits, the left hemisphere is goal-focused and competitive in the push for success, riches, winning, or whatever goal. This aspect of the left hemisphere can be a good thing, depending on the context. Many raise their position by pushing themselves to achieve what they otherwise would not.

The left hemisphere is also concerned with dominating its environment, seeking power and control over it. That can occur on a wide range of scales, from personal control to building empires. As a small example, the mini-empires and the in-fighting that result in companies, organizations, and academia are famous. These are frequently cases of left hemisphere control of whatever the environment offers. A manager or academic chairman creates his/her empire with the group they have available and crown themself king/queen. Of course, others can push back, creating the famous dynamics.

Unfortunately, the left hemisphere has a complete disregard for others and their welfare. Thus, it is entirely capable of major injustices without even noticing that anything is wrong. If a human does not engage their right hemisphere in these circumstances, their left hemisphere can promote unfettered horror.

Case Study: Mesopotamian 'States'

Scott [4] documents that the Neolithic human achievements, sedentism, farming, the Domus, irrigation, and towns were all well in place long before we see 'states' arise. He argues that the early Mesopotamian civilization that we hail as the origins of western culture was built on the oppression of peasants who were forced into agriculture as a means of generating a surplus for the king.

In what was then a multi-functional marshland, hunting and gathering was a far more appealing source of livelihood but was untaxable and thus not conducive to the creation of states. Elites then hijacked the Neolithic achievements as a foundation for power: "on the basis of what we now know, the embryonic state arises by harnessing the late Neolithic grain and manpower module as a basis of control and manipulation" [4]. It also appears that those who could escape to a life unfettered by the state did so. If he is right, this turns the traditional narrative on its head, but it provides a solid example of left hemisphere empire-building in early history.

Divides and Sub-divides

The left hemisphere is the source of language and logic, and the utilization of language is one of its primary weapons. It builds arguments logically and linearly to prove something, defend itself, or for any other goal.

Its first weakness is that the outward facts on which its arguments are based are isolated from the outside world. If the two hemispheres do not coordinate on this, a great deal of internal logic may be founded on complete untruths. Persecutions, such as the Salem Witch Trials, but of course also others, come to mind as examples. Those cases also exemplify other qualities of the left hemisphere that were equally culpable in the results.

The left hemisphere views the world in either/or choices; an offer is to do this or that. The search for a third, or alternate option is not a left hemisphere one. Of course, humans are fully capable of that search, but only when they engage their full brain. Computer code based on two options is the perfect left hemisphere tool.

While the left hemisphere wants everything in communication clear and precise, it is perfectly capable of making assumptions without clarifying them. As it operates within the world it understands and can control, its assumptions are homocentric, based on what it knows. Items outside of its knowledge, such as life forms too small to see, or time frames much longer than a human lifetime, are frequently not considered relevant.

There is an example from this topic area. For a long time, researchers tried to understand "what do the two hemispheres do?". That is a left hemisphere question that discounts the contributions of the right hemisphere. So, it is not surprising that the result was a considerable quantity of data that left the answer more confused than before. You can find several books that say there are no differences. It was not until they started to ask: "In what manner do the two hemispheres do what they do?" that they began to understand the differences [1].

The left hemisphere sees "the whole as merely the sum of the parts." As it sees the parts as dead entities, there is no room for them to interact with each other, and the left hemisphere is not good at recognizing relationships. Thus, it has no way to understand the interactions that create complex systems, living or non-living. In Meadow's primer on complex systems [5], she noted that one of our primary errors when operating complex systems was pushing the lever in the wrong direction. Our brains get so confused by complexity that they fail to understand the implications, even when it is an either/or choice.

The left hemisphere organizes, categorizes, divides, and subdivides the parts in a myriad of ways. We benefit in such organizations as structures of biological species, families, genus, geological rock and soil types, and many others.

One of the primary creations of this process of organization is bureaucracy. The organization of positions, their relation to one another, and the rules and regulations that control their interactions create an organization that can 'control' something. This organization may be a small group, a company, a government department, or the government itself. The lure of a 'system' to solve the many issues an organization may face, cuts across the many purposes or situations that define it.

The system's structural design is frequently supported by checklists and manuals of practice with rules and regulations on how to address any contingency. Because the left hemisphere would prefer to believe a directive than its own senses, this frequently leads to rigid, law and order approaches that are unable to address the human conditions of the people involved. Exactly the conditions the left hemisphere is ill-equipped to solve. The workers in those positions are people with human feelings about their position and how they are treated. The clients, and those who interact with the workers, also respond to how the employees and the 'system' treat them.

Many excellent employees do their very best to be helpful and constructive, but when the system is designed without thought to human qualities, it frequently incentivizes destructive procedures. The left hemisphere excuses itself by saying, "Don't take it personally; it is just business."

The other significant ramification of the left hemisphere perspective on division and sub-division is the specialization of knowledge, most evident in academic silos. There may be many causes of this, from defining a subject area that you can fully understand, to control of a piece of turf, to other cause.

Specialization has caused two significant impacts on society. The first is that all that focused brainpower has produced a massive explosion in information, which has exacerbated the second, that the only academic credential considered of value in society is deep-knowledge in a narrow field. Specialization is paralleled by a central focus on math and sciences as the only topics worthy of study and a drastic reduction in funding for the arts and social sciences. Is it clear that left hemisphere values and perspectives are a significant reason for this restructuring of society? Is this the result of a dutiful emissary or a rogue leader?

There is some recognition of the problem. There is a greater focus on teams and a substantial increase in combined fields where, for example, biology and chemistry combine into some new area, but generally to look at some specific issue from that combined perspective. A great deal of the pharmaceutical industry is based on this sort of combined perspective.

I attended an academic conference a few years ago, where the faculty was promoting cross-departmental study programs in environmental studies to provide their students with a broader perspective than they had obtained. From the presentations I attended, it appeared that the students had benefited from that exposure. However, the faculty appeared not in the least interested in widening their own perspectives. Their presentations were so narrow-focused they seemed utterly irrelevant.

One example of this having had significant ramifications on society over the past 40 years is climate disruption. Climatologists are experts in understanding the physics of large climatic systems that impact the planet's climate and weather. That is not a small achievement. Weather forecasting has undoubtedly improved since I was young and woke up to 6″ of 'partly cloudy.'

On the other hand, climatologists who are experts in understanding the atmosphere are less expert in understanding the land. To generalize the land characteristics that impact the weather, they have adopted 'albedo' or reflectivity as a measure. This is helpful because planes with sensors can measure albedo over large areas.

I do not know the basis for their decisions or what they know or do not know. What I do know is that albedo is not a good measure of planetary heat characteristics. The solar reflectivity of a forest varies due to species, but is typically noted at about 15%; NASA uses 14.0% in its models. The reflectivity of brick, and other construction materials, is also about 15%. The problem is that albedo ignores the 85% of the solar energy that is not reflected? In the case of the forest, 18% converts to heat, 1% is used for growth, and 66% transpires water that results in cooling [6]. In the case of an inanimate object such as the brick, all 85% converts to heat. Thus, a more comprehensive range of knowledge produces a very different understanding.

Case Study: Heat Planet

Heat planet provides an example of what must be one of the significant mistakes of science with tragic consequences, due; it would appear to over-specialization, and other left hemisphere characteristics. Greenhouse gases were codified as the cause of climate disruption in 1979 with the publication of the Jason and the Charney reports. The latter commissioned by the Carter White House to review the former.

The Jason Report states: "This report addresses the questions of the sources of atmospheric carbon dioxide, considers distribution of the present carbon dioxide among the atmospheric, oceanic and biospheric reservoir and assesses the impact on climate as reflected by the average ground temperature at each latitude of significant increases in atmospheric carbon dioxide" [7]. The conclusion was that greenhouse gases cause climate change.

The report was a detailed and sophisticated study of carbon dioxide (CO_2), based on a correlation of rising warming with rising greenhouse gas levels. The conclusion would have been valid if they had proved that all other climate characteristics remained stable. But the study did not investigate other causes. Science confused a correlation with causation, a violation of the scientific method.

Due to this, we have spent the past 40 years blaming the "pot lid" for the pot boiling over. Greenhouse gases trap heat and exacerbate warming, but they do not generate heat. With all the brainpower and expertise worldwide, no one seems to have asked, "where does the heat come from?" We need to think about 'turning down the stove.' Once we identify the stove, we have an enormous opportunity to reduce warming directly, locally, and in a short time frame, with the majority providing substantial economic and ecological benefits [8]. Perhaps equally disturbing, the world has fallen in line, deferring to the 'experts,' another left hemisphere quality.

Arrogant and Over-Optimistic

The left hemisphere has no place to process information that it does not understand. It is unable to generalize material where it cannot identify underlying issues. Thus, it tends to simply dismiss the information as being irrelevant. It also is not interested in information that it cannot control. If there is nothing it can do about something, that information is not of concern to the left hemisphere. Thus, many people focus very narrowly on specific topics, not even recognizing why they find only those issues important.

The left hemisphere is the classic Freudian ego. It denies its weaknesses, attempting to present an invulnerable façade. It is unable to admit ignorance and will claim to know subjects of which it is entirely ignorant. It is unable to accept responsibility and produces endless excuses for some other source of the problem. In true Freudian form, it is also unable to admit error and states that "we are not on the wrong path, but have simply not gone far enough on the path we are on" [1]. "Denial, a tendency to conformism, a willingness to disregard the evidence, a habit of ducking responsibility, a blindness to mere experience in the face of overwhelming evidence of theory: these might sound ominously familiar to observers of contemporary Western life" [1].

Case Study: Losing Earth

Rich [9] documents the pressure for action exerted on the government after the Jason Report publication. The Carter administration was eventually convinced to consider it and commissioned the Charney report, which generally confirmed what the Jason's had concluded. Then, Carter led the National Academy of Science and designed the one-million-dollar study of the carbon dioxide problem. The panel worked for the next three years, with Reagan in the White House, while everyone waited for their recommendations. When they emerged with a report, the 496 pages of "*Changing* climate" were filled with dire consequences of the worst kind. However, at the press conference, when speaking of the findings, the committee chairman, William Nierenberg, seemed to totally change his tune, recommending *"caution, not panic."* It was a serious problem, granted, but "if it goes the way we think, it will be manageable in the next hundred or so years. Better to wait and see. Better to bet on American ingenuity to save the day. Major, immediate intervention in national energy policy might end up being more expensive and less effective, than actions taken decades in the future, after more was understood about the economic consequences of a warmer planet. Yes, the climate would change, mostly for the worse, but future generations would be better equipped to change with it" [9]. The backsliding and unwillingness to take responsibility continued through the first IPCC meeting in 1988 and set us on the course that got us here.

In summary, the left hemisphere is not a person; it is a tool that we all have available to use appropriately. It can provide essential strengths to assist our efforts, but it is wildly undisciplined by itself and is entirely ill-suited to be in control. In *Voltaire's Bastards: The Dictatorship of Reason in the West*, Saul [10] provides a horrible, hilarious, and mind-boggling excursion into the ills of reason. He opens with three simple statements, the last being: "Like most religions, reason presents itself as the solution to the problems it has created" [10].

By understanding how it operates, we can recognize its influence, utilize its strengths, and control its weaknesses. To do that, we must engage our right hemisphere and ensure it remains the master.

The Right Hemisphere as Master: *"It Believes, But It Does Not Know"*

In recognizing the right hemisphere as the rightful master, we must also recognize that the left hemisphere's *Modus Operandi* includes devaluing or ignoring what it cannot understand or control, including the right hemisphere. It is not irrelevant to note that the corpus callosum where the nerve fibers from the two hemispheres meet, appears to be designed at least as much to inhibit communication between the two hemispheres, as to enhance it [1].

This is evident in current society that, as it acquiesces to left hemisphere arguments, devalues right hemispheres' qualities and reduces or eliminates activities and programs that build and support the right hemisphere. Art and the social sciences, not to mention religion and spirituality, have been devalued or viewed as luxuries in a rush to STEM (science, technology, engineering, and math) as the only "important" fields. Those in these "soft" fields know otherwise, and sometimes talk of STEAM to include art but are generally ignored.

Thus, in a society where technology and data are seen as the solution, support for a right hemisphere culture that could manage the left hemisphere has also been losing ground. This resultant lack of a balancing right hemisphere allows the left hemisphere an increasingly broad scope, leaving society dealing with all problems as isolated events and from one limited, piecemeal perspective. That imbalance also limits its ability to resolve human and cultural problems, leaves it without an understanding of systems, and deprives it of flowering of the human brain's combined strengths.

Of course, many individuals understand this and are working diligently to make a difference, but the 'trend' is against them. To repeat, "these contributions need to be made in the *service* of something else, that only the right hemisphere can bring. Alone they are destructive" [1].

An Open System

The right hemisphere is alert, engaged in reality, and not off in its own world. Disengagement and failure to observe a predator could be fatal. The problem of disengagement is a focus of many religious traditions as the cause of spiritual failure and touted as well as a significant business cost. A more robust right hemisphere culture might assist in that.

The right hemisphere deals with real, living individuals and does not ignore the messy details. Human and cultural problems are all based on human realities and the problems around them. We cannot ignore the "messy details" and still resolve the issues we face. There are many dedicated social workers, nurses, and many others who address these issues with the utmost professionalism and do an excellent job. However, society as a whole does not value their work and does not pay well for it. Many of the now-famous "frontline workers" in the pandemic of coronavirus disease (COVID) are likewise dedicated but severely underpaid, and until recently, wholly unrecognized. Will society now recognize them and ensure they get compensated at a reasonable rate in remembrance of the many who paid with their lives?

The right hemisphere recognizes that life is a process, things will change, and it takes that change in stride. It also accepts that there is much that is not known and even cannot be known, so it faces the unknown in the same manner as it faces changing circumstances. When preparing for the future is such a critical element in business and effectively all organizations, it seems counterproductive to approach that problem from a perspective that dislikes change. But that is what our rational mind does. Perhaps that is why most projections show no changes on the horizon, and we get blindsided by some occurrence, like Covid, that no one anticipated.

The right hemisphere is comfortable with implicitness and duality, birthing creativity and creative expression. That openness allows for metaphor and nuances of meaning, where poetry, drama, music, and humor can develop in the betweenness of words, images, sounds, and ideas. This is the stepping-off point for artistic creations where the exploration of meaning and levels of meaning can be woven together in new and exciting ways.

The right hemisphere is also open to wonder and awe. It can be consumed by the majesty and beauty of nature, natural events, and exquisite forms. As the left hemisphere cannot control our experience of beauty, it tries to stamp out the idea. "The left hemisphere…has here set about neutralizing or neutering the power of art" [1]. Moreover, while it has to a great extent made beauty culturally unacceptable, "we cannot get rid of the power of beauty by a decision in theory" [1]. The classical values of architecture were structure, function, and delight. Delight that lifts the human spirit is very much a part of being human, and all of the art recognizes and values its creation.

The open and connected right hemisphere is a nearly direct counterpoint to the closed and disconnected left hemisphere. It is fully able to deal with real, living individuals and their messy details, the flows of life and change, implicitness, and duality and yet to be open to the wonder and awe of incredible beauty. This is the perfect balance to the dead abstractions of the left hemisphere. With the right hemisphere as master, we as a species can genuinely live in the world, yet keep our abstract mental processes providing value, but isolated and away from human interactions where they might cause harm.

Concerned with Relationships

The right hemisphere is deeply concerned with relationships between living entities, but especially people, relishing family, and community. It values the relationships it builds with others and seeks these relationships as the basis of life. None of this is available in the left hemisphere, so our most basic human relationships are non-events to our "rational mind."

Due to these connections, the right hemisphere feels and understands the pain and elation that others experience. These connections are the basis of empathy and sympathy, which flows onto a deep concern for moral relationships and social justice. These concerns thus flow from direct connections to the social realm and can flow to the political realm with policies that care about and protect people caught in circumstances not of their own making. Without right hemisphere intervention, is it any wonder that a rise in marriage counseling, divorces, and social dysfunction have followed the drive to technology and efficiency?

The right hemisphere also works within relationships, in the spaces between objects, essential in artistic design. Followed by the excellent work *Drawing on the Right Side of the Brain* by Betty Edwards, providing an early discussion of the architectural implications of society changing its way of "seeing," Hale [11] proposes that American society changed its hemisphere of focus about 1820 with the introduction of Greek Revivalist architecture that focused on objects with meaning and message, left hemisphere ideas. He promotes returning to "The Old Way of Seeing" using the power of visual images and the relationships within them.

I fully agree with Hale and commend him for his work but propose that an "old way of seeing" is applicable, and even critical, for an awful lot more than aesthetic design. Most, if not all, the major problems society faces are also in need of that "old way of seeing." Our total dependence on our "new way of seeing" is how we got here, and its continued use will only get us more of the same.

So again, the human-centered right hemisphere is nearly the perfect counterpoint to the power and goal-centered left hemisphere. While the left hemisphere is out for itself, the right hemisphere is out for others, acting as a foil to protect the innocent. Thus, the left hemisphere's drives, which it is unable to control, can be readily reigned in by the right hemisphere. With the right hemisphere as master, the goals can be productive contributions to self and society, and the interactions assure that no one else gets hurt, and there is no downside to left hemisphere projects.

Intuitive and Wise

The right hemisphere bases its beliefs on its own experience and its concern for equity and justice. While individuals with limited experiences, such as youth, can be led astray, the focus on the whole of life supports a broad perspective and systemic understanding. Thus, it finds wisdom in a deep understanding of everything around it, like elders of aboriginal tribes that take advice from everyone and boil it down with a concern for fairness and equality to provide the best that society can deliver. That is not to say that the elders of old were never wrong, but that their thinking process was integrative and expansive, not reductionist.

The right hemisphere is non-verbal, but because it embraces implicitness, it plays a role in the nuances of words and meaning, as discussed above. McGilchrist writes on the possibility that music was the first form of communication; the emotional responses to music provide mutual understanding between people. The first languages may have been variations on song. Thus, the locus of communication developed in the right hemisphere but transferred to the left hemisphere with the development of speech.

The right hemisphere recognizes the whole as a living system. It recognizes relationships and sees how entities interact to create something more than the sum of the parts. This is particularly important in the living world, where systemic interactions are the basis of life. It is also important in understanding other complex systems, such as cities, considered the most complex entities created by humans.

Curiosity and breadth of knowledge bolster an understanding of systems. This combination is well-positioned to synthesize from the vast offerings of specialized knowledge to address society's systemic problems, both ecological and human-made [12]. The flowering of the Renaissance was the result of just such a synthesis of the two hemispheres with a degree of success rarely equaled. President Eisenhower identified the key to this approach, as noted in the opening quote: "if I ever find a problem I cannot solve, I make it bigger. I will never solve it by trying to make it smaller, but if I make it big enough, I will eventually find the outline of its solution." Effectively nothing was known about split-brain science when Einstein said, "You cannot solve a problem with the same level of thinking that created it." However, he clearly understood the different forms of thinking that we now understand based on the brain's bi-hemispheric structure.

The wisdom of the right hemisphere is more context within which life works than a direct counterpoint to the reductionist thinking of the left hemisphere. We benefit from the fruits of the left hemisphere's organizational skills but suffer from the sharp edges built into it. It is precisely these points where systemic racism and other forms of oppression are built into our social structures. The very acknowledgment of that context softens and humanizes the systems the left hemisphere creates, providing a review from a different *"level of thinking"* to build equity and human connections.

Realistic/Melancholy

While the left hemisphere is overly optimistic, the right hemisphere is realistic. The need for realism plays out in several ways. A realism in expectations is essential for creating plans with back-ups and alternatives that recognize things that might not go as assumed. We mentioned earlier that most plans are straight-line projections of current conditions. If alternatives are not considered seriously, it may leave you without preparation when events do not follow your script.

It is also critical to anticipate "unexpected events." While I am not aware of anyone having predicted the COVID pandemic specifically, I understand that many in the public health arena understood the likelihood of some form of a pandemic occurring at some point. Even without details, preparation for this sort of event goes a long way towards making it through. My understanding is that these alerts were ignored, and the government was unprepared.

This illustrates the need for realistic responses to warnings. Studies of civilization failures [13, 14] point to warmings provided to leaders about impending perils, some imminent, and others farther in the future. Many of the events that toppled civilizations were known about, but no, or few actions were taken to prevent them. The dismissal, denial, and over-optimism of the left hemisphere appear to rule.

Expectations for the future are complicated by our acceptance of the vocal left hemisphere as the source of intelligence. When we put our faith in "intelligent" leaders to the extent that their left hemisphere dominates them, they are more likely to be over-confident in their positions and unrealistic in their projections. Of course, a knowledgeable individual uses both hemispheres, but society does not always see it that way.

The right hemisphere is aware of the left hemisphere's limitations and works to humanize its creations and re-integrate them into the living world. It also works to keep the left hemisphere in line and not allow it to go off on its own. It is, however, clear that it does not always succeed.

This realistic perspective of the right hemisphere can leave it subdued and even melancholy as it views the future, aware of and concerned by others' suffering. This is particularly true when it sees ominous events emerging and society in its hubris, ignoring them.

Thus, once again, the realism of the right hemisphere can counter the over-optimism of the left. It can help us see the real world we inhabit and recognize and listen to warnings others make. In humanizing the left hemisphere, the right is more able to accept responsibility than the absurdity of the left hemisphere's denials of culpability.

Conclusion

> Wise men say, and not without reason, that whoever wishes to foresee the future must consult the past: for human events ever resemble those of preceding times. This arises from the fact that they are produced by men who ever have been, and ever will be, animated by the same passions, and thus they necessarily have the same results.
>
> Niccolo' Machiavelli

Let me note I am in no way condoning the horrible words and deeds of Machiavelli in the use of this quote, only recognizing what I see as a wise statement.

There is frequent talk of "outside the box" thinking, but I do not see much evidence that very many people have thought about what it means. After all, the box is defined as: "a closed system which cannot reach outside itself to whatever it is that exists apart from itself" [1]. It is not that no one is thinking outside the box, but there is a lot more talk about it than there is "outside the box" thinking. I hope this chapter at least provides an insight into the topic.

There is nothing easy about fully understanding all this material and integrating it into your thinking. It will take effort, time, and patience, but insights into your own thinking and recognitions into the thinking of others will occur. I discussed a parallel concept in Lifelong Learning as a Sustainability Strategy [2] about how we need to discover how to maintain and upgrade our built environment in the coming years. Perhaps the parallel would be helpful.

The end of the Nietzsche story provides a fitting conclusion. The emissary was able to overthrow the master, but that destroyed the domain and his own ruin. The power "struggle between the hemispheres" is stacked in favor of the left hemisphere, and it seems to be holding all the cards. Only when society recognizes the nature and ramifications of this struggle does the right hemisphere have a chance of success.

Core Messages

- The right hemisphere can provide balance and control for the strengths and abilities of the left hemisphere.
- An open brain can keep the closed system in contact with reality.
- The concern for relationships, people, and justice can balance the concern for power.
- The recognition of living systems can lessen the destructive aspects of over-division and provide context for interactions between elements.
- Realism and humility can balance the left hemisphere's arrogance and irresponsibility.

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8 The Dialectic of Mind and Matter in the Trialectic Approach: A New Path of the Cognition Process

Ulrich Richter

Sapere aude – Have the courage to use your own mind!

Immanuel Kant, reply to the question: what is enlightment? (1783)

Abstract

The essay does not solve any of the controversial problems on the borderline of the humanities and the natural sciences, but with the essay, a new path is presented, on which the necessary knowledge about the things of the world can be gained. With the method: the trialectical approach, the problem of the non-decidable dialectic of matter and mind is representable, argumentative, and visual, leaving open the concrete factual questions, which are stated in the process of science, putting back the given answer into the process of cognition. The principle of this method, a combination of the semiotic triangle with the critique of Hegel's dialectic, is analyzed and reflected in the horizon of metaphysics, the cornerstone of every methodology. The subject who thinks the dialectic of mind and matter is the focus of the argument. The core of my argument is the idea that neither the philosopher nor the physician can verify the truth of their arguments. The physician reaches his limits when he is to explain why his doing has not defeated the death up to now. This explanation fails because death is a constitutive moment of life that is not possible without matter, but life is more than mere matter. Up to now, the philosopher has failed to explain what the mind is because he cannot go beyond that what has been told and can be told in the myths about the being of man. The necessary narratives promise a solution which in life is denied by the dead, the factual existence of matter.

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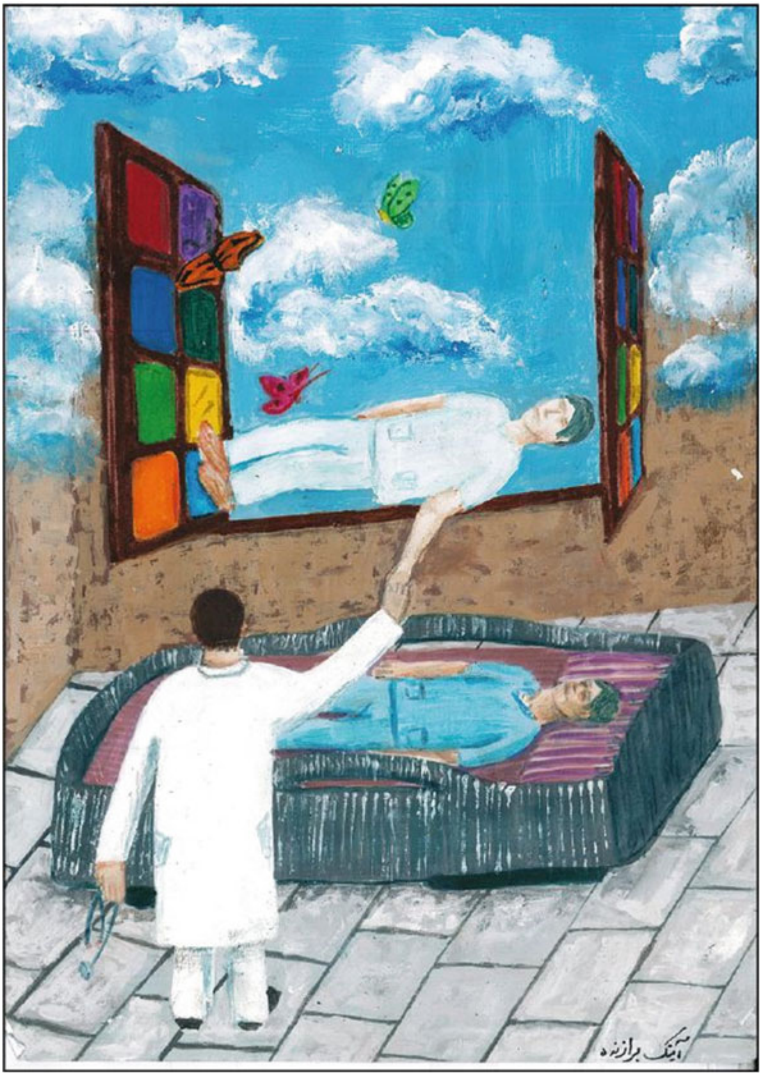
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_8

Graphical Abstract/Art Performance



Life: beyond predictions (Adapted with permission from the Health and Art (HEART), Universal Scientific Education and Research Network (USERN); Painting by Aytak Barazandeh)

Keywords

Dialectics · Difference · Humanities · Matter · Method · Mind · Natural sciences · Subject · Trialectic approach · Trialectics

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

The Outlines of the Problem[1]

In the history of men,[2] the distinction between mind and matter[3] had always been the object of the fiercest controversy, a dispute which is not dissolved either on one side

[1] The notes have the function of a subtext, too, (a). The orthography (b) and the terminology of the relational argument require further references which would have disturbed the flux of thought in the text. As something which is new, the text cannot refer back to a broad discussion in the relevant sciences, but I can point at my texts, explaining the relational argument, differentiated from the ontological argument (c).

(a) The subtext is limited to some remarks, because the limited space for the essay forced shortenings in the planned sketch of annotations. In general, I point to my homepage, where the texts are available as well as the links to the INDEX/register (*1).

(*1) www.ur-philosoph.de /bibliography, and /INDEX/register.

(b) There is to remark one particularity in my orthography which should not be ignored, because it is fundamental for the logic of the text. It is the use of the colon with final comma (point) which differs from the practice. The term which stands after the colon is the variable, the term before the colon is the constant, parts pro toto the concept: mind, and the concept: matter. The sign: ", is set, if in the variable the terms are separated by a comma or colon, pars pro toto the term: "the letters: a, b, … n," (*1).

(*1) INDEX/register, keyword: orthography.

(c) INDEX/register, keyword: relational argument und ontologist argument.

[2] In the horizon of the relational argument the distinction: history or historia, is to be observed (a). The term: historia, refers to the historical facts which can be documented with a document of historia. The term: history of men, refers to the narratives/myths which people tell each other, today and then. The debate: mind and/or matter, is conducted in this horizon. As far as the documents of historia point back in the history, the separation of mind and matter is the cantus firmus. People speak of the spirits which rule over the matter, the sea as well as the land and the sky. With the determination of the facts, nothing is explained, neither something about the mind, or anything about the matter.

(a) INDEX/register, keywords: geschichte und historia.

[3] The German terms: geist und materie, are translated with the English terms: mind and matter. The translation: materie ==> matter, (a) is unproblematic, the translation: geist ==> mind (spirit),

or on the other side. Either the opposing parties put the mind first, interpreting the matter as an emanation of the mind, or the matter should take the first rank, the mind understood as an unnecessary element of matter. In view of the historia, the fact of not being decided is indisputable, and the end of the dispute is not recognizable insofar as signs are appropriately interpreted. The thesis of the essay is that, on the one hand, this controversial question is not decidable, but, on the other hand, it has pragmatically to be decided in the process of science and is decided in one way or the other.

The opposites are the problem of the concepts: mind and matter, being in contradiction, negotiated in the dispute.[4] The objects of the dispute are things of the world,[5] but no binding measure is available, which is qualified, logically compelling, to show the valid truth of the knowledge about the things and their social assessment. As things stand, the problem cannot be solved without resorting to the belief of the people, dissolving (forcibly) the one quarrel, and creating a new quarrel. Also, the scientist,[6] the art scholar not different from the natural scientist, must justify each method in the horizon of the purposes fixed in his methods. He must justify why the found result is methodically correct and not wrong. The logic of the procedure, realized in each method, is undisputed but disputed is the result of the procedure held in an argument.[7] The founding reason of each method is a blind spot which, as stated in practice and played over in theory, is a place of twilight at which every argument, conclusively set, appears ambiguous. Neither with the methods of the natural scientists (= matter) nor with the methods of the arts scholars (= mind), the ambiguity of found knowledge can be resolved but much would be achieved if this ambiguity can be made visible in the argument methodically proven.

appears more complex. Either the term: mind, or the term: spirit, are possible, but with a different meaning, a distinction which cannot be done with the German term: geist, but it is possible to give additional explanations. With the term: mind, different phenomena are called, partes pro toto: anima or soul, including consciousness (of himself) as notions of the subject, thought in his forum internum. The thinking of the subject is to be included, too, grasping the things of his world in their materiality. The term: mind, refers most accurately to the object of the text.

(a) Here, the sign: ==>, is used in the meaning: translated.

[4] In the horizon of the relational argument, the adequate translation of the German terms: widerspruch und gegensatz, is difficult. It's usual to use the term: contradiction and opposite (contrast). The concept: contradiction, used in logic, is not the phenomenon: opposite (contrast), real in space and time, a complicated situation when the term: (to) contradict (= widersprechen), is used for the handling, formulated with the term: (to) opposite (= opponieren).

[5] The English term: thing of the world, is a translation of the German term: ding der welt. All the things which the subject can grasp, imaginated and formulated in the forum internum as concepts and ideas, and handled in space and time on the forum publicum, are things of the world (a). The possible distinction: "matter, life and mind", is subordinate.

(a) INDEX/register, keyword: ding der welt.

[6] The term: scientist, refers to any subject who perceives the things of his world, guided methodically. The common distinctions are subordinate, partes pro toto: "natural scientists or arts scholar, physicist or philosopher". The distinctive feature is that everyone is committed to the causality which is set by them in their autonomy.

[7] Set in the horizon of the relational argument, in the discourse every idea or every thought is treated as an argument (a), if the thought is methodically indicated in the horizon of the prevailing causality

(a) www.ur-philosoph.de /bibliographie /signatur: 029: argument.

The Controversial Question: Mind or Matter, Is Methodically Unsolved

What the mind or the matter is supposed to be, that, as stated in historia and history, is controversially discussed. The opposite is the constant in the discourse, but, on the one hand, the matter is present in the phenomena of nature; on the other hand, the mind is present in the phenomena of culture, mediated in the phenomena of life. It should be present that in the perspective of the own existence, the process of reflection on the difference: matter/mind, is guided by every scientist as the subject (= “individuum als ich”).[8] The difference: mind/matter, is argumentatively reflected by the scientist in the perspective of the mind, even if he can point out that the object of his doing is mere matter, undisputed according to the common understanding. The matter is moved, one state follows the other, but the mind moves something, always following a certain pattern, which can be described with a method. That, what is called by the term: something, are things of the world, undisputed according to the common understanding, events in space and time which cannot be determined in their sequence, determinable by a method. With this argument, a determination seems to have been made, which, according to the tradition, gives to the mind the primacy over the matter. This objection, however, must be countered by the fact that, if this interpretation of the methods is valid, the difference: matter/mind, would be pulled down and all, what is, is either only matter or only mind. The subject of the method would be without object; the object of the methods would be without subject. This answer does not correspond to the reality in which the scientist grasps his object with the appropriate method, necessarily presupposing the distinction: mind and matter.

[8] The term: subject, is the translation of the German term: individuum als ich, central for my thinking. A literal translation of the term is impossible (a). For this reason, the literal translation: the individual as I or the individual as a self, are misleading. Because I have not found an adequate translation for the German term: individuum als ich, I was forced to resort to the traditional term: subject, but I do not take over the connotations of the concept: subject, (b) discussed in the tradition.

(a) Based in my orthography, the problem is located in the words: Ich/ich. The German noun: Ich, is generally translated into English, either with the term: I, or with the term: self. Insofar, there is no problem, but I use the terms: Ich/ich, clearly differentiated. Grounded in my use of orthography, the meaning of the German terms: Ich/ich, cannot be mirrowed in the Englisch term: I. If I use the term: Ich, then is fixed, that I am the author of the thought and no other. If I use the term: ich, then is fixed the concept: das ich. According to the orthography, this differentiation is not possible in English. The sign: I, always stands for the traditional subject, the sign: i, is not used, standing for each other concept: “subject: I or self”.

(b) As the actor of all events the human being is the central concept of this essay, designated by the term: the subject, a term which is problematic regarding tradition. The problem is located in the general term: subject, which is used for opinions (= interpretations of the men) which are valid in the relational argument as well as in the ontological argument. For avoiding misunderstandings, I have developed the term: individuum als ich (*1).

(*1) INDEX/register, keyword: individuum als ich.

The Purpose of the Essay

The premise of the essay is that the distinction between mind and matter is valid, both for the natural scientist, who cannot disregard himself in his work, and for the arts scholar, who cannot ignore these things of the world in his reflections on the things in the world, which are something other, different from himself. The problem is how the scientist as a subject, determined in natural science or in the humanities, can succeed in his methods, linking the two aspects of his existence without losing sight of the other aspect. On the one hand, in the practice of the scientist as a natural scientist, the aspect of the mind is to ignore and can be excluded from case to case; on the other hand, the scientist as an art scholar can ignore the aspect of the matter, letting disappear the facts under the label: the dialectic of mind and matter. It is admittedly taken to knowledge that the practice to let disappear the fact and not to take knowledge of them is a universal phenomenon, but nevertheless, the problem of selective perception (= matter) and reflection (= mind) has not been eliminated from the world.

The essay tries to take it another way. The difference of mind/matter is accepted as valid but linked to the restriction that any conceivable method can be valid only if it is stated that the concepts matter or mind are designated as moments of their validity in the horizon of the other concept. The projected method, developed in the critique of Hegel's dialectic, is named "the trialectic approach." This method does not provide a conclusive answer to the specific questions. Being in disputation, the question and the answer over the phenomena of matter and of mind, mediated in the phenomena of life stay open, but it can be made clear what is the critical point of any method which no scientist can ignore if he wants that his knowledge is to be compatible with the conditions of the rational argument.

The Main Body

The Method: The Trialectic Approach

The trialectic approach is a process that, embedded in the European tradition, contradicts the fundamental principle of this tradition, the idea of being, which is an idea thought by the subject. The idea of being, the whole, is opposed to the idea that only the subject can be the subject, a part in the whole, who is the source of his knowledge of everything of the world which the matter and the mind are to be.[9]

[9] The problem: metaphysics, is to be mentioned (a). The horizon of my argument is a certain version of the concept: metaphysics. I make a strict distinction between the relational argument which I follow and the ontological argument which is the mainstream in the tradition. Both concepts mark the fundamental and only possible perspectives on the world. The subject autonomously decides which perspective it will hold, a perspective which is absolute true for the subject, but, viewing at the tradition as his measure, the subject cannot prove the truth of his decision, well grounded in faith.

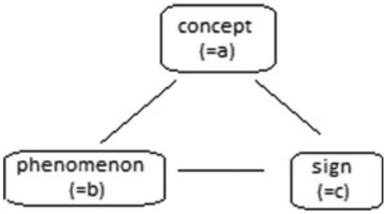


Fig. 8.1 The semiotic triangle, whose corner points are: the concept (= a), the phenomenon (= b), and the sign (= c)

On the Historia of the Method

The term: trialektic, a neologism, has been developed from the term: dialectic. In the number: 2, the principle of dialectic is fixed; the principle of trialectic is marked with the number: 3.[10] Two ideas of different provenance form the fundament of the method: the trialectic approach. One idea is the scheme of the semiotic triangle (Fig. 8.1), whose corner points are: the concept (= a), the phenomenon (= b), and the sign (= c).[11] The second idea is Hegel's dialectic, whose constitutive moments of position, negation, and mediation[12] are progressively joined together in a circle (Fig. 8.2). The combination of the two ideas constitutes the scheme of the trialectical approach (Fig. 8.3).

The Structure of the Method

The method of the trialectic approach is structured in a manageable way. Constitutive are three moments: a, no moment more; b, no moment less; and c, every moment in its rank equal (no priority) (Fig. 8.4). Every two moments are related to each other, excluding each third moment. The method appears complex when the moments, abstractly designated with the letters: "a, b, and c," are concretized with

(a) Here, the historia of metaphysics is not to be discussed, I refer globally to: Historisches Wörterbuch der Philosophie, 13 vols. Basel: 1971ff, keyword: metaphysik, vol. 5, sp. 870–924. Additional the reference to the keyword: geist (mind), vol. 2, sp. 154–204 (210), and the keyword: materie (matter), vol. 5, sp. 1186–1279 (1295).

[10] The terms: trialectic or triolectic, are to have been used publicly by Asger Jorn for the first time, around 1960(a). Without knowledge of the neologism, created by Asger Jorn, I formulated the term: trialectic, around 2000 in order to identify my philosophical intentions more clearly, being in contrast to Hegel's dialectic. The derivation of the term: trialectic, from the term: dialectic, is obvious, if the coinage is not amalgamated with the speculations of numerical mysticism. From the number: 3, nothing can be derived which goes beyond the rank: 3. The ideal image of trialectic is the number: three, in which the notions of a triangle and a circle coincide, conceived as a perfect unity. All other geometric figures are either derivatives or singular elements: point and line.

(a) According to Wikipedia, keyword: Asger Jorn.

[11] I confine myself to a general note and refer to the theory of signs which Umberto Eco had developed (a).

(a) INDEX/register, keywords: semiotisches dreieck and Umberto Eco.

[12] G.W.F. Hegel: Die Logik der Wissenschaft (a).

(a) INDEX/register, keywords: "G.W.F. Hegel and Hegel's dialektik", and www.ur-philosoph.de /bibliographie /signatur: 031:dialektik_weg.

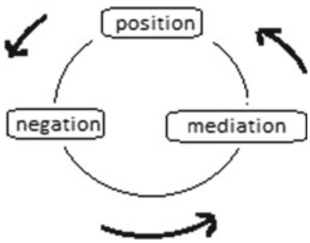


Fig. 8.2 Hegel's dialectic, whose constitutive moments are position, negation, and mediation

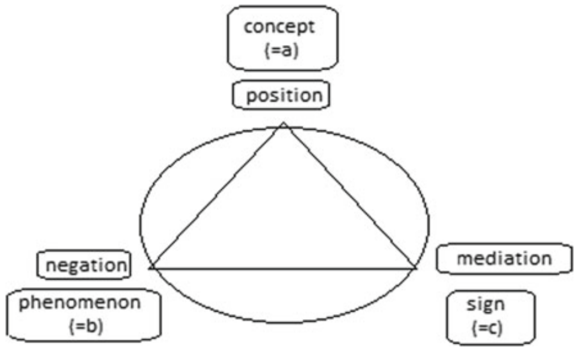


Fig. 8.3 The trialectical approach as a result of the combination of the semiotic triangle and Hegel's dialectic

the things of the world. Each concrete moment opens the view on the cosmos of possibilities which, represented in a certain scheme, holds open exactly as many possibilities as there are subjects who can think these schemes.

The Scheme

The scheme of the trialectic approach shows three moments, set in three relations: "a <==|==> b, b <==|==> c and c <==|==> a."[13] Every conceivable thing in the

[13] A special attention should be paid to the reading of the signs, used in the context of the method: trialectic approach.

The systematic compilation of conventions, used in this essay:

1. The moments:

– for every conceivable thing in the world every conceivable term can be used, also the usual letters: "a, b, … n … z" (read: small a b … n … z. (always without punctuation marks)).

– the small letters: "a, b, c … z", stand for things.

– the capital letters: "A, B, C … Z", for persons (read: capital A B C … Z).

– set as moment of another relation, the relation is set in parenthesis: ().

– the moments of a dependent and/or reciprocal relation are interchangeable in their position. Whether a moment takes the first or the second position of the relation, the formulas are equivalent.

2. The relation-signs: (no empty space before/after the sign)

– the simple relation: ==> (read: relates simple).

– the dependent relation: <==|==> (read: relates dependent).

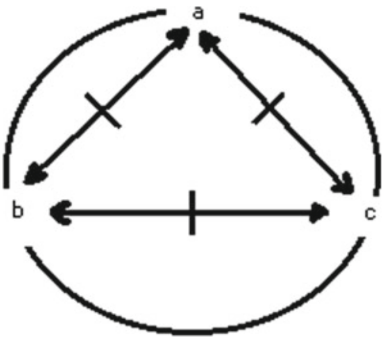


Fig. 8.4 The trialectic approach in a manageable way, whose constitutive moments are a, b and c, no moment more, no moment less, every moment in its rank equal (no priority)

world can be used in the positions of the moments: "a, b, and c," according to the application rule. It is a convention that the subject is used in position a. In positions of b and c, anything of the world can stand that is taken by the subject viewing at his world. The three moments and the three possible relations are parts of a whole which is designated by the term "world," which is, in the graphs, symbolized with the circle, on whose circular line the moments are arranged as corner points of an equilateral triangle. In relation to the object of the essay, the scheme in its graphic representation has the form shown in Fig. 8.5.

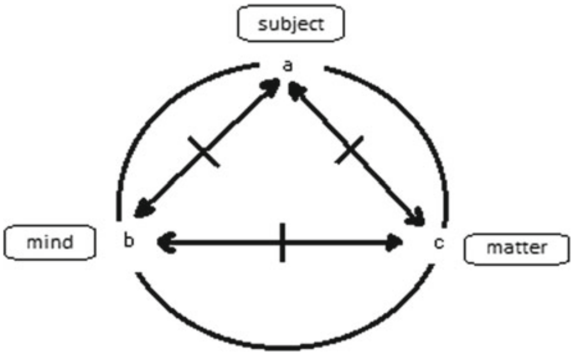
The Relations

In the scheme the relation can be:

- either: simple: a==>b,
  this is the situation of causality and is limited to what is referred to by the term: matter. It is the relationship: cause and effect.
- or: dependent: a <==|==> b,
  this is the empirical world in which the aspects: matter and mind, are crossed.
- or: reciprocal: A<==>B,
  this is the situation in which the subject:_A, and his comrade:_B, interact in a social relationship. This is the world of the mind.

– the reciprocal relation: <==> (read: relates reciprocal).
3. Used formulas, as far as reading is not self-explanatory.
– a <==|==> b (read: small a relates dependent small b).
– A <==|==> b (read: capital A relates dependent small b).
– subject <==|==> (mind <==|==> matter) (read: the subject relates dependent the relation the mind relates dependent the matter).
– cause ==> effect (relation) (read: the cause relates simple the effect).
– cause ==> effect (no relation) (read: cause result in effect).

Fig. 8.5 The scheme of trialectic approach as the collective of three moments and their relations



The subject sets the relations: A <==|==> b and A <==|==> c. With the relations: A <==|==> b and A <==|==> c, the subject:_A, has set the third relation: b <==|==> c. The relations of the scheme are parts in a whole which, as the whole, is an argument.

The Excluded Third Moment

Because only two moments can be related in the relation, each third moment in the scheme has the function of the excluded third moment. The moment in the function of the excluded third moment, determining the relation, is not a moment of the determined relation. The subject:_A, can set the determined relation: A <==|==> b, set in the horizon of the excluded third moment: c, not otherwise the relation: A <==|==> c, set in the horizon of the excluded third moment: b. The relation: b <==|==> c, is determinately set in the horizon of the excluded third moment, the subject:_A. It is an implicit problem of the trialectical approach that the scheme is constructed as a closed system that logically functions without contradiction in itself, but empirically, being subjected to the conditions in space and time,[14] the closed system produces opposites which can be explained with a new scheme which prolongs the resolution of the problem.

[14] The formula: in space and time, is a part of the concept of time, valid in the relational argument. The term: time experience, (a) is incompatible with the concepts of time, valid in the ontological argument (b). Living his life in the phenomena of his existence, the subject sets the things of the world which are commonly referred to the term: time. Distinguished by the traditional concepts of time, the phenomena of time are not a contradiction to each other, they are opposites which also can be mutually exclusive.

(a) The German term: zeiterfahrung, is translated with the term: time experience. In the horizon of the relational argument the term: time experience, marks all phenomena which are described as time, being exactly that time which time is supposed to be. In the terminology of the relational argument (*1), the traditional scheme of time is mirrored:

– present ==> the moment of the lived present
– past ==> the factum of the past
– future ==> the projection into the future.

(*1) INDEX/register: zeiterfahrung.

(b) Effective in the tradition, certain theories of time remain unaffected by the relational argument, pars pro toto, the time theory of the physical sciences.

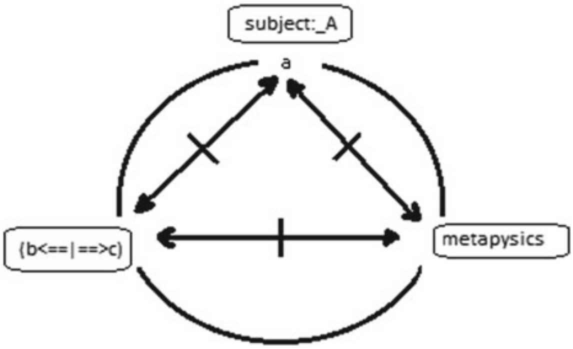


Fig. 8.6 A scheme of the trialectic approach, whose constitutive moments are the subject, metaphysics, and the third relation

The Metaphysics of the Method

Indeed, the dilemma of the system theory, namely the experience that the founding reason is not an element of the established system, can plausibly be demonstrated by the subject, applying the method: the trialectical approach. By setting the problem of determining the founding reason as a moment of the relation, the relation is determined in the horizon of the excluded third moment, which the subject has grasped in a different relation. Every attempt to name the reason with a set relation is an idea of the subject, which is located in a belief or in theory, in this text summarized under the term: metaphysics.[15] If, as a moment of the set relation, the third relation: b <==|==> c, is to be held, the subject must refer to his own ideas, which can be summarized in their multiplicity under the term: metaphysics. This is a new scheme; it is another scheme (Fig. 8.6).

The Problem of the Dialectic of Mind and Matter

Each scientist captures the object of his interest with a method that is determinately enclosed in the horizon of a named theory. The applied methods are distinguishable in their appearance, but their principle is causality[16] which every scientist

[15] The term: metaphysics, is limited to its declaratory function.

[16] The concept: causality, (a) formulate the relationship: if/then, as the logical foundation of every method. The set cause has an effect, fixed in the relation: cause ==> effect, (b). In space and time on the forum publicum, the effect and its cause are named by the subject. In the relational argument and in opposite to the ontological argument, set by the autonomous subject, every form of causality is absolutely binding for the subject who has set the causality, his comrade can accept or not the set commitment of the subject, being for himself autonomous in his decision. The problem of causality is not located in the mechanism: if/then, but it is founded in the subject who has set the ground (= faith), deciding what the effect is to be (= knowledge).

(a) INDEX/register, keyword: kausalität.

(b) Remark the difference: on the one hand the relation: cause ==> effect, on the other hand the relationship of things/matter: cause ==> effect.

instrumentalizes in his will to discern the things of the world when he deals with his object, which is at hand in connection with the other possible objects. His object, situated in the horizon of other objects, is a phenomenon, and as part of a convention, pragmatically classified, pars pro toto in the classes: matter or mind, but every object which appears prima vista as unambiguous, is situated secunda vista in twilight because in the process of the application of a method the phenomena can be named, but its assignment in the classes: matter or mind, is not clear. The phenomena of life can be assigned to the class "mind," as well as assignments that are denied in the object: life to the class "matter." In contradiction of the assertions, here the matter, there the mind, the life marks a third class, which is independent. In the extended scheme of classification, the dichotomy of the objects: mind and matter, is dissolved, and it can be demonstrated that regarded as a problem, the claimed dialectic of matter and mind is indistinguishable. For this reason, it is impossible to hold the mind with the principle: causality, but the principle: dialectic, misses the matter. Life seems to be a class of sui generis that is inseparably linked to the classes: mind and matter. Mediated by life, real in each individual, the scientist has the object of his research available, on the one hand, in the methods that are located either in the moment: matter, or in the moment: mind, on the other hand, with these methods the phenomena of life are not sufficiently held, an inadequacy which limits each method either to the principle of causality or to the principle of dialectic. Rational justified, this deficit of the traditional methods is empirically verifiable, but the inadequacy of the methods cannot finally be resolved with the critique of the methods. On the one hand, the method: the trialectic approach, expands the arsenal of the available methods; on the other hand, the intrinsic problems of the causal and dialectical methods remain effective and real in a state of flux. Different and new is the idea that the conflict situation can be made visible with the scheme of the trialectic approach, a method which makes it possible to classify every concrete resolution of a methodical problem, if the question is raised that, as a scientist, the subject instrumentalizes his methods for the purposes which are situated in his interest, individually justified.

The Trialectic: Life–Mind–Matter

It is the subject who determines what the matter or the mind or the life is supposed to be. With this assertion is predetermined, in accord with the tradition, what the moments: mind and matter, are, set in a relation, perceived and reflected in space and time. In the position of the excluded third moment, the subject determines what the matter and the mind are in their relation, mediated in life, changing in space and time.

On the one hand, the basic situation (Fig. 8.7) is abstract to be taken into account; on the other hand, real at every moment of his lived present, the concrete

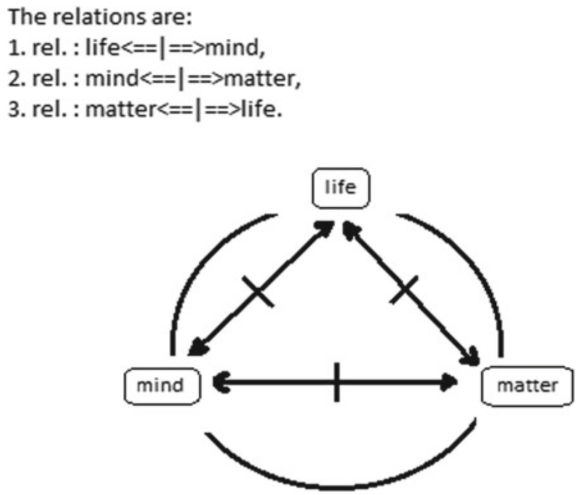


Fig. 8.7 A scheme of the trialectic approach, whose constitutive moments are life, mind, and matter

situation is present for the subject, setting the moments: "life, mind and matter," in a relation. According to the application rule, in the scheme of the basic situation, the subject can be set as a moment in each of the three moments. The schemes mark three distinct situations (Fig. 8.8a–c) that cannot fall identical.

The thought repeated in graphs[17] represent:

the basic situation (Fig. 8.7);
the concrete situations (these are the possible perspectives of the subject) (Fig. 8.8a);
the subject in the position of life (Fig. 8.8b);
the subject in the position of mind (Fig. 8.8c); and
the subject in the position of matter (Fig. 8.9).

If the scheme of the basic situation is put on top of each other with the schemes of the three concrete possible situations, then an image emerges which reflects the disputed core of every methodology.[18]

The object of the method, identical with itself and defined in the set relation, is destined for the subject. If the subject has grasped the determining moment in a second relation, the grasped moment cannot be a moment of the determined relation. In other words, if, pars pro toto, the subject grasps the things of the world from the class of matter with a method, then the subject can grasp the particular thing of the world only in the horizon of the ideas which are assigned to the class of life or to

[17] The graphs in the trialectic approach have an explanatory function, but they do not extend the represented thought. They visually make perceptible the things of the world which the subject thinks. The graph and the text are equivalent.

[18] This image is not a scheme in the trialectic approach. Three schemes are merged, not falling identical.

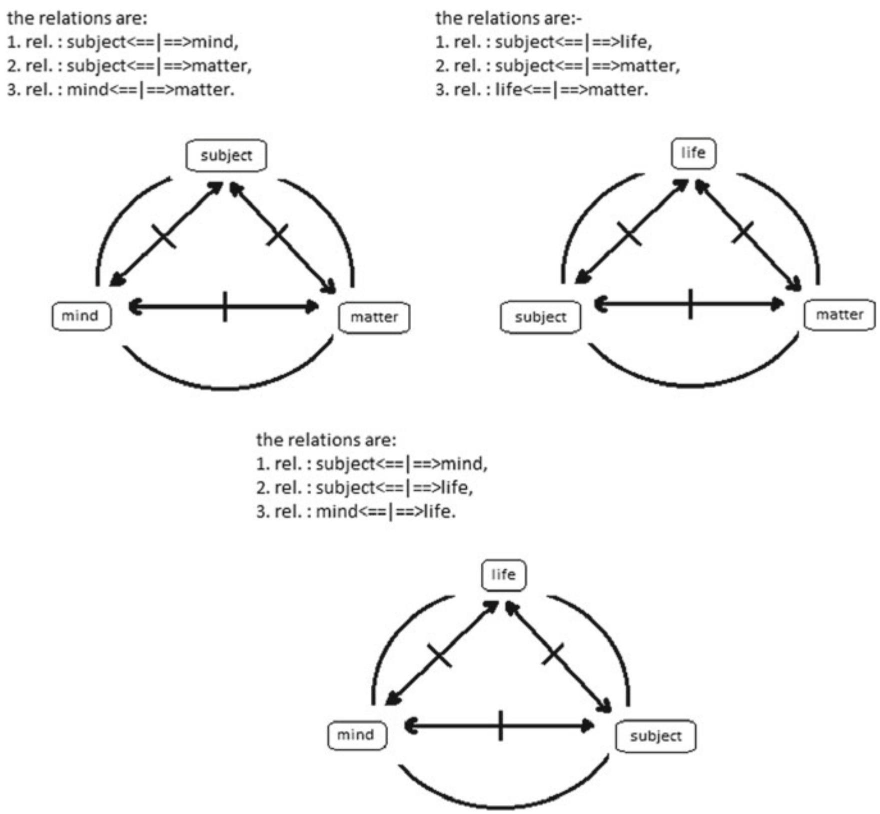


Fig. 8.8 Three schemes of the trialectic approach, whose constitutive moments are subject, matter and mind, or: life and matter, or: life and mind

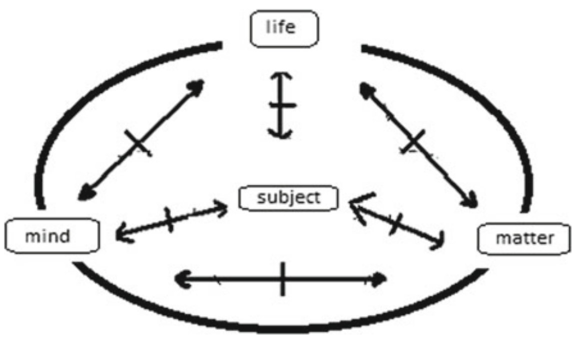


Fig. 8.9 A summary of three schemes of the trialectic approach, whose constitutive moments are the subject on the one hand and on the other hand life, matter, and mind

the class of mind. Without a conceded exception, the subject is at the center of every methodological consideration when the subject deals with his object applying a defined method. Guided by his set purposes, on the one hand, the subject has the object in view in order to subject it to the interests pursued in society; on the other hand, the subject must keep in view the things of the world which are assigned to one class or to the other class, either to life or to mind. In the particular method, each thing of the world, being for itself the third moment, can be effective as the excluded third moment.

The Relation: Mind <==|==> Matter, Set as a Moment

If the subject takes the relation: mind <==|==> matter, as the object of his reflections, then the subject makes these reflections in the horizon of a moment, which in Fig. 8.9, is indicated with the term: life. The concept "life" is, in the same way, controversial as the concepts: mind and matter. If the aspect of the method is to be accentuated, then it seems to be more appropriate and advisable to choose the term: metaphysics, even if the term "metaphysics" is equally controversial. If the problem of the relation: mind <==|==> matter, is to be analyzed and reflected, the phenomena of life and the phenomena of mind are so closely interwoven in the imaginations of the subject that a plausible separation between the possible arguments cannot be successful, intended to create clarity. Each argument creates a new situation, another situation, in which, on the one hand, the subject has set the relation: mind <==|==> matter, as a moment of the relation, whose defining horizon is the moment: metaphysics, which is set by the subject in a second relation: subject <==|==> metaphysics.

Again, the problem is the implied third relation:

metaphysics <==|==> (mind <==|==> matter). It is the subject himself who is the excluded third moment, not being a moment of the third relation, but giving this relation its definite meaning.

Designated as the excluded third moment, the subject must proceed in two steps, looking at the relation: metaphysics <==|==> (mind <==|==> matter) (Fig. 8.10).

In a first step, divided into two partial steps, the subject:_A, analyses the moment: "relation: mind <==|==> matter," and the moment: metaphysics, listing the involved arguments, separated in analytical intention, next to each other/one after the other.

In a second step, the subject synthesizes the material, separated in analysis, forming an argument, argument for argument separated in analytical intention. This argument concretely fixes the real meaning of the relation: metaphysics <==|==> (mind <==|==> matter). It is exactly the meaning which the moment: "relation: mind <==|==> matter," and the moment: metaphysics, are supposed to have in the perspective of the subject.

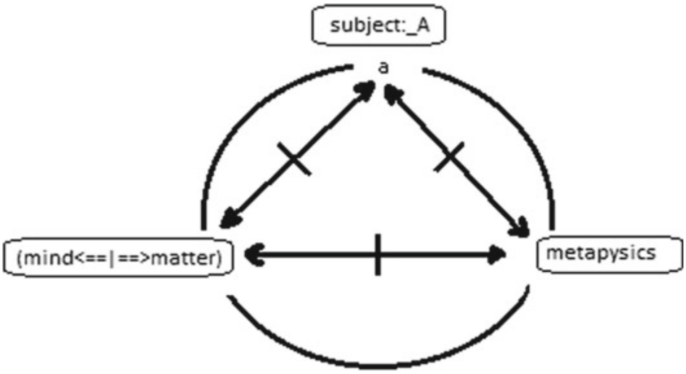


Fig. 8.10 A scheme of the trialectic approach, whose constitutive moments are subject:_A, metaphysics, and the relation: mind <==|==> matter (an extension of Fig. 8.6)

Analysis I: The Moment "The Relation: Mind <==|==> Matter"

In the tradition, the belief is dominant that there are links between the things of the world as matter and the things of the world as mind. The nature of these links is controversial. An effective consensus may be established with every documented analysis, but this consensus is denied with every synthesizing reflection. There are plausible reasons for certain phenomena, present in life as things of the world, which are either assigned to the class of matter or to the class of mind, banal formulated: a stone is a stone and this stone cannot think. It's a general practice to define for oneself the concepts: matter and mind, and to assert criteria for them by which it is possible to decide whether a particular thing of the world is held as a phenomenon with the concept: matter, or it is held as a phenomenon with the concept: mind. The concept, as well as the phenomenon, are distinguishable, and they are distinguished. The reasons for these distinctions, asserted in the determinative process, should not be disputed, but it must be acknowledged that it is precisely this or that reason which identifies the particular thing of the world: n, as matter or as mind. The idea shall be illustrated by two examples, located on the borderlines which are generally believed to separate the mind from the matter and the matter from the mind.

The first example is the network of nerve cells, which is active and produces chemical/electrical phenomena. With good arguments, it can be shown that the nerve cells are designated as (living) matter, but the chemical/electric phenomena are interpreted as manifestations of the (living) mind. As a fact, only the chemical/electrical process is detectable, made visible with a measuring instrument, which is a part of the matter, but, physically real present, the interpretation of the event is treated as a phenomenon of the mind which is physical undetectable.

The complementary example is the thesis of the existence of God, real physical present, but, the existence of the believed God, who is dealt with as a spirit, real present in space and time, is not verifiable with the known proofs of God,[19] because

[19] INDEX/register, keyword: gottesbeweis.

the act of creation, including the alleged causality, is not a part of the evidence, proving the existence of the creator: God.

The necessity of the discriminating concepts: mind and matter, is not in question, yet with every attempt to discern and clarify the phenomena differentiated with these concepts, the possible answers remain in the twilight of doubt. Dealt with the methods of the tradition, the problem of the distinction between mind and matter is obviously not resolved, and every found answer, renewing the distinction in space and time, is put back into the discussion, but, as the result of analysis, the aporie cannot suffice, because in his synthesizing reflection the subject pragmatically overlaps the aporie with arguments which the subject likes to label with the term: metaphysics, arguments which are phenomena of the mind, being perceptions of the subject.

Analysis II: The Moment "Metaphysics"

The subject holds the moment: metaphysics, in the relation "subject <==|==> metaphysics." With the setting of the relation, the subject determines the object which the subject wants to designate with the term: metaphysics, namely the definition of his own concept of metaphysics which the subject thinks, absolute valid for himself, a concept which is a contradiction to each other concept: metaphysics, thought by his comrade, a concept which, perceived as a phenomenon in space and time, only contradicts each other opposite, including the mutual exclusion of the opposite. A glance at the documents of historia suffices to identify the differentiation which can be established between the concept: metaphysics, which Aristotle had thought in antiquity, and the concept: metaphysics, which was thought by Martin Heidegger in the modern era.[20] The concept: metaphysics is an idea of the subject that is present to the subject:_A, as an argument which, according to the dominant conviction in the tradition, is a phenomenon of mind, excluding the notion that the argument of the subject could be a phenomenon of matter. The phenomena of matter and the phenomena of mind are two things of the world that cannot be identical, but, in the perspective of the subject, they are treated as equal without being equal. As a phenomenon of mind, the moment: metaphysics, is something other than the moment: matter, both set as a moment of the relation: mind <==|==> matter, but, both moments, either the metaphysics or the relation: mind <==|==> matter, are instrumentalized by the subject:_A, as the determining moment of the each other moment. In this structure, the exchange of moments: matter and mind, is possible, al gusto,[21] and the assertion of the eternity of the matter appears as a characteristic of just current metaphysics, and the asserted strictness of a metaphysics appears as the causal principle of the matter.

[20] Note: (09/a).

[21] The term: al gusto, marks the fact that, under the conditions of space and time, the idea of the autonomy of the subject (a) must be another idea than the idea of liberty, concepts and phenomena which are discussed in the societies, being real in the forms of civil liberties (b). Each form of the real civil liberties depends on the momentum of an incalculable arbitrition which is the implicit source of each autonomous decision, made by the subject.

(a) INDEX/register, keyword: autonomie.

(b) INDEX/register, keyword: bürgerliche freiheiten.

Synthesis (= Synthetizing Reflection): The Moment "Subject"

In the synthesizing reflection, autonomous in his decision, the subject can exchange the moments: mind and matter, asserting the separation of moments on the one hand, on the other hand, subjugating them to his set causality (= faith). In the function of being the excluded third moment which is the limiting horizon of the relation: mind <==|==> matter, the subject determines what is thought in the discourse about the problems of the world and what is also practically realized, fixed in the relation: mind <==|==> matter, which is subjected to the change of all moments in space and time. Only that can be valid which is decided at the moment of the lived present, things of the world which can be remembered as a factum of the past, on the one hand, or, on the other hand, things of the world which are reformulated as a projection into the future. In this way, set in his relation, the subject has grasped the concept: matter, as well as the phenomenon: matter, in the horizon of any metaphysics, settings which are valid for the subject, things of the world which proves to be stable as well as fragile. In the same way, the subject relates his ideas to the concept: metaphysics, and to the phenomenon: metaphysics, ventilating these ideas in the forum internum as well as on the forum publicum,[22] determined in the horizon of his concept: matter, real in the things of the world. The subject:_A, always precisely presents the concept in his imagination, either the concept of a certain metaphysics indicated in a document of the historia or the concept of a certain thing of the world, which can be a phenomenon of life or a phenomenon of mind or a phenomenon of matter. On the one hand, in his synthesizing reflection, the subject mixes the precisely formulated concept: metaphysics, with a phenomenon of matter, present to the subject in the manifold forms of appearance in space and time, on the other hand, the subject mixes his precisely defined concept: matter, as a phenomenon which is only a substitute for his concept of metaphysics, filling a gap in the concept. On the level of argument: language/thinking (= mind), in his metaphysics, the subject moves things of the world which are phenomena of the mind, yet the subject:_A, aims at something other, which is supposed to be matter. However, on the level of argument: things of the world (= matter), the things of the world, being matter, are something other than the subject himself. The subject can only bump into things, either to move them or to be moved by them. If the subject wants to be present as a subject, then the subject knows that the things of the world, which are supposed to be matter, can be handled by himself only on the level of argument: language/thinking, formulated in his own language, being a phenomenon of the thought mind. In his reflection on the things of the world, either analyzing or synthesizing, the subject is aware of the impossibility to transcend the

[22] The distinction: forum internum and forum publicum, (a) must be strictly observed. The subject deals with his ideas, phenomena of the mind, either autonomous in the forum internum, independent of space and time and closed absolute to the comrade, or, subjected to the conditions of time and space, in an act of speaking, the subject makes public his imaginations on the forum publicum, confronted with the notions of the comrade. Always a phenomenon of the mind, in the moment of the lived present the conception of the subject is either located on the forum publicum or in the forum internum—tertium non datur.

(a) //==> INDEX/register, keywords: forum internum and forum publicum.

dialectic of mind and matter because, being a mortal being and returning back to matter, the subject must expose himself to the dialectic of mind and matter as long as the subject lives, thinking his world.

A dramatic spectacle in the forum internum as well as on the forum publicum, the interplay of mind and matter can be demonstrated with the method: the trialectical approach, but the limit of the method is the purpose which each user sets, being the subject of the method. If being in the function of the scientist, trying to gain knowledge about the things of the world, the subject knows, that, being things of his world, his discoveries are subjected to each causality, set by himself, in order to be able to handle anything of the world, real or not, according to his purposes.

Conclusion

The Function of the Argument: Purpose, in the Scheme of the Trialectic Approach

The dialectic of mind and matter, reduced to the relevant methods, is a problem of the purposes which the scientist, as the user setting the method, realized on certain objects. For (good) reasons, these objects are assigned to the classes: "matter, life, and mind." Prima vista, the setting of the accent: purpose, has created a new situation in which the scientist cannot be the problem, but, secunda vista, by the argument: purpose, the problem is moved into the focus of the interests which are the third moment in the scheme of the trialectical approach, next to the moments: "method and the relation: mind <==|==> matter" (Fig. 8.11).

With each set purpose, the decision is made which method should be chosen and put, and how the relation: mind <==|==> matter, is interpreted, but the purpose can be set only by the subject. According to the application rule, the subject is to put in the position: purpose. In the horizon of the excluded third moment, the relation: method <==|==> (mind <==|==> matter), has exactly that form which the determining subject has given the relation in the moment of the lived present. From this situation, fixed in the scheme of the trialectic approach, it is strictly to be to distinguish that in each case a different situation is real, if, present in the documents of historia, the subject:_A, as the excluded third moment for the relation:

method <==|==> (mind <==|==> matter), is not the subject, but, his comrade: _B, is the subject. In the discourse, both are linked in a social relation, friendly or not. In this situation, the relation: method <==|==> (mind <==|==> matter) has the function of the excluded third moment (Fig. 8.12).

In all the sciences, the cognitive process is to represent in the following way, mediated in the relation: subject:_A<==>comrade:_B (Fig. 8.13).

The new image which links three schemes in the trialectic approach marks the structure of the cognitive process in which everything of the world is embedded, when, on the one hand, the subject:_A, linked to the comrade:_B, real or ideal, perceives the things of his world (= matter), shared with the comrade:_B, and, on

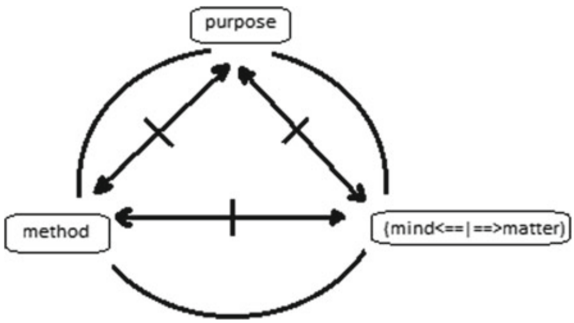


Fig. 8.11 A scheme of the trialectic approach, whose constitutive moments are purpose, method, and the relation: mind <==|==> matter

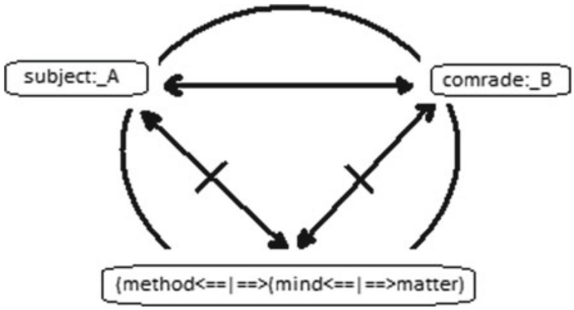


Fig. 8.12 A scheme of the trialectic approach, whose constitutive moments are subject:_A, comrade:_B, and the relation: method <==|==> (mind <==|==> matter)

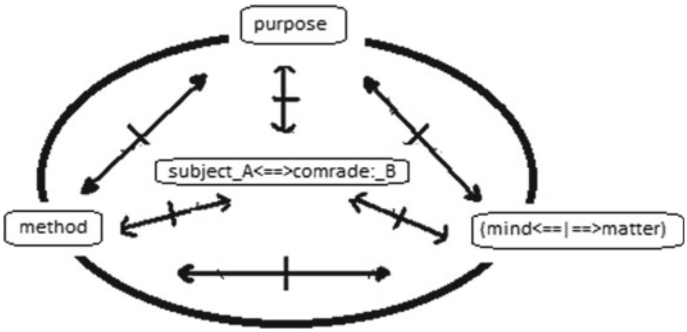


Fig. 8.13 A representation of three schemes in the trialectic approach, giving rise to the cognitive process in which everything of the world is embedded

the other hand, for himself, the subject:_A thinks the things of the world (= mind). In the same way, linked to the subject:_A, the comrade:_B handles the things of the world, thinking and perceiving. With this image, no statement is made about the things of the world what they are in their presence for the subject:_A, in his moment of the lived present as well as for his comrade:_B, but, with this image, the links are designated, when all, who are concerned, reason out the things of the world, be it in analysis or be it in the synthesizing reflection.

The Complexity of the Research Process (= Science)

The real process of research is a complex phenomenon,[23] which, by means of methods, can be broken down to a simple structure, in the extreme case to the causal relationship: cause ==> effect, which is regarded as the ideal case of science.[24] This approach may be acceptable as an element of reality, but this practice does not suffice to grasp the complexity of the research process, which is determined by a variety of factors. With the method of the trialectic approach, the complexity of research can be made visible,[25] but only the subject can win the real knowledge of the things of the world, absolute valid for himself when the subject sets his relation to the things of the world concrete in the application of a method to a particular object, as this object being an element of the class "matter" or the class "mind," always mediated in the phenomenon of the class "life."

The Responsibility of the Subject

The complexity of the cognitive process is not a problem of research; for the scientist, the problem is the mediation of the found results, analysis as well as synthesis present in the social process. In the perspective of analysis, it may be

[23] Niklas Luhmann has pointed out that every research process is conceived as a form of reduction of reality, complexly experienced (a).

(a) www.ur-philosoph.de /bibliography /signature: 014: das_politische, argument: 2.22.45, and the graphs in argument: 2.24.18.

[24] The application of the falsification principle, stated by Karl R. Popper (a) and defined as the logic of research, is conceivable only on the basis of the mechanism: cause ==> effect, including the logical axiom of the excluded contradiction. On this basis in his research, the scientist can only depict a part of the reality which the subject real lives.

(a) Popper, Karl R.: Die Logik der Forschung (1934). Tübingen: 1969.

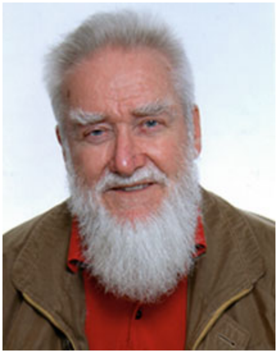
[25] Representing a problem, the purpose of the method: trialectic approach, is focused on making visible the reduction of complexity, but it must be aware that the simple scheme of the trialectic approach do not adequately grasped the complexity of the world. On the one hand, the scheme in its simplicity requires additional explanations in order to be adequate to the complexity of the world, on the other hand, these arguments create a new complexity. In the representation of this complexity, the graphs are limited efficient, because in a graph the complex representation becomes again confusing for itself. Here, this problem cannot be deepened, but more on this problem elsewhere in my essay about the dimensions of the political (a).

(a) www.ur-philosoph.de /bibliographie /signatur: 014: das_politische, arguments: 2.24.01-2.25.18 (the chapter: graphs), in particular argument: 2.24.23 (time experience).

expedient to disregard analytically certain aspects of the problem, but every result of an analysis is a fact which the subject cannot ignore in his synthesizing reflection because these results are present as the limiting horizon of any research activity. In view of each excluded third moment in the scheme of the trialectical approach, the scientists' assessments are distinctly different, but it should be clear that the subject himself is responsible for each assessment of the world things in their interconnection.

Core Messages

- The chapter presents the dialectic of mind and matter using a trialectic approach.
- The chapter provides a new path in the process of cognition.
- Neither the philosopher nor the physician can verify the truth of their arguments.
- The chapter concludes that the human being must be aware of his double bond, life and death, to develop solutions that are methodically identified in the relevant area without losing sight of the other area.



Ulrich Richter (1942) studied philosophy, musicology, and sociology and graduated with a Ph.D. in 1974 from the University of Cologne. His thesis was about "The Inconceivable Myth: Music as Practice of Negative Dialectics." For 20 years, he served as lecturer concerning political science, constitutional law, and sociology. In parallel, he has been working with philosophy on "The concept: the political, in the trialectic approach;" "Hegel's spirit of the world: that's me, that's you, that's all of us, each for himself;" "Reflections on the metaphysics and logic of the concept: border;" "freedom, and the possible concepts of freedom (Kant and Hegel) and the receiving subject." To look at Ulrich's philosophical works, visit http://www.ur-philosoph.de/.

Efforts Deployed in the Penetration of "Thought"

9

Eva Reyes-Gacitúa

> *"Like the entomologist on the hunt for butterflies of showy nuances, my attention pursued, in the orchard of gray matter, cells of delicate and elegant shapes, the mysterious butterflies of the soul, whose beating of wings who knows if one day will clarify the secret of mental life."*
>
> Santiago Ramón y Cajal

Summary

From the work of Edith Stein, a phenomenologist and Husserl's disciple, this paper intends to enquire about an original question: what can be thought of? For philosophy, "every thought is thinking in and of something." In these terms, "thinking of" is referred to as "an active grasp and, therefore, is related to understanding." The concepts *intelligere*, *intelligibile*, and *intelecto* pose a reflection about knowledge and, in this concordance, empathy, which is thinking of alterity, provides clues to complete this analysis, together with *cogito* and conscience. At the same time, it is pertinent to highlight those philosophical sources with which the author establishes a dialogue. So, thought formations may be acquired not only from experiencing real things but also from knowing about the possibilities of the essence. Here, "the figures of thought" mediate. These become important not only for artistic work but also for scientific work. On the other hand, is thinking of "nothingness" or thinking

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_9

of "the absurd" the possibility of empty thinking? Does being-thought remit to authentic-being?

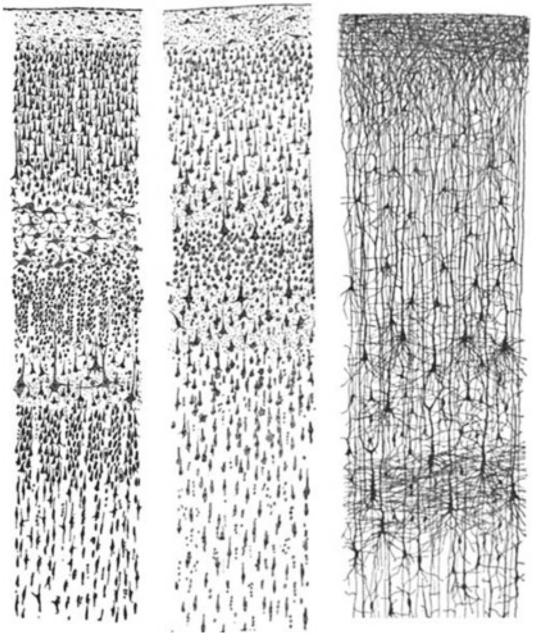

Image N^{0}1 Archivo Cajal cortex drawings
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Keywords

Conscience · Experiences · Knowledge · Phenomenology · Stein · Thinking

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

Edith Stein, a multifaceted woman and philosopher of Jewish origin who, attracted by phenomenology, arrives at Göttingen University in 1913, where her mentor will be Edmund Husserl, whose publications had deeply penetrated in philosophical ambits. By then, *Logical Investigations* stands out in study circles, fostering the radical abandonment of Kantian and neo-Kantian idealism; the piece of work is even venerated in terms of a "new scholastics." This event is considered as a preamble for Edith to be liberated from every rationalistic prejudice to then face the world in an intellectual attitude of openness [1]. Francisco Javier Sancho pointed out: "even when, in time, Husserl directs himself to idealism and his other disciples follow other tracks, Edith remains as faithful as nobody else to the original foundations of the purest phenomenology. It is a value has not been sufficiently put in evidence in philosophical ambits yet" [2].

For Stein, the starting point for philosophizing is found in an unreflexive certainty. The first fact, the simplest we are sure of, is that of our being. It is the focus of the Augustine, Cartesian, and Husserlian consideration of doubt. It is not about a conclusion—*cogito, ergo sum*—, but, rather, a certainty: *cogito*, *sum*: thinking, feeling, wanting … I *am* and I am conscious of this being. Certainty of being that precedes all knowledge [3]. This starting point was also held by the master, Husserl, who made a *hesitant consideration* similar to those of Saint Augustine and Descartes: what I think may not be true, what I perceive may not really exist, everything may turn into an error, a dream, deceit, but the fact I doubt about, I perceive, I cannot doubt, neither of the self, the thinker, the perceiver, the doubtful, "I exist" [3, p. 550].

Stein calls for Descartes himself, who sets the *universal doubt*. That which cannot be doubted about is the *very fact of doubting*, and after, in a more general way, the very fact of *thinking*, and thinking of the *self: cogito, sum* [3, p. 645].

We face an energetic and dialoguing philosophy, where the thought is found as a function of totalities. Certainly, Stein has the intention of approaching phenomenology in anthropological terms and, at the same time, interchanging results with a medieval tradition, safeguarding their educational value [4]. Edith relates to great Catholic intellectuals and friends from the phenomenological circle: Conrad-Martius, Adelgundis Jaegerschmidt, Kauffmann, Ingarden, Heidegger, etc. She opens to new friends, among whom Gerda Walter, Gertrud von le Fort, Erich Przywara, Martín Grabmann, Alois Mager, Odo Casel, Peter Wust, Rafael Walzer, Pius Parsch, Heinrich Finke, and Martín Honecker stand out … characters, mostly, who did a great work within the German cultural life, particularly in the Catholic sector [3, p. 34].

The author does not address the topic of "thinking" or "thought" in a systematic way; this rather flows from several philosophical considerations. From this focus, inquiry about the itinerary of this thinking, the connections of sense, the object, and the subject of thought are made from a comprehensive reading of her writings. Consequently, we face a phenomenology of thought whose deployments make up the object of study of this piece of research.

Thinking and Thought

Edith Stein indicates that we can think in a lively way [3, p. 621], that the thought activates itself constantly [1, p. 801], and, from certain supporting points, it is possible to reconstruct the strain of thought [2, p. 411]. If the subject submerges into a "thought" and truly familiarizes with it, this one suddenly adopts "a character of reality" [1, p. 457]. When this something is realized, then what is thought manifests itself as "full meaning" and takes distance from the absurd. In fact, philosophy concedes that every thinking is "thinking of," about something *Denken an*; it means directing the eyes of the spirit to an object we do not have immediately in front of our eyes [3, p. 927].

In turn, knowing an object, something that had not been captured before, is captured, something that appears. Stein claims: "the different acts of knowledge correspond with different objects, different ways of dation and different ways of being of the objects" [3, p. 560]. In this formulation, relevance is acquired by perception, the qualities of things and their processes, whose "dation" is due to sensible manifestation, as a way of being as it exists in space and time [3, p. 560].

Concerning thought processes, philosophy attributes them a penetration—deeper —into the internal structure of the thing, which is not sensorially perceived [1, p. 740]. In this sense, she claims: "when we turn our spirit to a thing we perceive with the senses, we do not call this "thinking of." On the contrary, we can perceive the books in front of us and, at the same time, "think of a book" we read yesterday"

[3, p. 927]. In this concordance, the philosopher argues, "the book comes to my mind" or "I remember it" [3, p. 927]. It is important to note that the spirit in Stein makes reference to the concept of person, understood as the support *suppositio* of nature endowed with reason, characterized by its capacity to refer to itself and its opening to things different from itself [5]. It is about a concept concerning conscience operations, cognitive operations, and adhesion to values [4, p. 68]. In fact, sensible perception for Stein is a spiritual act because it is an expression of the openness of the person [6].

For this reason, "thinking of" is an active grasp and, consequently, it is related to "understanding" *begreifen* [3, p. 927]. This *quid*—as she claims—in which I *think* is dependent on *my thinking* is applied to the object by *my thought*, making up what is called "formation in thought." The latter originates from an objective knowledge that has come from sensible experience but is it separated from its original existential foundation and, therefore, it is sustained by the spirit [3, p. 929]. In this disaggregation of levels, Edith puts the spirit in a referential place of epistemological experience: "grasp is a beginning for understanding: I see from a distance a thing that I cannot still recognize and, precisely, its indetermination stimulates the activity of thinking: this mysterious thing, I want to see more closely" [7].

In this way, the goal of every thinking is arriving at the understanding of the world of experience [3, p. 933], a safe terrain for Stein, where Aristotle has placed the philosophical thought continued by scholastics. In fact, she intends to show a value in placing herself in the natural experience and vice versa: that the experience can be sustained by a knowable foundation from pure reason.

These thought reflections make philosophy open to acts of experiences linked to the animic self. They are "theoretical acts," connected to acts of perception, of representation, of associative or inferential thought, directed to an object where "the self and the acts" are not there at all [1, p. 181]. In effect, there is a possibility to take a reflective look at them since they are permanently ready for being perceived. What is the meaning of this distinction for Stein? She wonders if it is thinkable that a subject, having a world of objects in front of himself, lives only in theoretical acts without ever discovering himself and his conscience, without "being there" for himself. If this subject perceives, thinks, and, in addition, has thoughts, this would not be possible. Because the subject, in having feelings, does not only experience objects but also himself [1, p. 181]. This interpretation allows highlighting the anthropological character of this paradigm.

Owing to the life-giving energy of certain experiences, taking possession of the subject may become a source of impulses and tendencies. In this occurrence, the internal energy may lead from one thought to another in a motivating connection [1, p. 299]. "But suddenly, the memory evoked by a new experience, and the impression felt, and the thoughts it awakens make me understand that it has always worked on me, even that I would not be without it what I am today" [8]. Such memories and thoughts gradually configure the "self." According to Stein, it is the inner form of indistinctive sensible feeling in the highest sphere of the awake consciousness. It lives in the body and the soul, "in me," at a depth generally unknown that rarely opens. The life of the awake and conscious self is the road to enter the soul. In this concordance, philosophy highlights that the inner and the most intimate become the most spiritual. Nevertheless, it specifies that each material making is full of spirit [3, pp. 968–972].

From these internal connections, Stein conceives that such experiences are not to be only individual acts, but this allows understanding—due to a sense of associationthat community experiences are formed. In this case, the experiential current of a group congregates it as a unit: "sometimes with simple acts of thought, other times being accompanied by intuitions that fill or illustrate, and finally also in the form in which the realizing experiences are distributed among a plurality of individuals. But, whenever a unit of sense is realized, then the realizing experiences enter the unit of a motivating connection" [9].

In this perspective, she considers that the networks of senses exist regardless of the way they are realized in the course of concrete experiences; hence, there will be subjects who realize them more quickly than others. Nevertheless, there comes to mind if the power itself will be enough to attain an objective or if it is more sensible to abandon such endeavor. In the face of all this, you can decide to continue and finally arrive at where you set your mind. From this experience, Stein infers that the first decision, even if it is motivated by knowledge, is not thoroughly rational since an important factor was not put under consideration, that of body capacity. Then, man can propose objectives after a mere spiritual reflection, but he cannot achieve them without the collaboration of his body [10]. Analogously, not every spiritual act, for example, every joy, every affliction, every activity of thought, is languishing and decolored when "I" feel downhearted, but also every bodily action, every movement I make" [1, p. 129]. This dependence or connection to the vital energy is immersed in the *physis*, the corporeality and *psique* of the subject. In this regard, she claims: "fear blocks my understanding, that is, I experience a paralyzing effect on my acts of thought; or I am "maddened" in joy, I do not know what I do, I do actions with no aim" [11].

In this reflection, man is valued as a man, and his corporeality is not left out. For this reason, Stein considers the act of thought and the free act in an affectation on purpose. This means that the self of the subject may give a direction to his being, "engendering," in a certain sense, his own life by committing himself to a determined direction. This may occur in an expressed inclination to a thought "that uplifts" and also the conscious rupture of a sequence of thoughts, such as asking, promising, etc. All these are "actions" of the self, delivered to certain content of experience in view of the freedom to determine oneself [3, p. 967]. In this regard, Edith reaffirms the "course of thought" since the appearance of thought awakens a whole series of mental representations *because* the "self" has originally thought of them in this sequence. Later, in reviewing the contrast between the *easiness* of this course and the effort that the original process has meant, the sequence itself acquires a real capacity and vital energy disposition to act in that direction [1, p. 326]. Then, the current of thought and the content of thought express freshness and vitality corresponding to this experience [1, p. 367].

In summary, Edith Stein highlights the condition of openness that exists in the spirit. For this, it is possible for the human being to think in a lively way, directing the eyes of the spirit to an object that is not immediately before his eyes. On the other hand, it gives preeminence to the task that man has in being situated in front of a world of objects, in view of discovering himself and his conscience.

About the Thinking Subject and Its Intellective Qualities

Edith Stein gives language the statute of the *medium*; she recognizes that "speaking" is a phenomenon of expression whose objective content of discourse is shared by the human gender. So, understanding language is not a problem for perceiving the other person, "when someone speaks," that is, when he pronounces words that I understand, he does "acts that give meaning" [1, p. 844]. What do you want to pose? I am only specifying that the speaking subject, by means of an empathizing representation, converts certain data into content with the help of the acts of understanding. These are spontaneous acts designated as "thought" in the *speaking* subject, no matter what arrives at the expression, either the content of intuition, an individual, and universal content and at the same time as a *thinking* subject. These are the "faculties" that provide the subject with *intellective* qualities [1, p. 845]. This tracing allows understanding a phenomenology of language, originally initiated by Husserl himself, who locates it in a central position [12].

For Stein, thinking and speaking are closely linked in language theory; it makes up just one process. In other words, thought has become mature in its plain clarity and precision; it has been articulated in logical, grammatical categories, and, therefore, it is possible to express it. However, when it is not possible to find the correct linguistic expression, the mental process has not come to an end. For philosophy, that which cannot be manifested is "obscure and confused in the soul and that one who cannot express himself is like a prisoner in his own soul: he cannot move freely, neither reach the others" [10, p. 547]. In this concomitance, concepts are *formed*; they are the 'products of thought' [3, p. 707]. But something else is necessary, and without that something, the lexical treasure contains a danger: the temptation of utilizing linguistic expressions instead of speaking. Now, the distinction that must operate among grammatical categories is not only 'purely external,' but it consists in penetrating its sense. That is, exercising forms of thought, a path toward understanding the two-fold meaning of language: being able to express what is lived in the soul and, thus, share it with the others [10, p. 547]. Hence, learning a language means for Stein forming thoughts, not according to our own way of thinking, but according to that of the other language [10, p. 703].

In this respect, how does Stein define an authentic "being of thought"? Only in the relationship of being formations of thought full of sense, linked to the essential being. That is to say: "the forms of thought are "copies" of the pure formations of sense and may be acquired not only from the experience of real things, but also from the knowledge of the possibilities of the essence" [13].

It is an intelligible connection for philosophy, where creating makings (such as poetic creation) entails a fundamental scope from the possibilities of the essence. This is the way it is expressed in artistic work as well as scientific work [3, p. 928]. Nevertheless, these makings have been formed and prefigured insofar as "possible," entailing something of the atemporality of the being. Then, the making of thought emerges in the intellectual fabric, and the act of judgment that can also be called "knowledge" arises [3, p. 900]. This knowledge is described in terms of having to be oriented to the "truth." There, the *act* of judgment is recognized, which, to reach the universal idea, does a series of acts of knowledge and analytical and synthetic acts, separating *quidditas* from *haecceitas*, that is, the substantial from the accidental [3, p. 566]. Thus, the makings of thought, which logic also deals with, fit their forms [3, p. 882]. In effect, we are in front of an *actu intelligibile* considering that: "the possibility of a new movement of thought conceiving it is based on every making or formation of thought and thus acquires a new being in the thinking spirit" [14]. So, the *intelligibile* is found related to that spirit that can understand and, therefore, penetrate into it [3, p. 1076].

On the other hand, conscience and thought are related to the experience of the subject; both are articulated in the way of thinking and the attitudes toward another person. Hence, "I do not forget my friends when I do not think about them, because they belong to the unnoticed horizon of the present of my world, and my love for them lives even when I do not live in it and influences my being and present work. I can, out of love for a person, omit actions that may be disagreeable for him without being "conscious" of it. So, the resentment that was instilled in me in my childhood against a person can weigh as a pressure on my life later, although I may be thoroughly pushed to the background and not think at all in that person anymore" [15].

This perspective allows philosophy to weigh the effectiveness of the "whole" of life in every moment of existence; being indifferent at what distance from "now" is found the starting point of the experience that acts. In other words, it is feasible to notice how early childhood experiences remain "in this moment," which cause some effects "on me." Even "without thinking about it," it may remain in the "background" of the subject, influence behavior, and become a present experience [1, p. 156].

In this formulation of meanings, the patrimony of conscience is connected to what concerns the perception experience, where we find an "I am" such as memories and acts of thought [1, p. 763]. From this illation, she claims: "I can leave undecisive whether the *thing* perceived by my senses actually exists or not, but the *perception*, as such, cannot be erased. I can doubt that the conclusion made by me is correct—but the thought that results from the conclusions is an undoubted fact" [16].

This series of ideas, thoughts, feelings, and movements will rise to consciousness clearly. According to Stein, it is an effect of what occurs under it [10, p. 565]. The thought does not show anything about the purity and strength of the soul, but it does show the reasons for which this thought is directed and also the whole life of the mood [1, p. 438]. The man knows the good, and his conscience tells him, in concrete cases, what he has to do. Then, spiritual life becomes relevant; what is dominant in life, either thoughts, works, tasks, or passions, reflect my "self." In this search, he claims, "the thought that fulfills me, the tasks that guide my work, they are real spiritual powers that intervene in my life" [10, p. 992]. But will does not only tend to what has been understood as a good; it lets itself be determined by sensible instincts [10, p. 426]. For this, it is necessary to get clarity and acuteness in thinking to ensure the intellect is the guiding position that corresponds to the construction of human personality [10, p. 534].

In sum, the thinking subject and the speaking subject, one and the same, through an empathizing representation, converts, with the help of the acts of understanding, a content, giving rise to the "thought." This distinction in view of grammatical categories is not only external; it penetrates in two senses: expressing what is lived and sharing it with others.

Acts of Thought and the Thought of the Object

What are acts of thought for Edith Stein? For "acts of thought," a whole series of experiences of diverse characteristics are compiled: the act of judging with its corresponding subject and predicate, the act of making a conclusion, the comparison or distinction with its references, the act of linking and enumerating, etc. [1, p. 364]. Such acts of thought can be reproduced by a community, capturing the connections of sense already discovered [1, p. 412].

Strictly speaking, it belongs to the particular being of the objects of thought, being "a second-hand entity," that is, being related to a more originary entity: the entity called object, that is "presupposed" for logics [3, p. 811]. In other words, this being in thought presupposes another being, that of the *entity* whose knowledge is taken by the formations of thought or that makes up the model according to which they are "configured." The being that is its foundation is not necessarily the real being. For this, the formations of thought are "copies" of the pure formations of sense and may be acquired not only from the experience of real things but also from knowing the possibilities of the essence [3, p. 928]. Now, these objects or relationships of states of things make up the "originary entity" to which makings of thoughts are related, e.g., concepts, judgments, reasonings, according to which they are "configured" [3, p. 811].

The philosopher intends to go into a perspective about the theory of knowledge —with certain original distinctions—where the *object* has been understood as something fundamental in itself, and *knowledge* as something that it itself pretends to be, that is, a universal capturing of existing *states of things*. Nevertheless, for Stein, both considerations may be deceitful appearances and dissipate as soon as laws functional for the conscience are discovered. Then, she decides to make some distinctions. She previously clarifies the matter about *categories*; Kant already wanted to conceive them as functions of subjectivity, specifically of understanding. If this is so, it could be said that "functions may function and the subject may be able to have experiences with it, without him capturing them" [1, p. 760]. Now, these functions blindly exercised should not be designated as *concepts* of understanding; therefore, it could not be indicated that the "thought" of the object and the categories determining it are captured by thinking and added to the current material of knowledge. Stein brings up the doctrine of categories because conscience is subjected to certain functional laws that make comprehensible the fact that an objective world appears in the conscience. These functions arrive at the conscience; however, they are independent of its functioning, being able to be captured or not [1, p. 760].

Concerning the *states of things*, these are formations of an articulated structure; they presuppose "objects" in the strictest sense of the word [3, p. 730]. In the content of these objects is their foundation: essence and being, showing itself in its separability and reciprocal belonging. The so-called *states of things* involve for Stein a spirit whose knowing is realized in steps of separated thoughts, but they are not to be considered as "formed" by the spirit. The structure of the world of objects forbids the states of things their articulation and indicates the thought that advances step-by-step along its road. According to this, the being of the *state of things* is not a 'mere being thought of' because it possesses a *fundamentum in re*; but, as it has the need of a foundation, it is a *deduced being* [3, p. 731].

Stein goes deeper: supposing that the subject brings to his conscience the functional laws with which he must explain that the objects appear to him, then, will he have the thought of the object as we understand it spontaneously? Or will he have the thought, the concept of objectivity as it is before our eyes in a non-reflexive grasp of knowledge? Will it not happen precisely with this that, in considering categories as functional laws and *only* as that, the thought of objectivity is abandoned? [1, p. 760]. Then, there is the possibility that functional laws do not exist at all since if conscience proceeds according to these determined laws, we would evidently incur in an endless process [1, p. 761]. Perhaps, it would be advisable to change the knowledge of conscience and its laws into its object, thus showing that such knowledge is possible. Precisely, this is the argumentation: showing that the knowledgeable belongs to the conscience and, to argue the impossibility of knowledge about the transcendent? According to philosophy, neither of these has been shown. Definitely, so far, certain functions of subjectivity are required so that objects can appear in the conscience. However, for Stein, this does not mean that *the* being of the objects is due only to these functions of subjectivity; rather, the objective deduction can disconnect from the subjective deduction and provide a different conception of categories [1, p. 761]. It must be taken into account that the makings of thought, logics deals with, are adequate for their forms [3, p. 882].

In synthesis, the objects and acts of thought are shown in their separability and reciprocal belonging. Knowing is realized in steps of separated thoughts, but they are not considered "formed" by the spirit. So, the world of objects orders the states of things, which presuppose the objects need to get to their foundation.

Concepts Correlated to Thought

According to the exercise of *thinking*, it is possible to consider other elements that provide connections and breaks about acts and sequences of thought. One of them is the concept of "idea," concomitant to that of "thought" [3, p. 338], feasible to capture [3, p. 902]. For Stein, it is making or formation of understanding: freely active, elaborated and formed by thought. For this reason, it becomes connected to the thinking spirit [3, p. 342]. For a better sample, we can consider the artist's relationship with his work, designated "in thought." Many times, it has to do with a process, where the sculptor can first have the "idea" and later look for "material" convenient for this idea. It may be a marble block eliciting the "occurrence" in him of what could be made out of it. In the second case, we can have the doubt if it deals with a relationship only given by the thought of the artist with the work. In this case, the marble block is not the work yet, and, however, it is an essential part of it. Hence, the "project" of the artist owes its existence to this marble block and may also be conditioned in its content by this block [3, p. 901].

On the other hand, the sensation is found as an immanent datum that starts a movement in the subject. Stein claims: "the sensation datum appears as something that uses my present life and fills it and, however, is independent of me in a certain sense. It comes without being called, it enters in my connection with life, it breaks, maybe, a process of thought in which I lived" [17]. Now, there is a possibility to change sensation data into an object by means of a reflexive attitude [1, p. 366].

Fantasy is described as follows: "in thoughts," I can stand up from my desk, go to a corner of my bedroom and observe it from there. And if I do not do this, I do not carry with me my living body [1, p. 127]. But, in fact, I am tied to it: I am where my body is, even if "with my thought" I can move to the other end of the world and even overcome all spatial barriers [10, p. 654]. We are in front of an involuntary "fantasy game." Stein depicts it: "while I am immersed in a difficult strain of thought, I can reject it by a tension of my will and remain in my work; it is possible that, then, it disappears, but it is also possible that, together with a process of thought at the background, I continue in it or, that I voluntarily interrupt the sequence of thought and give myself to the intentions of the fantasy process" [18].

For Stein, it is possible to distinguish between the *intention* of fantasy and its *intuition*. What do these differences consist of? The philosopher explains it as follows: when we speak about the castle of *Sleeping Beauty* and intuitively represent it, we have as many intuitive objects as there are intuiting subjects. This intuition does not offer, before our eyes, the thought to an object, as perception does, but it represents it, and each individual represents it in his own way [1, p. 363]: "the act that "thinks" an individual object, without bearing it in mind or without representing it as present, heads towards something that it does not arrive at, but that is offered to it and leads it to its plenitude, when the thought object becomes intuitive" [19].

On the other hand, intellectual openness makes possible a *comprehensive* accompaniment with the animic life of others; it deals with openness, different from simply being touched. It is not mere life that unites, but specific life in the broadest measure, the spiritual activity in reciprocal barters of thoughts, feelings, etc. In a common relationship of thinking, feeling, wanting, and precisely in this common proceeding, the phenomena of being led by the force of the other are shown [3, p. 512].

Another concept here I discuss is arbitrary imagining. Stein interprets it as follows: “I can form the concept of “triangular circle.” But this is a contradictory concept that I cannot transpose into an adequate view. However, it has a “being of the thought.” But “*I* cannot imagine” a three-angle circle (that is, I cannot represent it to myself in a geometrical view) since “that thing does not exist” [3, p. 725]. It is about something that is not found in reality and, at the same time, impossible in itself.

This sequence includes deceit, which is possible on the basis of personal experiences and also the course of some thoughts. For Stein, it is about thoughts that have been “adopted” and attributed to themselves, presenting them as their own, showing a capacity that they do not have [1, p. 858]. In *The idols of self-knowledge*, first published in 1911, Scheler conducts a qualified study on the concept of deceit. Edith cites this work and addresses those deceitful appreciations related to the sensible capacities of a subject. After all, it is possible to unmask deceit from understanding on the basis of other manifestations dating back until getting to their origin.

In turn, what is the situation of “nothingness,” “the absurd,” and “the countersense”? According to Stein, we think about “nothingness,” but it is not a “making or formation.” It is deprived of content and, therefore, lacks essence. It does not even deserve to be denominated as a hollow form because the hollow form remits to something. With this, the incapacity to think for taking “something” out of itself is proven [3, p. 928].

With regards to the absurd, we are in the presence of something that allows supposing a sense, but it does not lead to any understandable sense. In addition, countersense is understood when the certain formation of senses, linked to one another, are irreconcilable to each other, for example, a triangular circle. Stein argues that this way of “thinking” has no sense of realization or filling. Rather, it is about the impossibility of intuition; it makes up a proof of the absence of essence of that apparent making of sense, based on a contradiction in a faulty fashion, for example, “The leaf is green and is not green” [3, p. 929]. It is about vain attempts of thinking that pretend to form an object full of sense, according to their own will. However, they only help clarify the relationship between the being of thought and the essential being: an authentic being of thought, that is, the being of the formations of thought full of sense, lies on the essential being of the pure formations of sense. When it frees from the laws ruling the formations of sense, it makes these hollow formations of appearance [3, p. 929].

Finally, the concepts of the idea, sensation, fantasy, etc., are related to and at the same time differentiated from the content of thinking. This network of expressions makes it possible to distinguish what Edith calls “attempts of thinking.”

Particular Sciences and Thought Exchange

Concerning particular sciences, the philosopher puts forward a series of perspectives with which she intends to explore how thought is constructed. In fact, this is set in motion by its object [3, p. 835]. Indeed, the historian must address "the original experiencing." How? By representing it in his thought so as to make it his own in order to understand it. The aim of its exposure is to push others to represent it in their thinking. So, for representing the understood experience, the historian must change it into an object; that is, it needs objectivization, although this is only a transitory stage. Meanwhile, for the psychologist, experiences are objects that he pretends to analyze, describe, and explain as a scientist. To take hold of these objects and see them intuitively in their full vitality, he has to experience or represent them in his thought, adopting an "understanding" attitude, the same as the historian needs: adopting an objectivizing attitude [1, p. 337].

According to the philosopher, when the other "communicates" his thought, he opens the way to understand the sense that was originally formed. Furthermore, when he "experiences it," he impels to "continue thinking" in an original production, in view of a new partial existence of the connection with the sense of totality. In this way, joint thinking, which is not experimented with as an experience of one and the other, but as common thinking, is forged in "the exchange of thought." For Stein, every study of science must be done in this way, hence: "what I provide as my 'own contribution' to the development of science, with an original performance of my thought, all this is born under the patrimony already gathered which "I receive," and becomes, in turn, the foundation on which the others will continue building" [1, p. 382]. In fact, Stein's thought takes distance from a supraindividual unit of personality [1, p. 423]. In the case of particular sciences, when pluralism is possible, wealth is provided to the whole set. Under this perspective, we must be reciprocally "open," wherever an individual's attitudes do not clash with the other but penetrate in him and deploy their efficiency. It is there where community life *exists*, where both are members of a totality, the community being not possible *without* that relationship [1, p. 423].

As to acquiring mathematical knowledge, a certain type of intellect is necessary. Stein describes counting on "sense" for mathematical formations, understanding the nature of numbers, space forms, abstract thought, progress from premises to consequences, etc., that is, what the mathematician and the logistician have in common. If they "have intelligence," this means "*intelligere posse*." The philosopher does not extend this power to everyone for everything, neither the same to everyone. In this correspondence, the "born" mathematician is ready since the beginning of his being *in potentia illorum intelligibilium*. Consequently, each intellect has certain inclinations that are proper of it by nature [3, p. 350]. In turn, may specific "mathematical thinking" exist? That is, thinking that is not regulated by the laws of thinking contents, but having a particular noetic characteristic, a particular acuteness and tension of reasoning, a notable spontaneity in the mental procedure, a free game with all the possibilities? In this regard, Stein claims that such spiritual *habitus* is determined by nature and the way in which each individual spiritually acts in these ambits, and, on the other hand, spiritual experiencing is determined by the experiencing of the community in which he participates. Likewise, we are in front of a retroaction of individual life in search of community life [1, p. 369].

So, it is possible to represent and observe remnants of creative activity in the artistic field through empathy *Einfühlung*. The external figure of the work of art shows a way of looking at the world; its content of meaning reveals what pleases the artist's soul, what has been the attitude of his thought and feelings for the world [1, p. 850]. According to the philosopher, every work of art arises from a feeling, an "expression." In it, people's affective life is deposited, which has been unchained by the world around them [1, p. 850]. Indeed, thought and feeling put in motion creative work, and the contemplated objects hold a qualitative "aspect" visible in Stein's thought due to the spiritual structure of the subject. It is about a fundamental issue carefully dealt with in her doctoral thesis: *Empathy* is understood as the experience of the other subjects and their experiencing. Caballero Bono claims that such a concept agrees with that of his master Husserl, although the explanation may be divergent, even leading him to fundamental distinctions with Theodor Lipps [20].

"The capacity of thinking is aimed at thinking;" this sentence, for Edith Stein, involves the being that lives within the one who does the action, such as a thought in the thinker. With this, she specifies the possibility of a (scientific) thought, that is: having that capacity which, although not thought at that moment, will only become real in its execution. According to the philosopher, several concepts are imbricated: ἐνέργεια, understood as operating efficiency, and δύναμις as a possibility or capacity that, since it provides power, aims at τέλος, reality. Consequently, ἐνέργεια (energy) means the *real being* as opposed to the possible being: δύναμις, the possibility of a *work* being also called ἔργον. So, the working results exist by themselves, for example, the house that exists due to the architect's activity. In the first case, it is thoroughly clear that ἐνέργεια and ἔργον (efficiency and work) make up just one thing and since the possibility has attained its objective in the real being, this is also called ἐντελέχεια (entelechy), a term that could be translated as the *realization of the being* [3, p. 620].

In summary, thinking and communicating thought makes it possible to understand that expression in which it was originally formed. In this direction, science as a whole, art, and the different disciplines make an effort for enunciating content that is expressed as correct knowledge. Stein highlights joint thinking, which is not experimented with as an experience of one or the other, but as common thinking whose aim is to arrive at ultimate clarity.

Conclusion

We began this feat of "thinking" by giving an account of not only the limits of *cogito ergo sum* but by deploying towards the "I am." For the philosopher, it is about a certainty: the fact of the being itself, originary knowledge from which the spirit breaks into the world, the objects, and the things, showing them in their separability and reciprocal belonging. Moved by the spirit, this “I am” constantly indicates where we are immediately thinking, feeling, and wanting.

In this concordance, Edith Stein emphasized the condition of openness existing in the spirit. For this, it is possible for human beings to *think in a lively way*. If the subject has a world of objects in front of him, the soundness that provides him with “I know I live” gives rise to the discovery of himself and his conscience in his spiritual and community experience. It is about walking in view of a connection with the sense of totality and, from this ambit, clarify the sense of “being” in the world, his place, and his relationship of belonging.

Core Messages

- Stein highlights the openness in the spirit, in the human being who thinks vividly.
- Thinking subject and speaking subject, one and the same whose acts of understanding give rise to thought.
- The concepts of idea, sensation, and fantasy are related and differ from the content of thought.
- Thinking and communicative thought allow us to understand that expression in which it was originally formed.

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8. Stein, Edith Endliches und ewiges Sein 246: Aber plötzlich wird sie mir durch ein neues Erlebnis wieder in Erinnerung gebracht, und der Eindruck, den sie nun auf mich macht, die Gedanken, die sie hervorruft, lassen mich erkennen, daß sie die ganze Zeit in mir gearbeitet hat, ja daß ich ohne sie nicht das wäre, was ich heute bin. Published Online: https://www.karmelitinnen-koeln.de/edith-stein-archiv-kk/gesamtausgabe
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14. Stein, Edith Endliches und ewiges Sein 219: Andererseits ist in jedem Gedankengebilde die Möglichkeit einer neuen Denkbewegung begründet, durch die es nacherzeugt wird und in einem denkenden Geist ein neues Sein gewinnt. Published Online: https://www.karmelitinnen-koeln.de/edith-stein-archiv-kk/gesamtausgabe
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16. Stein, Edith Endliches und ewiges Sein 35, 36: ich kann es dahingestellt sein lassen, ob das Ding, das ich mit meinen Sinnen wahrnehme, wirklich existiert oder nicht—aber die Wahrnehmung als solche läßt sich nicht durchstreichen; ich kann bezweifeln, ob die Schlußfolgerung, die ich ziehe, richtig ist—aber das schlußfolgernde Denken ist eine unbezweifelbare Tatsache. Published Online: https://www.karmelitinnen-koeln.de/edith-stein-archiv-kk/gesamtausgabe
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Pseudo-Thinking and Real Thinking

10

Ryota Ono

> *"At the bottom each person is asking, "Who am I, really? How can I get in touch with this real self, underlying all my surface behavior? How can I become myself?""*
>
> Carl R. Rogers

Summary

A simple meditation exercise reminds us that so many kinds of thoughts, ideas, and emotions are continuously trying to trespass into our minds. The major part of those thoughts obviously has to do with our major tasks such as our job or study. In contrast, the minor part of them, which is not necessarily less important, is related to our concerns as to how favorably others see us. Most people cannot help but engage in the second type of thinking, called "pseudo-thinking" in this chapter, because they are deficiency-motivated people, as defined by Maslow. While they always try to acquire something from the outside to overcome the sense of deficiency, they are deficient in understanding the real self on the inside. Maslow's self-actualizing people, on the other hand, understand their real self and live by following what the real self provides. The thinking of self-actualizing people is called "real thinking." People can become self-actualized not by reducing deficiency-motivation but by experiencing events called "peak experience" and "quantum change." The world seen through real thinking is peaceful, united, loving, and completely opposite to the world from the pseudo-thinking perspective. This chapter suggests a way for people to approach real thinking even before they are transformed into self-actualizing people.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_10

Real thinking does not need approval
(Adapted with permission from the Health and Art (HEART), Universal Scientific Education and Research Network (USERN); Painting by Tanisha Vihol)

Keywords

Abraham Maslow · Carl Rogers · Deficiency · Motivation

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

When you practice meditation for the first time, you would probably face a very difficult fight where various thoughts, ideas, and emotions continuously try to trespass into your mind. To keep your mind empty as long as possible, you would be forced to keep pushing those trespassers away.

Such experience makes us realize that our brain has no time to rest. Kegan and Lahey [1] state that most people in an organization are devoting much of their time and energy to carry out a second job that generates no income, which is "covering up their weaknesses, managing other people's impressions of them, showing themselves to their best advantage, playing politics, hiding their inadequacies, hiding their uncertainties, hiding their limitations" [p. 1]. To conduct this job successfully, they think about the most desirable outcome, develop effective means, carry them out, and evaluate the results of the whole process so that they can increase the probability of success.

The reason why many people end up engaging in this second job comes from the fact that they have concealed "the self." When humans are hiding something from other people, they are likely to develop and present unusual behaviors. While those behaviors sometimes help achieve the purpose of hiding, they will often bring about unexpected consequences. In the field of personality development, Kegan and Lahey [2] argue that most people develop an internal immune system called "the immunity to change" as a by-product of hiding the self.

At some point in their lives, an individual will realize the necessity or urgency to grow further. He plans to achieve the desired condition and starts learning new skills and knowledge, changing priorities in life, doing good things for health, and improving interpersonal relationships. However, although the plan may proceed successfully for a short time, it often results in a halt sooner or later. Even if the person sincerely wanted to achieve that condition for their personal growth, the end results of the challenge often turn out to be somewhat disappointing. Kegan and Lahey [2] demonstrate that such unsuccessful cycles of self-motivated growth endeavors are caused by the immunity to change. The immunity to change is a very effective anxiety-management system, where the anxiety is not acute or episodic but constantly running through one's life. The immunity to change is unconsciously created on the inside of most people and functions to protect what they hide, which is the self. Regardless of how good or useful the desired goal is for the person, the immunity to change cares about neither the goal nor the person's commitment but constantly monitors possibilities of the person's self-being exposed to others. When the immune system senses that implementing the plan might hinder the already successfully established impressions by others on the person's personality, it induces him to give up the initiative by presenting him probable dangers against his identity. In this way, the person's self, hidden from others' attention, remains protected; however, it leaves the person to lose his chance to grow further.

Psychic Fingerprint and the Real Self

What is "the self" of an individual whose immunity to change is constantly trying to protect from others? Stone and Stone [3] argue that a newborn comes into this world with a unique quality of being, called the "psychic fingerprint." While the psychic fingerprint is the core self of the newborn, it is intact, very defenseless, and vulnerable upon being exposed to a new environment. To deal with vulnerability, the infant's personality begins to develop. Stone and Stone [3] refer to personality as a system of a variety of subpersonalities (selves or energy patterns), and a key self that develops at an early stage of the person's growth is called the "protector/controller."

They claim that the protector/controller self is the primary energy pattern underlying a person's other selves and is most concerned about how favorably and positively the person is seen and perceived by others. The protector/controller makes the person focus on his safety in every possible way and stick to norms and traditional values of the past and present (i.e., status quo). Given the very conservative role played by the protector/controller self, it can be inferred that the "immunity to change," conceptualized and discussed by Kegan and Lahey [2], is the work of the protector/controller self. The more powerful and successful the protector/controller of the person becomes, the more his immunity to change is strengthened. As a result, how the person lives and grows increasingly deviates from how his unique psychic fingerprint wants to live, and he becomes more uncertain about who he is and where he is heading. Maslow [4] discusses this psychic death in a person's childhood as below.

> He has been rejected, not only by them (others), but by himself. (He is actually without a self.) What has he lost? Just the one true and vital part of himself: his own yes-feeling, which is his very capacity for growth, his root system. [p. 56]

The protector/controller would do anything to keep hiding the person's most vulnerable self, the psychic fingerprint. Such obsession for hiding makes the person continuously worry about the possibility of someday being threatened by someone saying, "I know who you really are."

Deficiency-Motivated People

Maslow [5] pioneered and led the humanistic psychology movement. His motivation theory asserts that human behaviors and actions are activated and directed by five needs as shown in Fig. 10.1: the "physiological needs, the safety needs, the belongingness and love needs, the esteem needs, and the self-actualization need." He regards the bottom four needs as "deficiency motivation" and the top need for self-actualization as "growth motivation."

Maslow [5] delineates the characteristics of deficiency-motivated people as follows:

- They generally "prefer a safe, orderly, predictable, lawful, organized world" [p. 41];
- They have the "desire for reputation or prestige (defining it as respect or esteem from other people), status, fame and glory, dominance, recognition, attention, importance, dignity, or appreciation" [p. 45];
- They feel "unnecessarily guilty or ashamed about too many things and feel anxiety in too many unnecessary situations" [p. 155];
- They often do not have "the slightest idea of who they are, what they want, or what their own opinions are" [p. 159];
- They cannot "make up their own minds, but have their minds made up for them by salesmen, advertisers, parents, propagandists, TV, newspapers, and so on. They are pawns driven by others rather than self-moving, self-determining individuals" [p. 161]; and,
- They "must have other people available, since much of their need gratifications (love, safety, respect, prestige, belongingness) can come only from other human beings" [p. 162].

These characteristics show that deficiency-motivated people lack self-confidence and tend to depend much on other people. They cannot help but refer to others' thoughts and reactions about themselves. Such uneasiness obviously influences and determines the type and content of thinking in which they engage. This is the crucial consequence of having moved away from their psychic fingerprint in the process of personality development. They are always afraid of others who might find out and spill the beans about their hidden intact self. An analogy of deficiency-motivated people can be someone protecting their territory, as depicted in Fig. 10.2. They talk with others from inside a hole, and as a result, always feel somewhat awkward. They remain in the hole because there is something in their personality that should not be revealed to others.

Maslow [6] further argues that the defensive attitude of deficiency-motivated people leads them to take the same attitude towards themselves by fearing their own emotions, impulses, potentialities, and destiny. They struggle against their own greatness and evade personal growth. The irony is that they do not know this reality.

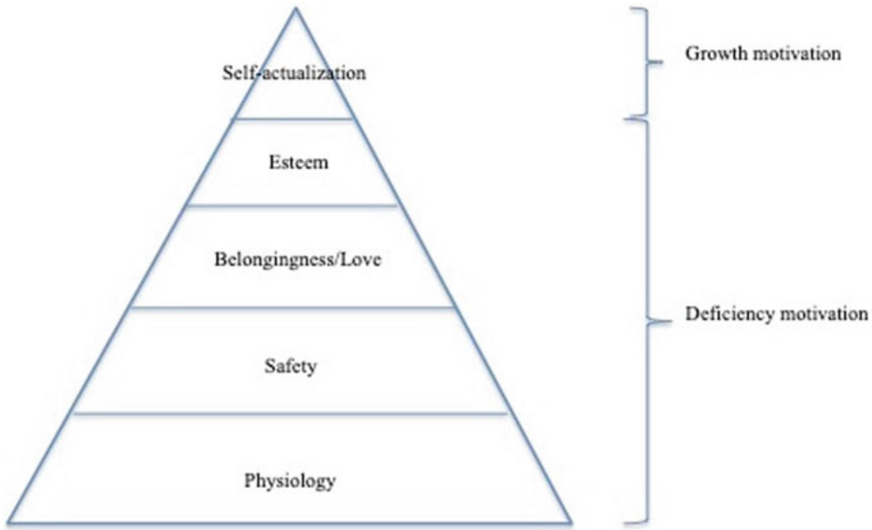

Fig. 10.1 Motivation theory

Fig. 10.2 Analogy of deficiency-motivated people

> The adult human being is far more subtle and concealed about his anxieties and fears. If they do not overwhelm him together, he is very apt to repress them, to deny even to himself that they exist. Frequently, he does not "know" that he is afraid. [p. 121]

Maslow [7] calls the cognition of deficiency-motivated people "D-cognition." He argues that people with D-cognition perceive the world "only from the vantage point of their own interests" and use society and the world for their ends. They are not rightly perceiving society and the world but perceiving themselves in it. For deficiency-motivated people, any behavior is synonymous with instrumental behavior, and it is conducted to meet their needs. Maslow regards D-cognition as a very active, tense, highly volitional, and energy-consuming process because it constantly pays attention to the holder's needs and fears, distinguishes what and what not to perceive, and classifies, compares, and evaluates.

In *On Becoming a Person*, Rogers [8] declares that human beings already possess learning experiences, which could bring about the decreasing of various tensions and conflicts, and "could aid in the development of mature, non-defensive, understanding persons." However, this declaration seems to be a reflection of the fact that not many people have been able to put such learning experiences to use wisely. The characteristics and cognitions of numerous people Rogers had associated with as a psychotherapist for many years are similar to those of deficiency-motivated people revealed by Maslow [7]. Rogers [8] writes about one client:

> He learns how much of his behavior, even how much of the feeling he experiences, is not real, is not something which flows from the genuine reactions of his organism, but in a façade, a front, behind which he has been hiding. He discovers how much of his life is guided by what he thinks he *should* be, not by what he is. Often he discovers that he exists only in response to the demands of others, that he seems to have no self of his own, that he is only trying to think, and feel, and behave in the way that others believe he *ought* to think, and feel and behave. [pp. 109–110]

Given that the D-cognition of deficiency-motivated people is heavily influenced by the presence of others and imagined reactions of those people, the condition of the man above is not necessarily specific to him but is observed in many people, who are mostly deficiency-motivated people. Rogers [9] writes that although the infant had his own valuing process stemming from his organism and used it to evaluate the surrounding circumstances, he gradually begins to move away from the original valuing process and starts to introject the value judgments of others. The cause of this shift is the sense of deficiency.

> … in an attempt to gain or hold love, approval, esteem, the individual relinquishes the locus of evaluation which was his in infancy, and places it in others. He learns to have a basic *dis*trust for his own experiencing as a guide to his behavior. He learns from others a large number of conceived values, and adopts them as his own, even though they may be widely discrepant from what he is experiencing. [9, p. 162]

As fearing others is the key characteristic of the protector/controller self, it seems clear that deficiency-motivated people are heavily controlled by the protector/controller. The underlying emotion of fear and anxiety promotes deficiency-motivated people to ponder various strategies to protect and defend themselves constantly. The more the valuing process of deficiency-motivated people is influenced by the value judgments of others, the farther the goal of the valuing process shifts, from that of judging like or dislike to that of judging safe or dangerous.

Theatrical Relationships

Goffman [10], who developed the dramaturgical analysis of the organization of social life, argues that a person's everyday life is like a theatrical performance. All theatrical performers are given, in most cases, one specific role to play out, and they angle for the audience to dive into their imaginary world. The performers' thinking is geared toward the realistic actualization of their assigned identities, and whether or not they succeed in the actualization determines whether or not they are good performers. Based on this perspective, Goffman [10] argues that in a social organization of people, what is truly important for a person is evaluating other people regarding how well he is performing his ideal self. The idealized self is equivalent to the assigned identity/role for a performer. Many people gradually build their idealized self (i.e., mask) through trials and errors in the process of personality development. They always wear this mask and claim to others that "This is me." As they believe that they should have a great degree of control over how to be seen, evaluated, or judged, they result in devoting much of their time and energy to trying to control others. Goffman [10] states:

> … it will be in his interests to control the conduct of the others, especially their responsive treatment of him. This control is achieved largely by influencing the definition of the situation which the others come to formulate, and he can influence this definition by expressing himself in such a way as to give them the kind of impression that will lead them to act voluntarily in accordance with his own plan. [pp. 3–4]

This task is equivalent to what Kegan and Lahey [1] call "the second job." Branaman [11] points out that Goffman considers what a person really is as something seldom discoverable, nor really an issue. Goffman [12] wrote, "What is important is the sense he provides them through his dealings with them of what sort of person he is behind the role he is in" [p. 298]. Branaman [11] argues that Goffman, in fact, doubts "the individual complete autonomy in deciding the images of self to be conveyed" to others and writes, "What matters is not how the individual identifies him or herself ("self-identity," "ego-identity") but rather how he or she is identified by others ("personal identity")" [p. lii]. The individual's best performance does not necessarily bring about what he aims for, and this reality makes people's thoughts vulnerable and complicated.

Performers cannot exist by themselves, and they require the audience to watch and react to their performance. Similarly, people (i.e., deficiency-motivated people) need other people for two purposes: as the subject who provides them with much of their need gratifications (love, safety, respect, prestige, belonging); and as the subject who helps complete the idealized self.

Branaman [11] clarifies that Goffman discusses dualistic images of the self: "the self is the mask the individual wears in social situations;" and also "the human being behind the mask, who decides which mask to wear." The former is called the "self-as-character" or "socialized self," and the latter is called the "self-as-performer" or "all-too-human self." While both the self-as-character and the mask are always equated with the self in our society, Goffman regards this part of the self as a social product. The other part, the self-as-performer, is:

> The individual as performer is the thinking, fantasizing, dreaming, desiring human being whose capacity to experience pride and shame motivates him or her not only to perform for others but also to take precautions against embarrassment. [11, p. xlviii]

The function of the self-as-performer, especially taking "precautions against embarrassment" as seen in the last phrase, is linked to the role played by the protector/controller self. Thus, based on the preceding discussions on the self of

Fig. 10.3 Three layers of the self

human beings, the human self can be understood to be composed of three layers, as shown in Fig. 10.3.

In Fig. 10.3, the real self at the core of a human being is the psychic fingerprint discussed by Stone and Stone [3]. Rowan [13] defines, "This (real self) is the feeling of getting in touch with my own center, my identity, my true self - the self that lies behind or beyond all self-images or self-concepts" [p. 15]. As its existence was concealed at the very early stages of personality development, all of us, except for some very few psychiatrists, do not know what it exactly is. The self in charge of hiding the psychic fingerprint is the protector/controller self. This self, also called the "self-as-performer" or "all-too-human self" by Goffman [12], controls how the outer layer of the self, socialized self, is presented and perceived by other people.

The cognitions of deficiency-motivated people who have departed from their psychic fingerprints are controlled and managed by the two outer layers of the self, mostly by the protector/controller self. The real self has nothing to do with those cognitions because the protector/controller self has suppressed it. In this sense, the thinking of deficiency-motivated people cannot be "real thinking," and thus is called "pseudo-thinking" in this chapter. In summary, most people are constantly occupied with a sense of deficiency and trying to fill the void on the inside. Even if the cause of these struggles is the lack of presence of the real self, people do not recognize such a fact. As a result, they end up acting fervently to try to reach the idealized self (i.e., socialized self) so that what he presents or demonstrates can be accepted and respected. Regardless of how effective peoples' thinking behind those actions and behaviors are, it continues to be "pseudo" as it is not based on the real self of the individual.

Self-actualizing People

Maslow [5] considers, however, that there are people who are able to rise to the highest level of maturation and self-fulfillment. Although his theory is often illustrated as the five-layer triangle presented in Fig. 10.1 and is understood as a presentation of the five different types of human motivation, Maslow [5] clearly distinguishes the top "self-actualization" layer from the bottom four layers and addresses its fundamental difference:

> The distinction between deficiency motivation and growth motivation implies that self-actualizing itself is not a motivated change. Self-actualization, the coming to full development and actuality of the potentials of the organism, is more akin to growth and maturation than it is to habit formation or association via reward, that is, it is not acquired from without but is rather an unfolding from within of what is, in a subtle sense, already there. [p. 233]

Thus, the crucial differences between the top layer and the bottom four layers are depicted in Fig. 10.4. Self-actualizing people are motivated to grow, and this motivation is inherent to the psychic fingerprint. They quite differ from deficiency-motivated people in that the former builds their life on the real self, and as a result, demonstrate unique characteristics as discussed below. Using Horney's [14] terminology, Maslow [5] refers to deficiency-motivated people as the "pseudo-self" and growth-motivated people as the "real self." The pseudo-self is equivalent to the socialized self, and the real self is the core self, as shown in Fig. 10.3.

Maslow [5] assesses self-actualizing people as follows:

- Their "higher need gratifications produce more desirable subjective results, i.e., more profound happiness, serenity, and richness of the inner life, as well as desirable civic and social consequences" [p. 99];
- They "live more in the real world of nature than in the man-made mass of concepts, abstractions, expectations, beliefs, and stereotypes that most people confuse with the world" [p. 154];
- They accept the unknown and "are comfortable with it, and, often are even *more* attracted by it than by the known. They not only tolerate the ambiguous and unstructured; they like it." "They do not cling to the familiar" [pp. 154–155];
- They "find it possible to accept themselves and their own nature without chagrin or complaint or, for that matter, even without thinking about the matter very much" [p. 155];
- They "feel bad about discrepancies between what is and what might very well be or ought to be" [p. 157];
- They "have some mission in life, task to fulfill, and some problem outside themselves which enlists much of their energies" [p. 159];
- They "live customarily in the widest possible frame of reference. They seem never to get so close to the trees that they fail to see the forest" [p. 160];
- They "are not dependent for their main satisfactions on the real world, or other people or culture or means to ends or, in general, on extrinsic satisfactions. Rather they are dependent for their own development and continued growth on their own potentialities and latent resources" [p. 162]; and

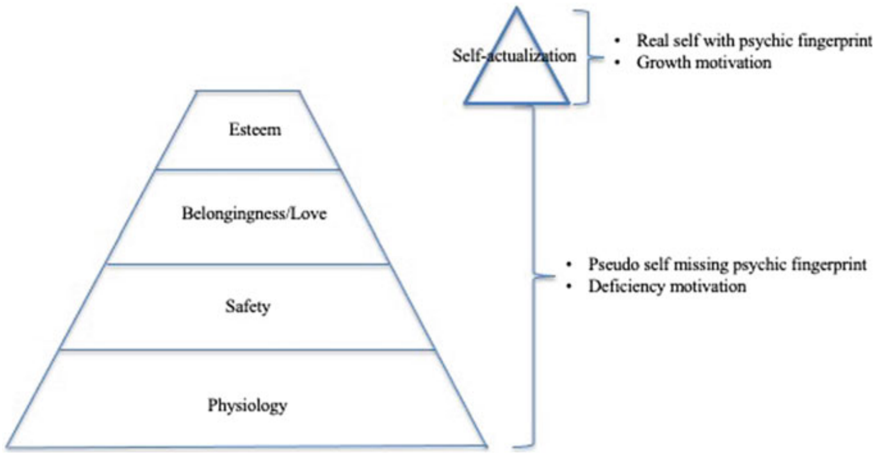

Fig. 10.4 Another view of the motivation theory

- They "have the wonderful capacity to appreciate again and again, freshly and naively, the basic goods of life, with awe, pleasure, wonder, and even ecstasy" [p. 163].

Maslow [7] further considers that self-actualizing people respect nature and refrain from projecting human purposes upon it. By citing prominent theories such as "the Hindu stages of life," "Erikson's theory of pshychosocial development," "Freud's theory of the id, ego, and superego," "the ancient Jewish tradition's understanding of human progression," and "Kohlberg's stages of moral development," D'Souza and Gurin [15] show that Maslow's theory of self-actualization is closely related to these theories [p. 211]. They conclude that the more self-actualizing people live in the society, the more the society flourishes.

O'Connor and Yballe [16] write:

> … a cascade of positive consequences in the self-actualization process that are antidotes to the powerful forces of pop culture and bureaucratic life that keep so many of us operating in a deficiency mode. [p. 749]

O'Connor and Yballe [16] explain that [all italics mine] "self-actualizing people *are* deeply committed in action to core values that look very similar to those put forward in all major religions." The self of self-actualizing people is placed in the wider world, and it holds a contributory mindset to seek improvement in the well-being of the world. Self-actualizing people are those who were called to act and who responded to the call. O'Connor and Yballe [16] state that "Self-actualization is essential to strengthen and deepen the internal anchors needed to persevere in the face of unprecedented turbulence and uncertainty" [p. 751]. Hoffman [17] shows that a significant commonality of self-actualizing people is the strong commitment to helping humanity, which is also their defining characteristic.

Based on experiences with one who could find the real self through his psychotherapy, Rogers [8, 9] presents several distinct characteristics of those people, such as:

- the individual becomes less defensive and more open to experiences. He gradually comes to accept and embrace the experience of his childlike feelings as a part of himself, which he was not able to tolerate before;
- the individual becomes more aware of reality instead of perceiving things in his preconceived categories;
- the individual begins to open "himself to internal feelings that are clearly not new to him, but which up to this time, he has never been able fully to experience." "He will find those internal feelings less distressing and will be able to live closer to his own experiencing." As a result, he also moves to accept the experiences of others;
- the individual realizes that his own organism can "discover the most satisfying behavior in each immediate situation. He lives by values that he discovers within and develops more trust in the process going on within oneself;"
- the individual "increasingly comes to feel that the locus of evaluation [of choices, decisions and judgments] lies within himself and looks less and less to others for approval or disapproval, standards to live by, and decisions and choices. Living in a way that truly expresses him starts to matter;"
- the individual "becomes more content in being a process, which is fluid and flowing, rather than a product, which is fixed, static, and solid. He becomes a continually changing constellation of potentialities, not a fixed quantity of traits;" and,
- the individual negatively values facades, the compelling feeling of "oughts," and meeting the expectations of others.

Rogers [8] sums up these characteristics with Kierkegaard's word "to be that self which one truly is" [p. 181], and suggests that not necessarily limited to clients in therapy, but an individual, an organization, and even a whole nation can obtain them. From these characteristics, we can see that the "real thinking" of self-actualizing people is free from other peoples' perspectives and stems from the inside of them, specifically from their psychic fingerprint. Self-actualizing people are not ashamed of their psychic fingerprint and are embracing it, as depicted in Fig. 10.5.

They are standing on stable foundations, and their posture looks like they are emitting outward energy from inside. How they look is quite the opposite of how deficiency-motivated people look, who are constantly concerned about each other, as seen in Fig. 10.2. It would not be too difficult for anyone to choose which figure he would rather be. Rogers [9] writes:

> I believe that when the human being is inwardly free to choose whatever he deeply values, he tends to value those objects, experiences, and goals which make for his own survival, growth, and development, and for the survival and development of others. [p. 166]

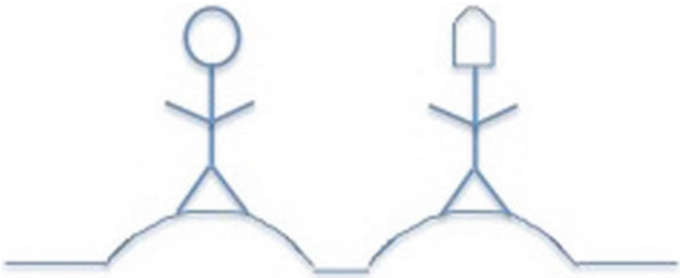

Fig. 10.5 Analogy of self-actualizing people

Rogers [9] argues that such an individual is a worthy player and a positive example in the process of human evolution. Maslow [18] declares:

> The empirical fact is that self-actualizing people, our best experiencers, are also our most compassionate, our great improvers and reformers of society, our most *effective* fighters against injustice, inequality, slavery, cruelty, exploitation (and also our best fighters *for* excellence, effectiveness, competence). [p. xii]

He goes on to argue that the higher goal of education is to support "the person to grow to fullest humanness, to the greatest fulfillment and actualization of his highest potentials, to his greatest possible stature. In a word, it should help him to become the best he is capable of becoming, to become actually what he deeply is potentially."

Given that the real thinking of self-actualizing people is better for both himself and the bigger community such as his organization, community, society, and the world, a question may now arise: "How does a leap from deficiency-motivated people to self-actualizing people take place when both types of human beings go through similar developmental stages of personality?"

Peak Experiences

Bauer et al. [19] state that most of the stage models of psychological maturity do not address the well-being of human beings and that empirical research has also shown that "higher levels of maturity do not correlate with higher levels of well-being." However, as discussed in Section "Self-actualizing People", Maslow [4, 5] depicts self-actualizing people as the happiest people and identifies them as people possessing the characteristics that structural, cognitive development theories could not clarify. How then do self-actualizing people, who do not seem to follow the stage models, emerge?

Although he does not address any causal relationship, Maslow [4, 5, 7] discusses that most self-actualizing people have "peak experiences," and so do McClain and Andrews [20], who also point out its correlation. Maslow [7] defines peak experiences as follows:

> … some of these basic cognitive happenings in the B-love experience, the parental experience, the mystic or oceanic, or nature experience, the aesthetic perception, the creative moment, the therapeutic or intellectual insight, the orgasmic experience, certain forms of athletic fulfillment. These and other moments of highest happiness and fulfillment I shall call the peak-experience. [pp. 44–45]

Wuthnow [21] presents empirical data showing that peak experiences are common to a wide cross-section of people and that peakers (i.e., those who have had peak experiences) regard their lives as more meaningful, feel more confident in themselves, and think a lot more about the meaning and purpose of life. He claims that his data supports Maslow's view that peakers are self-actualizing people. Wuthnow [21] argues that as peak experiences change people's orientation to culture and society, the social potential of peak experiences should not be overlooked.

Maslow [7] discusses outcomes of peak experiences as follows:

- A peak experience seems independent from relations, usefulness, and purpose;
- It makes the person forget the world where he is in;
- It makes the person feel he is outside of time and space;
- It makes the person begin to focus on himself without seeing oneself in relation to others;
- It can change the person's perception to be relatively ego-transcending and richer;
- It helps him validate and justify oneself; and,
- It is good and desirable, perfect and complete, and never evil.

Noble's [22] "transcendence" resonates with peak experiences. She characterizes transcendent experiences by six qualities such as ineffability (i.e., difficult to describe), noetic quality (i.e., a heightened sense of reality), transiency (i.e., beyond time and space limitations), passivity (i.e., no active cause), unity (i.e., a sense of existence in the universe), and positive effect. She sums it up by saying, "individuals emerge from the experience with a sense of purpose and meaning in life, significant changes in underlying value systems, and a desire, at times a compulsion, to integrate the experience into every aspect of their daily lives" [p. 602]. Thus, what she discusses as transcendence seems almost identical to Maslow's peak experiences.

Maslow [18] clarifies that everyone has or can have peak experiences, and self-actualizing people are those who appreciate such experiences. He calls the others "frightened by peak experiences and fight them off" as "non-peakers." Non-peakers react to peak experiences as threats to their rational, materialistic, mechanistic philosophy of life. Overall, Maslow regards peak experiences as crucial to individual mental health, and Hoffman et al. [23] confirm that "peak experiences are sometimes transformative."

Quantum Change

Miller and C'de Baca [24] researched a vivid, surprising, benevolent, and enduring personal transformational experience called "quantum change." Quantum change is:

- vivid because the person cannot deny that something extraordinary happened to him;
- surprising as it is an inner transformation that occurs without any prior external event;
- benevolent because the person feels much love through the experience; and
- enduring because the person undergoes pervasive and permanent changes.

Although quantum change might be equated to religious conversion, Miller and C'de Baca [24] clarify by stating, "… quantum change frequently are not described in religious terms, nor do they usually lead to committed involvement in organized religion. Although they overlap, quantum change is a much larger phenomenon than religious conversion" [p. 7].

In November 1991, a local newspaper in the US placed an article about a phenomenon similar to quantum change. Through the newspaper, Miller and C'de Baca called for readers who would be willing to be interviewed about their own stories on quantum change. They received many telephone calls and were able to interview fifty-five quantum changes. Miller and C'de Baca [24] categorize quantum changes into insightful and mystical types (or epiphany). The insightful type is reacted by "aha" moments and leaves the person stunned or breathless. It suddenly leads the person to "a new realization, a new way of thinking or understanding." The mystical type is more dramatic in the noetic "sense of being acted upon by something outside and greater than oneself." Miller and C'de Baca [24] explain, "perhaps quantum change is some sort of adjustment or problem-solving process that goes on at a subconscious level, presenting its results only as a finished product" [p. 165]. They regard it as a sudden forward leap in or a developmental jump to self-actualization. Quantum change seems to be a part of peak experiences, but it has a distinct feature: it changes the person to a peaker, transforming his personality.

At the end of preceding Section "Self-actualizing People", the question, "how does a leap from deficiency-motivated people to self-actualizing people take place when both types of human beings go through similar developmental stages of personality?" was posed. One answer to the question seems to be this "quantum change." To see the validity of this statement, qualitative data of personalities transformed by the quantum change are compared and contrasted to the characteristics of deficiency-motivated and self-actualization, respectively. Table 10.1 shows that quantum changes worked to eliminate some of the characteristics inherent to deficiency-motivated people. Table 10.2 indicates that personalities transformed by quantum changes are similar to some of the characteristics of self-actualizing people.

Table 10.1 The characteristics of deficiency-motivated people altered by the quantum change

Characteristics	Alteration
Prefer a safe, orderly, predictable, organized world	• Before, I used to schedule my days pretty tightly. Now I don't plan ahead on events or scheduling … Some really interesting things just unfold out of the day. I know to trust that the day will unfold [p. 54]
Desire reputation or prestige, status, fame and glory, dominance, recognition, attention	• My interest in things I was previously interested in has really dropped off [p. 53]
Feel anxiety in too many unnecessary situations	• I have a total comfort with what I am supposed to be doing [p. 55] • I felt whole, and the wholeness contained every part of my body. No matter what could happen at that moment —a hurricane or anything—I would have a sense of OK-ness, a sense that everything was all right. The entire universe was all right [p. 62] • I feel really lucky that I get to live my life like this. I'm no longer afraid, and that's a beautiful way to live. It really is [p. 130]
Do not have the slightest idea of who they are, what they want, or what their own opinions are	• I knew that the way I was living was not right—that there was more, and most important that there was more to me … That one day, I just became very aware of this. I just felt this presence of a real self within me … Now, all of a sudden, I had a sense of myself, that I had a specific course to take, and I couldn't meander any longer [p. 61]
Devote much of their time and energy in trying to control how they are seen, evaluated or judged by others	• I am in no position to judge anything. Just see it as it is, … I feel a lot more tender toward people, in contrast with how I isolated myself before [p. 64] • Now I feel connections with other people. I find that most people have a shell. With some people I can't see the real person inside them. The shell's just too thick [p. 108] • I realized that I was now identifying with what it is to be a real human being instead of with stereotypical attributes of what a person should be. I remember saying to myself, before all this happened, that it's important to be friendly, gentle, caring, helpful—all those things—but I was intellectualizing it all. With the change, it seems like now I feel it inside [p. 161]
Be driven by others rather than being self-moving, self-determining individuals	• My motivations and my whole sense of direction in life have changed. My values changed. What I thought was important changed. I just completely shifted gears. It's given me a sense of purpose and direction I never had before, a real meaningful purpose in life. I'd always sought that before, and I'd been searching different avenues … Yet always there was that kind of restless searching. Now I feel like I know exactly what I'm supposed to do [p. 130]

Noted that all descriptions in the 'Alteration' column are direct citations from [24]

Table 10.2 The characteristics of self-actualizing people and gifts from the quantum change

Characteristics	Gift
Accept themselves and their own nature	• The dam broke, and the tears flowed, and parts of my soul that had been isolated were reunited … pain is just the other side of love. They come together as a package [p. 43] • There were a lot of tears and a lot of regret for the things I had done, but it was like a great weight had been lifted … It was just important to start from that day and do things differently [p. 114]
Have the locus of evaluation within him/herself and look less and less to others for approval or disapproval, standards to live by, and decisions and choices	• I feel I can do just about anything I want. I feel that I control my life; life doesn't control me anymore. There's just this inner strength in me. I knew it was there, but I had never been able to tap it. Now it's there, and it's getting stronger all the time [p. 60]
Become less defensive and more open to experiences	• When I learned not to reply on my own directing and controlling things all the time, life became much more harmonious [p. 56]
Be called to act on missions in life, tasks to fulfill, and problems outside themselves, to which they respond	• I see more clear signs of where I can be of help now, … I'm trying to be aware of where my time can best be spent in service to others [p. 55] • I'd like to be more of a living force, to see it as it is and be able to do something about it (i.e., homeless people, street kids). I used to think, "There are other people who do that, those people out there," and now I see that I am those people. There is no designated group of people who are placed on the earth to do good works. It's each of us. That's where I am right now, realizing that I do have the ability, that I do have the power, that I do have the response to do something about it [p. 63] • I know that there is something I'm destined to do, that there is a greater purpose for me … I have found my place on earth … There is something specific that I'm here for [p. 63]

Noted that all descriptions in the 'Gift' column are direct citations from [24]

In terms of altered characteristics, many quantum changers felt that their quantum change wiped off a sense of the heavy burden they used to carry regarding human relationships and their life. Interestingly, quantum change is not just a one-time phenomenon. Miller and C'de Baca [24] write, "Many quantum changers said that it (the experience) had not ended at all but was still continuing, still flowing. Their experience was not of a completed change but the opening of an evolution, a new capacity for seeing and understanding, a new link to the universe" [p. 17]. Such a new worldview helps quantum changers realize that the material world is a small and unimportant part of a much greater reality. They are grateful for the gift of this new worldview and are inspired to devote their time significantly to compassionate service for others after that.

It should be noted that the quantum changers immediately understood the message given through the quantum change as something ‘true.’ Quantum change seems to provide the person with truly significant knowledge, unique to the person himself, and has nothing to do with ‘knowledge’ as generally understood. Although the impacts of quantum change may seem to be more than that of religious conversion, many subjects sensed the presence of something profoundly great. Miller and C’de Baca [24] write, “for those who believe in God – as most quantum changers do, at least after their experience – the hand of God is a plausible way to understand what happened to them. Although not all of them gave it the name of God, most people with a mystical quantum change felt the presence of a greater and profoundly loving being beyond themselves …” [p. 174].

Many quantum changers shifted the object of love from oneself to others by receiving the message/knowledge given to them by the presence of a greater and profoundly loving being. One quantum changer reports:

> The exciting part of it is that I can honestly say that I’ve had an important experience of God coming to me, and the most exciting part of it is that message coming through to me when I wasn’t looking for it. [24, p. 97]

Miller and C’de Baca [24] observe:

> Many also felt moved by their experience to acts of compassion and service to others, usually things that would not even have occurred to them to do before their quantum change. Some have volunteered their time to visit prisoners in jails. Others have gone into the streets to feed and care for the homeless. Such acts were rarely from any sense of requirement. Rather, they were the natural result of experiencing, in essence, that *love* is *what we are* and *what we are meant to be*. It is our nature. [p. 188]

Three Levels of Existence

Regardless of calling it by the name of God or not, most quantum changers felt that something much greater than anything they had known of was the initiator of the quantum change. Such abrupt understanding of the phenomena seems to be closely related to Chopra’s [25] theory on the nature of the three levels of existence:

i. The first level contains all physical things observable in this world, such as human beings, animals, trees, land, sea, air, oxygen, and microorganisms. Things in this level have a beginning and an end and are ruled by the principle of cause and effect;
ii. The second level, called the quantum domain, is formless and is composed of information and energy (or waves). Einstein’s equation “$E = MC^2$” shows that a mass (M) of something is proportional to certain energy (E) and explains that matter (mass) and energy (or waves) are the same, just in a different form. Thus, all physical things in the first level are manifestations of certain information and energies in the second level;

iii. The third level is pure potential, full of possibilities. This level transcends space and time and consists of “infinite consciousness” [26]. Infinite consciousness organizes energy soup, creates and structures things, and controls them. Chopra [26] shows that anything present in this universe (i.e., in the first level) is one materialized possibility emerging from countless possibilities in the third level governed by infinite consciousness.

There are people in the world who have produced completely new or innovative things as an output of their creative work. Sometimes it may be difficult even for the creator himself to trace back logically how the product was first conceived. Familiar exemplars are artists, musicians, and novelists. In terms of creativeness and surprise, the message and knowledge quantum changers receive through quantum change does not look different from what creative people receive through their production process. Both are given or gifted to them by something greater and powerful. Chopra [26] calls this something “infinite consciousness,” and his theory suggests that they are touched by infinite consciousness. Chopra [26] offers an analogy of sea waves to describe this, as shown in Fig. 10.6.

Although a single wave appears to emerge suddenly and randomly, it was formerly a part of the sea, was created into a specific form by the sea, is governed by the sea, and holds the same nature as the sea. What this analogy tells us is that any object, including visible objects like human beings and nature and invisible ones like ideas and thoughts, is not an independent existence but an existence inseparable from infinite consciousness, just like a single wave in the sea can never be separated from the sea itself. If we begin to perceive ourselves as the wave formed from a bigger and much more powerful sea and inherit all the natures of the sea, we can begin to understand the meaning of our existence in this physical world.

Some of the testimonies of quantum changers reported in Miller and C’de Baca’s [24] *Quantum Change* clearly point out the relationship between level 1 and 3 discussed above as follows:

> The whole thing came together for me, where I realized that there is a universal whole and through it I’m tied to you and to everything in the universe. I saw that there’s something much greater than this physical world that we live in, and I started asking, “What is real, what is the meaning of life, what should I strive for?”. [p. 44]

> I became aware that there is so much out there that we aren’t aware of. … I felt the reality of so many levels of existence, of being able to tap into it. [p. 84]

> All of a sudden, out of just absolutely nowhere, I just got a sweeping experience of the presence of the Holy Spirit, I guess … Not exactly a voice or anything like that, … but it was sort of saying yes - … I guess what that all comes from is a kind of unasked question that I’ve had, or an unverbalized question. [p. 94]

> I have heard this described as the “drop in the ocean experience,” where the ocean is God and we feel like a drop in that ocean. I know what truth is. I know that you and I are the same. [p. 99]

> Now, I’m not a religious person, but there’s something about “Thy will.” It’s that there’s something happening I don’t know about but I can tap into, I can surrender to it. I get in trouble when I try to impose my will, what I think should happen, on the process. [p. 136]

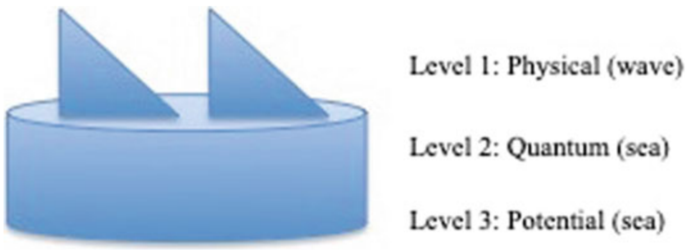

Fig. 10.6 Sea waves as an analogy of the three levels of existence

Miller and C'de Baca [24] observe that a quantum changer often undergoes a powerful and direct experience of unity with other people, nature, the universe, and everything else. The person senses an interconnectedness of all beings, and as a result, his identity and personality, which have functioned to build the boundaries around him, become less important. The quantum changer feels that he is in the hands of a *Higher Power* and is completely loved. He no longer regards himself as an isolated being. This shift in understanding one's place in society occurs because quantum change reconnects the person directly to all of humanity and life. All quantum changers say that they acquired a fundamentally different sense of self after the experience. Miller and C'de Baca [24] conclude that this spirituality then becomes the lens through which quantum changers perceive everything in this universe.

Conclusion

While quantum changers have no idea why the quantum change happened to them, they can undoubtedly confess how much they have changed because of the quantum change. The same situation is observed in self-actualizing people who have gone through peak experiences. Quantum change and peak experience both transform the individual's personality to become rooted in the real self (i.e., psychic fingerprint). As a result, it is argued that his thinking is transformed to become real thinking. On the other hand, the thinking of deficiency-motivated people remains pseudo-thinking as they live with their pseudo-self and their real self is disconnected. Some major distinct differences between pseudo-thinking and real thinking are presented in Table 10.3.

The belief that he ought to figure everything out and know all the answers to everything pushes him to think that it is inevitable to work hard and live competitively to establish and sustain one's position in this world. The lack of the concept of infinite consciousness or a higher existence or a greater existence leads to the belief that he is the only entity that must care for everything concerning himself. Thus, since the goal has everything to do with 'becoming,' 'how' becomes the main theme in pseudo-thinking.

Table 10.3 Characteristics of pseudo-thinking and real thinking

Criteria	Pseudo-thinking	Real thinking
Analogy	A defender in a hole[a]	A wave in the sea[b]
Psychic fingerprint (the real self)	Disconnected	Connected/reconnected
Concept of infinite consciousness or a higher/greater existence	NA	Intuitively understood
Mask (the socialized self)	Inevitable	NA
Goal	To persuade others that he/she is who the mask represents	To be oneself and continue to grow
Other people	Whom one takes advantage of	Whom one serves
Everything in the world	What one takes advantage of	What one treasures
Energy	Generate for oneself	Receive
Key emotion	Fearful, frustrated, lonely	Grateful, confident, empowered
Meaning of life	Uncertain	Surely to love oneself as well as others

[a]Refers to Fig. 10.2
[b]Refers to Figs. 10.5 and 10.6

Self-actualizing people, on the other hand, understand that such a belief was just an assumption built in the process of personality development and that the real world where he is placed is much bigger than what he believed it to be. By finding their real self, they become able to tap into the source of rich energy. Thus, real thinking of self-actualizing people stems from the whole (e.g., infinite consciousness, a higher/greater existence) to which one belongs. All truly significant messages and knowledge they receive are never the results of their own conscious, logical thinking. It is thus also considered that pseudo-thinking is very personal thinking, and real thinking is universal thinking.

The preceding discussions argue that peak experiences and quantum changes can transform a deficiency-motivated person into a self-actualizing person. However, no research has found how to bring about a peak experience and/or quantum change upon an individual's will because their occurrence is always beyond human power and control. They may be caused to happen by the hands of a *Higher Power* or infinite consciousness. Given this reality, a question will then arise: "Is there any way for people who have not yet become self-actualized to tap into real thinking?"

One key characteristic of self-actualizing people is the lack of a sense of deficiency, which promotes self-actualizing people to appreciate everything available for them. This includes nature, people, community, and many other sorts of physical objects, as well as everything invisible such as emotion, concepts, knowledge, ability, and condition. Self-actualizing people would no longer take all these things for granted. Many quantum changers are still grateful for what happened to them [27].

Gratefulness can eradicate fear and frustration that control pseudo-thinking. Figure 10.5 shows self-actualizing people standing on what has been provided for them and trying to grow further. Self-actualizing people know that their existence is being sustained by many things and consider them gifts to their life. They intuitively understand that all those gifts come from a higher existence or greater existence. Such understanding forms the foundation of their values, attitudes, beliefs, actions, emotions, and thoughts.

There is an experiment in which people are asked to answer whether the glass in front of them, with water filling exactly 50% of its volume, is half empty or half full. Deficiency-motivated people are quick to answer the words “half empty,” whereas self-actualizing people will say “it is filled up halfway.” How they perceive what stands before them leads each of them to the two differing conclusions. Thus, for deficiency-motivated people to tap into real thinking, it is suggested that they stop identifying whatever they consider being deficient as there is no end to such identification and start appreciating everything they see around them. “Thank you” is the words that every visitor/traveler going to a foreign country never forget to learn, and therefore, it is the baseline of any thinking in any culture. Being grateful is such an important and inherent nature of human beings. When this attitude is applied, an individual will begin to understand what real thinking truly is and how it will benefit him.

> Pseudo-thinking pushes people to find an answer to the question “Who am I?” Real thinking is just there to free you from much burden and make you happier.
>
> Ryota Ono

Core Messages

- Most are deficiency-motivated people who conceal the real self and nurture an idealized mask.
- Their thinking is pseudo, as much of it is devoted just to protecting the self-created mask.
- They perceive the world only from the vantage point of their interests and use others, society, and the world for their ends.
- The thinking of self-actualizing people, who live with the real self, is called real thinking.
- They have a contributory mindset to seek improvement for the well-being of the world.
- Peak Experiences and Quantum Changes can change the individual’s thinking from pseudo to real.

Acknowledgements I wish to express my appreciation to Professor Jenifer S. Winter of the School of Communications in the College of Social Sciences for her hospitality during my sabbatical stay at the University of Hawaii at Manoa.

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Three Paradoxes of Thought: Thought Power Measured

11

Tamás Lajtner

"You can never cross the ocean unless you have the courage to lose sight of the shore."

Christopher Columbus

Summary

(i) "your thoughts change even when they do not change;" (ii) "if you are thinking today what you thought yesterday, you are already thinking something else;" and (iii) "in order to remain in one place, you should run" are three paradoxes of thought. To understand these paradoxes, we have to understand what thought is. Thought is force. This force is a real force that makes impacts on living and inanimate (non-living): thought force creates the brain's electromagnetic signals. The existence of thought force can be captured by appropriate mechanical and electronic devices, where thought power and energy can also be measured. This study presents some thought power and energy values measured by the first electric thought power meter in the world. Knowing these values, by using, for example, this device, it is possible to control objects like a computer, switch on the wall, etc., by thought force. Mainstream science refuses to accept the existence of thought force. In the second part of the study, a short physics explanation describes how thought force works. This physics necessarily goes beyond mainstream physics, giving a new definition of time and space. Thought force is in a given size range. Like all forces, thought force also

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_11

creates its own counterforce. The counterforce and other forces in this size range can be created by living and inanimate. Saying this, thought force can be created with and even without brains. This new recognition causes the three paradoxes of thought.

Keywords

Electronic thought force sensor · Paper wheel · Space · Submarine · Thought · Thought force · Thought power · Thought power meter · Time

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

"According to the current, widespread understanding, measurable thoughts (or their effects) are the brain's electric/**electromagnetic** signals. These signals can be demonstrated in several ways" [1]. The devices measure either the brain's electromagnetic activity or the electromagnetic activity of any contrast agents.

As it is well-known, neurons are the basic elements of the brain. Each neuron has a negative electrical charge. If ions[1] with positive charges enter neurons, they will be discharged. Modern brain research can measure the discharges of neurons. These measured values are analyzed, and the result is compared with the corresponding data in a database. The measured signal has a "thought pair" in the database, defined by a series of earlier experiments. The database and the measured electrical signals of the brain together make the thoughts identifiable and measurable. Using electroencephalography (EEG) and a computer that can convert the electric signals of the brain into such electric signals that an electric sensor "understands," it is possible to run any devices by electric signals of the brain, i.e., thoughts.

How to measure the brain's electric signals? We have many instruments [2] that can measure these signals. One of these instruments is the EEG [3]. The EEG's output varies by changes in the brain's electric signals, i.e., thoughts. As a result, the measurable (effects of) thought and the brain's electric (electromagnetic) signals have been synonymous. "Since the brain is in the head, thoughts are also supposed to be in the head. Thought can, indeed, leave one's brain. EEG provides evidence of this since it records the thought data outside the head along with the skull" [1].

Nowadays, we can do more than just read information out of the brain. We can put information in the brain. The method that can write in the brain is called transcranial magnetic stimulation (TMS) [4]. TMS can write information into the brain through the skull. The brain can understand signals sent by TMS. On the other hand, the brain cannot recognize that these magnetic signals are not the brain's own signals. The brain uses these signals as its own product.

Using EEG and TMS, a new communication method between two people, that is, between two brains, can be built. We can call this communication a kind of "telepathy" based on computers and electromagnetic waves. In Fig. 11.1, Sanyi "senses" Béla's thoughts. Béla's thought read by EEG, sent via the Internet, and written by TMS, will be Sanyi's own thoughts [5].

[1] In the given case an ion is an atom that has a net (+) electrical charge e.g. potassium$^+$ ion, sodium$^+$ ion.

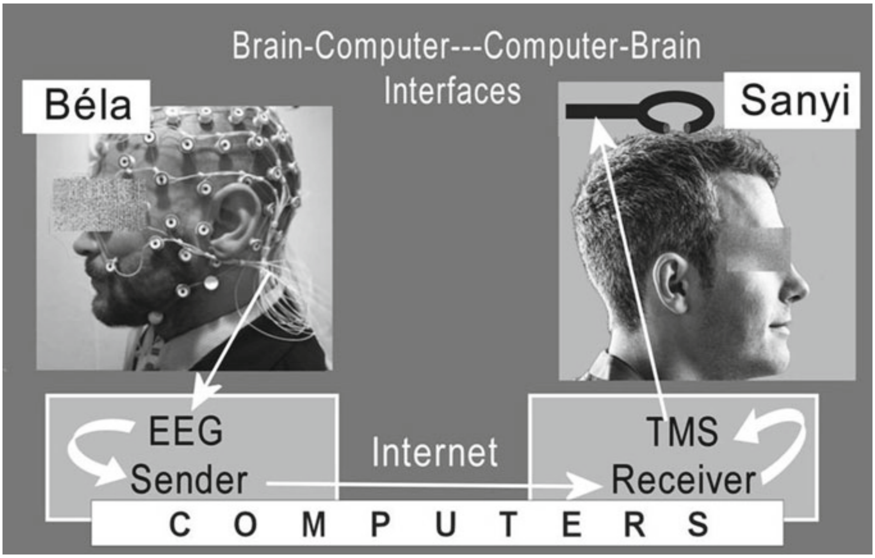

Fig. 11.1 Using computers, two brains communicate. The computers are connected with EEG and TMS [6]. Model. Adapted from [7] and modified under a Credit: © T. Lajtner

It seems to be immaterial who or what has created these signals. If there is an appropriate signal in the brain, the brain will sense it as thought. Here information flows in one direction: from Béla to Sanyi. Sanyi cannot send data to Béla; it is one-way communication. This communication does not work without using devices EEG and TMS connected to computers (Fig. 11.1). This communication works if Béla and Sanyi are in the same room or if Béla is in Europe and Sanyi is in the USA or even on the Moon. The transmission of electromagnetic waves is a well-known technology. What is revolutionary new is about reading information *from the brain* and writing it *in the brain*. If Béla's brain's signals are sent to Sanyi's, and this information will appear as Sanyi's thought, we can accept it: brain signals sent from human to human. It is also possible that Béla's thoughts are stored in a computer, and these stored thoughts will be sent to Sanyi after Béla's death. It sounds horrifying, but it works. Sanyi will not be able to detect when these signals were created. His brain uses these signals when it receives them. The next possible step is that Sanyi receives electromagnetic signals created by a computer; see Fig. 11.2.

Sanyi's brain will not be able to detect who or what has created this signal. The thoughts that will appear in Sanyi's brain are produced by a non-living inanimate thing [7]. Those "thoughts" are born from electromagnetic signals that are not created by the living brain.

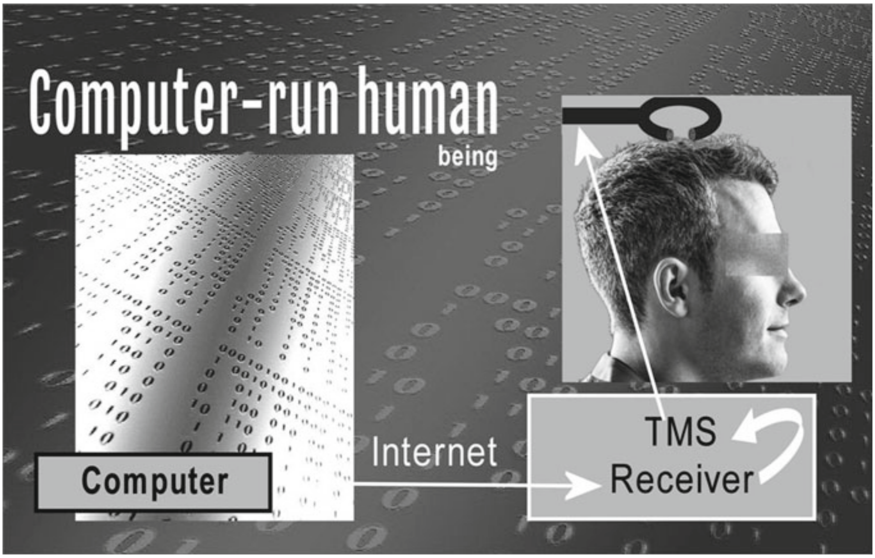

Fig. 11.2 Computer-run human being. Adapted from [7] under a Credit: © T. Lajtner

Let me summarize those mentioned above:

- Human brains create electric signals;
- These signals can be led into other human brains (e.g., Sanyi's brain);
- The brain (of Sanyi) will not make a difference between its own electric signals or made by other brains; and
- The brain accepts electric signals even if these signals are not created by a human brain, i.e., made by an inanimate (non-living) thing, for example, by a computer.

Our brain can create and receive thoughts. Is it unnecessary to be able to receive thoughts if nothing sends thoughts, i.e., there must be something in nature that sends thoughts. As mentioned above, we saw that our brains are "unified" because our brains can receive thoughts from others. This "unified" brain is useless, and it cannot exist if brains are not connected. There must be a close connection between human brains. So, the conclusion is evident: our brains are also able to send thoughts.

What can we conclude from being aware of the possibility that a computer can generate thoughts in human brains? We can say the brain must have an additional attribute. Our brains can sense signals that can be converted into thoughts: *indeed, our brains can create, receive, and send thoughts*.

Thought Is an Unknown Force

Thought cannot be the brain's electromagnetic signals because these are created by the meeting of positively charged ions and negatively charged neurons. Neurons do not move, while ions do. What drives the positively charged ions? It is obvious that the streams of the ions in the brain are generated by something. This something must have existed earlier than the electromagnetic signals because it creates the electromagnetic signals. What is this something? This something is *the thought*.

The electric signals of the brain are simply its indicators. What is thought? How can thought move ions in our brains? Ions are real objects with mass. If thought can move real objects, it means that thought has force. Where is this force? Is it in the brain or out of the brain? Can we measure thought force without studying the operation of the brain? Yes, we can measure its effects on real objects. Can we measure these effects far from the head? Yes, we can. Does thought force use one of the four known fundamental interactions (electromagnetic force, weak force, strong interaction, gravity)? No, it does not, according to the current research related to, for example, the study group of Princeton Engineering Anomalies Research (PEAR).

Mindpower Experiments at Princeton University (USA)

PEAR [8] studied the "power of the mind." The power of the mind is not the electromagnetic force of the brain. The researchers wanted to go deeper and aimed to find the phenomena behind electromagnetism. "PEAR employed electronic random event generators (REG) to explore the ability of the mind" [1]. Now, there are many experiments in the world that use REG-like devices. REG is an electronic device that shows the "influence of mind" on the device. The thought of a human being tried to change the normal (Gaussian) distribution that the device creates. The power of the mind can be shown if the normal distribution changes. At the end of the experiment, you have two functions: the theoretical one and the measured one. If the two functions are different, then the power of the mind appears in this difference. To calculate and understand the difference, a statistical method is needed to analyze all statistical values, like variance, mean, median, etc.

There was a very small difference between a theoretical distribution and the values measured by PEAR. "In other words, PEAR's experiments were able to show the "influence of the mind" (thought force) on physical systems, but the results were not convincing enough.

The effect of thought occurs accidentally. The influence of thought was unpredictable and incalculable. The effect works "mysteriously," that is, the electric/electromagnetic signals of the brain cannot explain the results, and there is no theory to explain the phenomenon. PEAR has ceased to exist, but the device REG still exists at Psyleron, selling REGs online. Psyleron and presumably also Princeton University admit [9, 10] that they do not understand the working method of mind power (thought force), and no theory until now has been able at all to describe it" [1].

PEAR was partly successful and partly controversial. It proved the existence of the power of the mind (force of thought). On the other hand, the device was a "black box," and there was no explanation for how and why thought influenced the device. REG was able to indicate the mind power (thought force). PEAR was not successful since it could not measure this mysterious power of thought, and the statistical method PEAR used did not have a not too impressive statistical confidence level.

After these semi-convincing results, the nature of thought has not been identified, although we know now that thought is more than just the electric signal of the brain. Thought force can affect objects that are outside our brains. Note here thought power and thought force seem to be synonyms, but they are not. Force and power are two different categories in physics. Force is a push or a pull phenomenon that changes the motion of an object. Power is the amount of energy that is transferred per one-time unit. Energy is the cause of any changes; it is the capacity to cause movement or heat.[2]

Thought Changes the Behavior of Electrical Components

The assumption in the background of the following process is simple: thought has force if thought can move and push atoms (ions). This force is likely to move electrons with a much smaller mass than the mass of ions (atoms). For example, sodium (Na) has an atomic weight of approximately 23. This means that a single atom of sodium weighs 23 atomic mass units. The invariant mass of an electron is approximately 5.5×10^{-4} atomic mass units. The mass of sodium ions is about 40,000 times bigger than the mass of the electron. And the thought can move many ions, so the thought must also be able to move many electrons. The energy of moving electrons in a circuit can be measured. This method could prove the existence of thought force. This is a simple theory. But how can this theory be verified; how can this be proven? If we cannot build an electrical circuit where electrons are run by thought force, the above-mentioned remain sophistry.

Lajtner's thought force sensor is the first thought force sensor in the world [11]. It shows that thought force can change current and voltage in the appropriate electrical circuits. These results have revolutionary outcomes. It is possible to build machines that can be run by thought force without using "brain-reading" devices. The following are three different experiments on thought force, a real phenomenon. The magnitude of thought force is really impressive. How does thought force work if thought force is not any of our four known fundamental interactions? To find the answer, we have to know some surprising facts. Based on these facts, an outline of a physical theory of thought force can already be made.

[2] In the International System of Units (SI), the unit of **force** is the newton (N). 1 N = 1 kg × (1 m/1 s^2).
In SI, the unit of **power** is the watt (W). 1 W = 1 N × (1 m/1 s) or 1 W = 1 J/1 s.
In SI, the unit of **energy** is the joule (J). 1 J = 1 N × 1 m.

Three Simple Experiments on Thought Force

The following experiments make thought force "visible." Each kind of experiment is captured by video, and each one can be watched here [12]. The numerical values given in the following part come from experiments visible on www.lajtner.com or from earlier experiments that are no longer visible on the Internet but in Lajtner's private collection.

Presentation Using Lajtner's Thought Power Meter

To build an electrical thought power meter, we have to use electrical components that are "thought-sensitive and thought-flexible." "Thought-flexible circuits" can be built of them. The main characteristic of these circuits is that they can change their electrical properties under the influence of thought force. When the effect of the force of thought ceases, they return to their basic state. This is the way how the first thought force sensor in the world works. Does it reliably show thought force? What is more, using a thought force sensor in an appropriate electrical circuit, i.e., in a thought power meter, we can measure the thought power by measuring the changed electrical power in the circuit ΔP. ΔP can be given by changing current ΔI and voltage ΔU; look at Eq. 11.1:

$$\Delta \mathrm{P} = \Delta \mathrm{U} \times \Delta \mathrm{I} \ (\mathrm{Watt} = \mathrm{Volt} \times \mathrm{Ampere}) \tag{11.1}$$

The changed electric power ΔP is caused by thought power; therefore, thought power is equal to ΔP—we know the power of thought. Let us see a diagram showing the thought power measured during the presentation on thought force. This presentation was more than just a measurement. Here the force of thought was also utilized. During the presentation, the computer turned on a lamp, turned it off, started a coffee maker, and brewed a coffee. The computer was controlled by thought force; see Fig. 11.3. This presentation introduced the first-ever thought force-run computer in the world (for more details; see [10]).

The essence of this presentation is that it clearly shows that thought force exists and works. The red dots show the values of thought power. The two wooden boxes (under the monitor) contain the thought force sensor and the thought power meter that measure the power of thought. The thought power meter is connected to a computer. It makes it possible to control different devices like lamps, coffee machines, or anything else. The distance between head and sensor can be long, even five meters or more.

Figure 11.4 shows many interesting facts. Most surprising is that thought force, power, and energy can be made "visible," i.e., thought force can be measured (indirectly). In Fig. 11.4a, a very important fact becomes apparent. Thought power is able to move electrons, causing changes in current and voltage in an electrical device in the thought force sensor. The current changes because of the conscious concentration of the given person, who increases his thought force and thought

Fig. 11.3 Though power measured by a first thought power meter in the world. Thought force runs lamp and coffee machine. The person concentrates and increases his thought force and power. Adapted from [12] under a Credit: © T. Lajtner

power. The changes of thought power are measurable with the thought power meter. Given that thought force can create electromagnetic force moving electrons, the mystery of the brain's electricity is solved. In the brain, thought force moves ions. If ions are moved by thought force, then the force of thought must be created before the electric waves. In other words, thought exists before the electric signals happen to the brain.

Ions are much heavier than electrons. Is thought force also able to move bigger objects than atoms? Yes, thought force can move relatively large objects, e.g., molecules or even a paper wheel.

The rise of the curve caused by the concentration of a human being is clearly visible. With concentration, it is possible to increase the force of thought. Thought force can be consciously changed. Figure 11.4a also shows an extremely remarkable phenomenon. The effect of thought force (power) lasts almost two times longer than the concentration itself. Figure 11.4b contains the ratio of thought energy. It can be calculated by calculating the area under the original curve or as a definite integral of a fitted curve. In Fig. 11.4b, a simple polynomial regression curve is fitted, degree = 2. The amount of thought energy is much larger than the energy of the brain's electromagnetic waves. How can thought force control different devices? Very simply: we define different action lines (e.g., AL1, AL2) before the concentrated thinking. If the value of the power of thought is over the AL1 during the

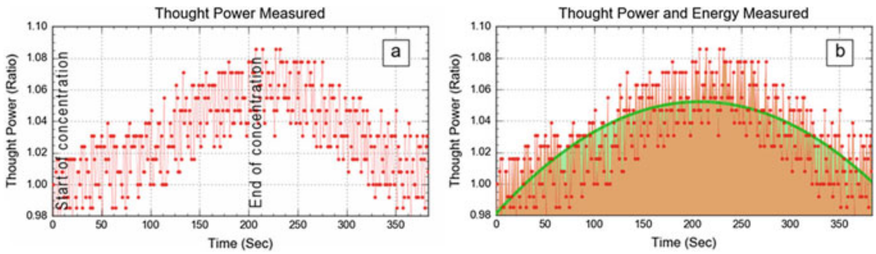

Fig. 11.4 Thought power Pm and thought energy measured. The time is given in half a second. The changes of thought power measured are displayed here. The ratio $R_{(i)}$ on the y-axis is calculated as follows: $R_{(i)} = P_{m(i)}/P_{m(0)}$, where *i* means half a second and i = 0, 1, 2, …, 378. The chart's y-axis does not start at zero because thought power existed before the concentration, and its value is not measured. The figure highlights a wavelike feature of thought power. This waving characteristic appears in every measurement. The reason for it can be either some noise or thought force simply works that way. Adapted from lajtner.com under a Credit: © T. Lajtner

concentration, then action1 (A1) appears, e.g., the lamp will be on. A1 occurs only in the first case when the power curve first becomes larger than AL1. When the red (gray in print) point is the first time over the AL2, then action2 (A2) comes, e.g., the lamp will be off. There were three action lines and three actions in the given presentation pictured in Fig. 11.5.

Of course, there are different types of though force sensors. The sensor used here is a relatively slow device. There are also faster sensors that give results in a matter of seconds. Such fast sensors can be built into almost every device, e.g., mobile

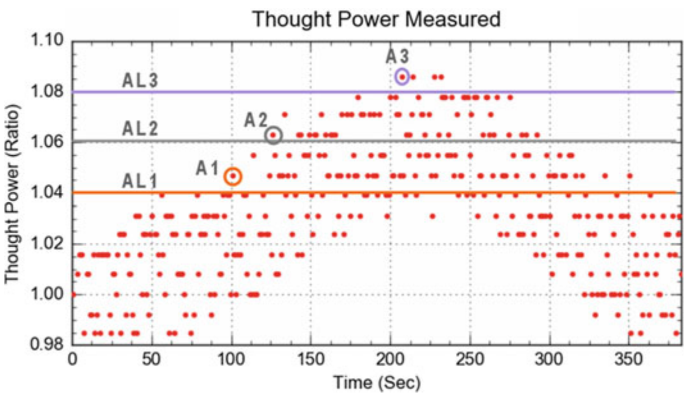

Fig. 11.5 How to control devices using thought force? Using actions lines (AL1–AL3) and actions (A1–A3). The time is given in half a second. Adapted from [12] under a Credit: © T. Lajtner

phones or electric switches on the wall. On the other hand, this “slowly” sensor is useful for everyone who wants to know how his own thought force works and how to train it. Let us summarize this small chapter. We know that thought force is able to move electrons in the thought force sensor, i.e., thought force is able to change the current and voltage in an appropriate environment, e.g., in a “thought-flexible circuit.” Thought force exists. Now we have to define what thought force is, where it is and how it works. To understand these important things, let us choose a different device—a small submarine in a glass of water.

The Submarine Presentation

Here thought force brings a small submarine to the surface of the water. The distance between the head and the submarine can be long, even five meters or more. 60–65% of the human body and 90–95% of the brain are made of water. Therefore, the submarine experiment shown in Fig. 11.6 is of paramount importance to us. If thought force can move the water in a glass, it can move the water in our body. Thoughts can heal or create new thoughts in the brain of a third person. Every force has its counterforce, so does thought force too. In many cases, this counterforce is hardly to sense consciously in the human brain, e.g., in most cases, it is impossible to sense the motions of electrons in the electric circuit. Using only electrical circuits, the counterforce, the essence of working thought, remains a mystery. We cannot understand the working method of thought refusing our human experience on the thought force-created counterforce. In the submarine case, the counterforce of thought force is expressly strong; it is well perceptible to the brain—only the existing counterforce and the human reports on its existence make it possible to understand the way thought force works. What do transmit thought force and its counterforce? A new, unknown particle? The existence of an unknown particle is not very likely. If there is no particle, what is it? Some kind of wave? Yes, waves seem to be the appropriate solution. But what kind of waves?

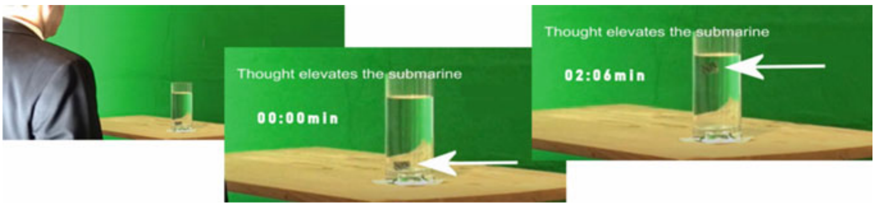

Fig. 11.6 Thought force elevates the submarine. The motion of the submarine is vertical. The energy caused by thought is also calculable in a submarine because we know every detail of the experiment. Adapted from [12] under a Credit: © T. Lajtner

The Paper Wheel Presentation

In this experiment, there is a paper wheel that can rotate (Fig. 11.7). Its motion is horizontal. During the experiment, the wheel was at rest, and then it started rotating (50 s). In the first few seconds, we calculated with uniform acceleration. In the following time, the velocity of rotation did not change significantly. "The average thought energy of a seemingly ordinary person can be expressed as $E_{rot} = 1.62\ 10^{-11}$ J" [1]. It is about such a tiny amount of energy that Fig. 11.8 shows. A butterfly hardly moves its wings.

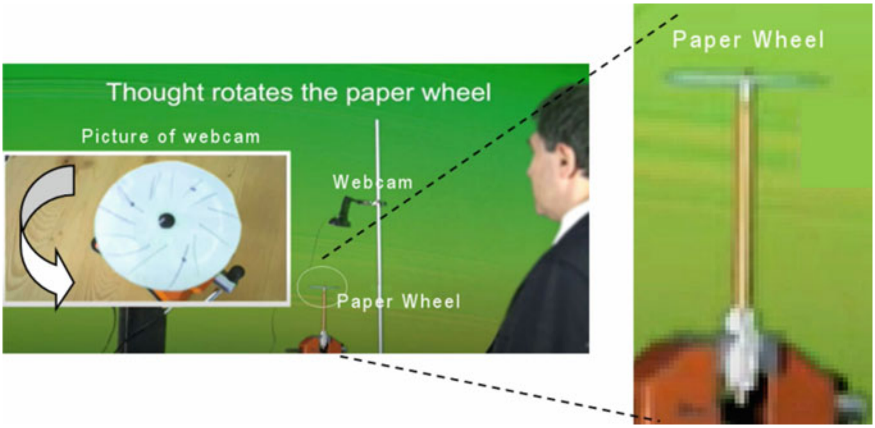

Fig. 11.7 Paper wheel rotated by thought force. More details on this experiment can be found in [12]. Adapted from [12] under a Credit: © T. Lajtner

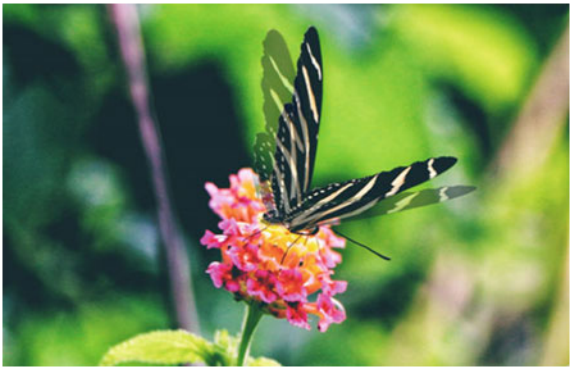

Fig. 11.8 A butterfly hardly moves its wings Adapted from [7] under a Credit Butterfly © T. Lajtner

"E_{rot} is a very small amount, but not small enough. As mentioned above, measurable thought is considered to be the brain's electromagnetic signals. The brain radiates electric waves in a spectrum of 0.01–800 Hz (Hz = 1/s) [13, 14]. These waves do not have perfect sine or cosine functions" [1]. So, if we use sine functions to calculate their energy, we will have some errors in our calculation. In this case, this error is negligible now.

"Our brain [15] has about a hundred billion (10^{11}) neurons. The energy that turns the paper wheel is $E_{rot} = 1.62 \times 10^{-11}$ J. This energy must be created by neurons. Suppose every neuron worked exclusively on rotating the paper wheel (which is, of course, impossible). In that case, every neuron should produce a big average energy value and transmit this energy to the wheel. Sending this kind of energy from the brain to the wheel presupposes electromagnetic waves. According to Planck's law" [1] displayed in Eq. 11.2:

$$E = h \times f. \tag{11.2}$$

Here E is energy, f is the frequency of the particle, and h is the Planck constant [16–18]. "Thus, the average frequency of electromagnetic waves is in the spectrum of microwaves [19]. There is no such thing as microwave radiation of the brain. To go one step further, this wave has to be generated by every neuron for 50 s. This is an impossible result. That is, the paper wheel cannot be rotated by the electric/electromagnetic signals of the brain. Does that mean that the paper wheel cannot be rotated by thought? No, because that is what occurred; the wheel rotated. So, what can we conclude?" [1]. The rotation of a paper wheel is an electromagnetic interaction, too. Thought force can generate electromagnetic force and move real objects.

Thought Is Force

"A paper wheel is nothing other than a simple thing that can be rotated by force. Without force, it cannot start rotating at all. It rotates if a force acts upon it. What do we measure using a rotating paper wheel? The paper wheel reveals one's thought in its true form. A human being only has to think "Go," so the thought is "Go," and the paper wheel "goes" (i.e., rotates). The computer that analyzes the rotation of the paper wheel displays a big "Go" (Fig. 11.9). If humans think "Stop," the thought is "Stop," and the paper wheel "stops." The computer displays the word "Stop." Saying this, the thoughts "Go" and "Stop" are visible. These forces are not the effects of the thought; they are thoughts. We measured the thought itself and thought itself is force" [1].

Fig. 11.9 The computer shows thought "Go". Adapted from [7] under a Credit: © T. Lajtner

How Does the Accelerating Force of Thought Come into Being?

"What is thought force? Let us think of it this way: from a state of rest, the wheel begins rotating, the submarine starts to lift off because the force of acceleration works upon it. According to Newton's Second Law of Motion [20], the force of acceleration *F* is given in Eq. 11.3.

$$F = m \times \left(s/t^2\right), \tag{11.3}$$

where *s* represents spatial distance, *t* time, and *m* mass of the object. Newton's Second Law of Motion makes it possible to understand the force of acceleration and its factors. Let us see the wheel. Force F does not exist if the wheel remains at rest, s = 0 and t = 0. F comes into existence and rotates the wheel when s > 0 and t > 0, that is thought changes time and space" [1]. How?

To answer the question, Lajtner's Space-Matter Theory will be used. This theory is not a fully developed theory; it is actually a new framework. Here more old axioms are replaced with new axioms. The space-matter framework gives new definitions of time, space, and matter. Based on the space-matter framework, it is possible to build a new physics theory that can lead into new directions.

A Touch of Physics: Wave of Space

Space Waves

We know from quantum mechanics that particles of matter are in constant vibration. It is a physical impossibility for the matter to contact space without matter's vibrations having an effect on space. Based on the Casimir Effect [21] and other physical phenomena, we state that space exists in waves and vibrations. Can we describe a model of waving space? Yes, by using Lajtner's space-matter framework.

How to Picture Space Waves?

We use Einstein's idea [22–28] in an unusual way to calculate space waves. According to his idea, gravity depends not only on mass density but also on other factors. Newton used in his law of gravity the density of mass and no other attributes of mass. Einstein used more than one attribute in his gravity model, where gravity is expressed as the curvature of spacetime. According to general relativity, the curvature of spacetime depends on sixteen attributes of matter, including mass density, energy density, energy-flux density, pulse current density, impulse current density, and various pressures and fluxes. In the space-matter framework, there is no spacetime, only space and time. Applying these sixteen attributes to our unusual way, we have sixteen attributes that modify space and time. In the space-matter framework, every attribute of matter has a print in space as a modified space wave. Therefore, it is possible to calculate with more than one space wave or just with their sum, but here only the space wave created by mass density is shown in Fig. 11.10 because it is the simplest model.

If an observer can measure the wavelengths of a space wave, he would find the *shortest* wavelengths of space waves if the mass is at rest—that is, mass does not move in the given inertial frame of reference. An inertial frame of reference is where there is no acceleration. The motion of an inertial frame of reference has constant velocity in a straight line. If we stand motionless, we are moving at constant zero velocity. According to modern physics, only an object with mass can have an inertial frame of reference [29]. If mass moves in the given inertial frame of reference (or with the whole inertial frame of reference), the wavelength of space wave made by moving mass is longer; faster or bigger masses create longer wavelengths.

Space Waves Are Connections Between Masses (Matter)

Space waves are connections between masses (matter). This is why gravity exists between masses. "Thus, among bodies experiencing gravity, the wavelength of

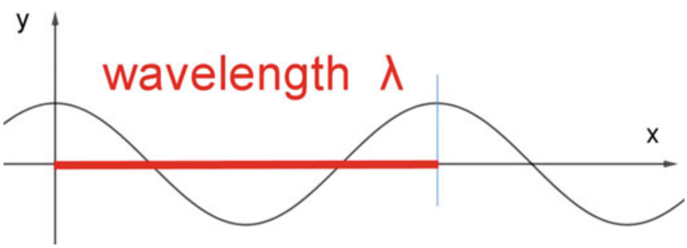

Fig. 11.10 Space wave created by mass and x and y are spatial distances. The wavelength is the length of one wave period—a two-dimensional model, not proportional

space waves increases. That is, the space “pressure” between the bodies decreases. The big (orange) mass in Fig. 11.12 makes the wavelength of space waves longer on the left side of the small (blue) mass. On the other side of the small mass, the wavelength of space waves is shorter” [1]. The shorter wavelength means greater frequency, e.g., more hits from the right than from the left. The difference between the densities of the hits (i.e., forces) moves the mass forward. If the small mass starts to move, it will increase the wavelengths of space waves between the masses. The mass will accelerate, and the wavelengths will be longer; see Fig. 11.11. The small object accelerates further, and that is why there is the gravitational acceleration. The space wave (set of space waves) between the two objects can be seen as a communication channel. Space waves make it possible that both objects detect all movements of the other object, i.e., every action creates a reaction. This is a system with feedback.

Why Is the Speed of Light Constant?

It is a simple question, but physics has not answered it yet. Instead of an answer, there is a law: the speed of light c is constant in a vacuum: c = 299,792,458 m/s. But how can the speed of light be constant from the viewpoint of masses in every (inertial) frame of reference? The speed of light can only be constant if the light is in the given frame of reference. How can it be? It can happen by using space waves created by the inertial frame of reference. According to space-matter framework, space waves are part of the frames of reference. Light travels on space waves created by mass: it does not change the wavelengths of space waves but uses space waves as reference waves. A longer space wave causes a longer light wave in the case of the same light (Fig. 11.13), and bigger gravity means longer wavelengths of space waves. The result is the gravitational redshift of light.

Light travels on space waves generated by mass. Space is written in capital S means space that masses change. We know light does not create gravity in our space; that is, light does not change the wavelength of space waves. But the matter has a copy in space, and light is matter; light must have a copy in its space. Saying this, light has gravity in a different space, not in the space of masses. The space of

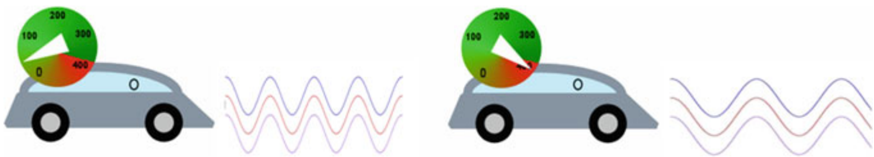

Fig. 11.11 The space waves are longer if the object is faster. Model, not proportional. Adapted from [29] under a Credit: © T. Lajtner

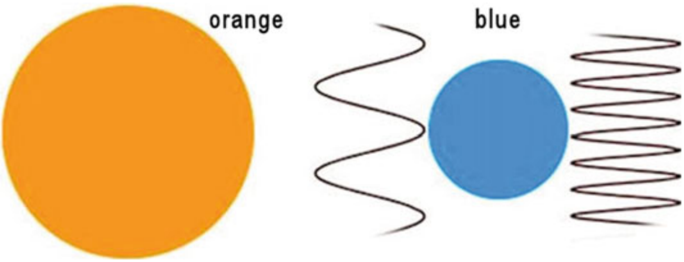

Fig. 11.12 Gravity caused by space waves. Gravitation occurs when space shifts. Model, not proportional [30]. Adapted from [30] under a Credit: © T. Lajtner

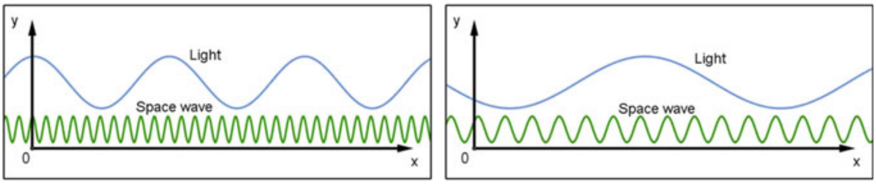

Fig. 11.13 Space wave and light wave at several velocities of mass. The gravity is bigger in the second picture, and x and y are spatial coordinates. Model, not proportional. Adapted from lajtner.com under a Credit: © T. Lajtner

light, i.e., space wave generated by mass, is part of the frame of reference of mass; it is "glued" to the mass, that is, the mass and the space of light are in one inertial frame of reference independent of the velocity of mass, i.e., independent of the wavelengths of space waves. In this inertial frame of reference, the velocity of light is constant c.

According to those mentioned above, there are several spaces. The mass has its space, and light has its space, and they are different. Therefore, the definition of space is not self-evident. What is space? What is time?

Space-Matter Model: Spatial Distances Given by Space Waves

Can we measure space? Measuring space, we measure matter. The meter is the length of the path traveled by light in a vacuum during a time interval of 1/c = 1/299,792,458 of a second [31]. If we measure space by means of light, we use a kind of matter that has its own nature. We cannot measure space at all. We measure only matter. We can "see" the length of space through light glasses.

Wavelength and Spatial Distance

As shown in Fig. 11.14, here we remember the length contraction of special relativity. Yes, this part is about it, but here length contraction is explained in a different way. The given spatial distances of the object and the observer can be given as the sums of the wavelengths of space waves. If the object moves in relation to the observer because they are in different inertial systems, then the observer and object will realize different space wavelengths. Longer wavelengths mean higher speed. Different speeds mean different lengths of wavelengths of space waves. The same spatial distance measured from Object A to Object Circle can be made out of different wavelengths of space waves according to different observers [32].

The length contraction described in special relativity is the viewpoint of "R." Using space waves, this situation can be given as a length dilation of the wavelength of the space wave. "A" is the original situation and "B" is the changed situation.

"R" is the way how relativity presents the distance of "B" as length contraction. In reality, solution "B" exists because the wavelengths of space waves grow.

The wavelength change is a real phenomenon in space, not the observer's viewpoint, as special relativity states. Behind the relativistic length contraction of spatial distance is a real difference between the space's wavelengths of observer and object, says the space-matter framework.

Time Given by Space Waves

What is time? Today's physicists claim that time is what we measure as time. What does the phrase "what we measure" mean? We can measure only matter. One second is defined as a changing character of the cesium 133 atom we can measure [33]. If we measure time by means of mass, we use a kind of matter that has its own nature. We cannot measure time at all. We measure only matter. We can "see" time

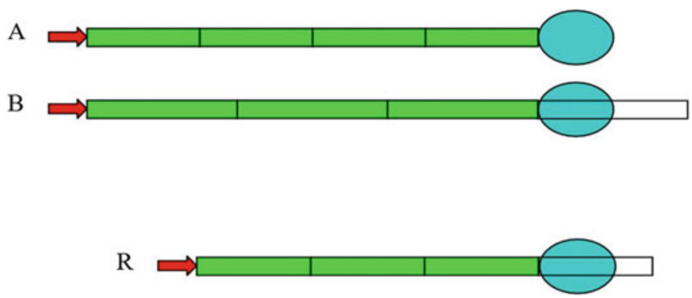

Fig. 11.14 How does spatial distance change? Model, not proportional. Adapted from lajtner.com under a Credit: © T. Lajtner

through the glasses of mass. One second has its start and has its end that we measure. The main element of time is its change. If there is no change, there is no time. We measure changes of matter by measuring time.

According to the space-matter framework, time exists without having been measured.

Time as Spatial Waves

"In the space-matter model, time comes into existence when matter and space meet. Time is the action-reaction phenomenon of matter and space and appears as a spatial wave" [1]. There is no way of putting space and matter together without action and reaction coming into being. Or in other words, there is no way to put space and matter together without time coming into being (Fig. 11.15). Time depends on two things: on the given space and on the given matter that travels in space. According to modern physics, mass causes time; so, our time is the action-reaction of mass and space that exists as space waves. The wave of space is not the only space wave, i.e., not the only time; it is just *our own time*. In our life (and in physics models), we use the time created by mass, but "non-mass" objects may use different space waves as time. Photons create *their own time*, although physics states that a photon has no time. As mentioned above, it is impossible since a photon is a matter that causes changes in its space.

Our Time Wave and Time Unit

From the viewpoint of mass, the actions between space and mass can change between strong and weak. It oscillates. The change is periodic, and one period is one unit of time. This unit of time has two parts:

i. the hit, when space acts upon mass most strongly; and
ii. the period between hits when the force of space acts less strongly upon mass.

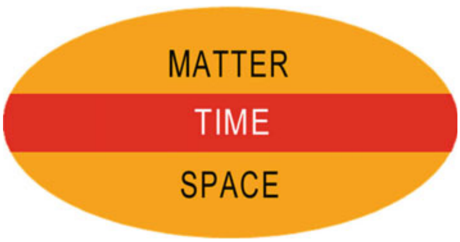

Fig. 11.15 Lajtner-burger. 3D space + 3D matter = 3D space + 3D matter + time. Adapted from lajtner.com under a Credit: © T. Lajtner

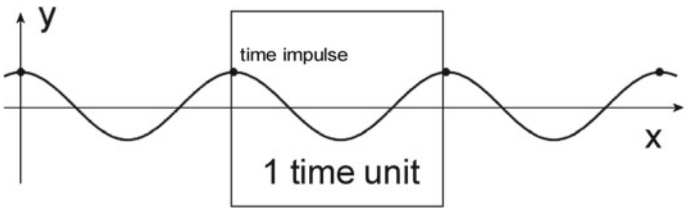

Fig. 11.16 Time as space wave and x and y are spatial distances. Model, not proportional. Adapted from lajtner.com under a Credit: © T. Lajtner

If we employ a cosine function to describe time, we get a periodic wavelength. Hence, it appears to be a good model, where: in the case of i, the value of the function equals the positive amplitude of the cosine function, and every other value of the function creates ii, only one positive amplitude in a unit of time (in a single time wave). Therefore, there is only one hit in a time unit. Time is a repetition of these units. Time is the continuous alternation between i and ii. From the viewpoint of matter, time is characteristic of the periodic way that space acts upon mass. In Fig. 11.16, a pulse of time is marked as the point. This is followed by a lack of time pulse:

pulse pulse pulse . . .

The longer the wavelength of the space wave, the rarer the time impulse:

pulse pulse pulse . . .

We can understand why the paper wheel is rotated by thought force. Thought force changes the wavelength of space wave; time and space are changed, and the paper wheel will rotate. What else can we conclude from this? We can conclude if the wavelength of the space wave grows, mass accelerates. "Solely through the use of space waves, we can express spatial distance, time, and energy" [1]. Space waves are, however, not only indicators of these phenomena.

Is the Velocity of the Mass Always Constant?

The Velocity of Space Waves Is Constant

If time waves are derived from space waves generated by mass, a strange phenomenon arises—time and distance are the two sides of the same coin from the viewpoint of mass. An object with mass cannot change any spatial distance without changing time, and changing time means changing the position in the given space.

Space Unit and Time Unit Given by the Same Spatial Wave

Now we can use the idea of Minkowski geometry in Fig. 11.17 to make a new time and distance model visible. In the following coordinate systems, both time *t* and distance *s* are expressed in meters. We can realize that the mass velocity according to space waves is always 1 because distance Δt is always as long as Δs. The wavelength of space wave always defines 1 unit of time *t* and 1 unit of spatial distance *s*.

Bigger velocity makes the wavelength of the space wave longer. The wavelength of space wave creates the unit of time and spatial distance for the given mass. The velocity of an object with mass changes the length of the wavelength of the space wave but not its speed. The growing length of units does not destroy the proportion of the units. Equation 11.4 shows that mass velocity is constant in its space from the viewpoint of space wave and mass, too:

$$v_{Mass\_in\_Space} = \Delta s_1/\Delta t_1 = \Delta s_2/\Delta t_2 = 1 \tag{11.4}$$

Figure 11.17 explains how space and matter create and change time. An object gets moved in space. This is the action. The reaction of space is the change of wavelength of the space wave. Time is created and changed. This is how the electromagnetic force works. First, the electromagnetic force acts. The object moves; so, the wavelength of space waves changes. In the case of thought force, the situation is reversed. There is also a third situation. Let us study the accelerating Universe! Why does the Universe accelerate? Mass in space will accelerate once it starts moving. It will accelerate unless acted upon by force created by matter, i.e.,

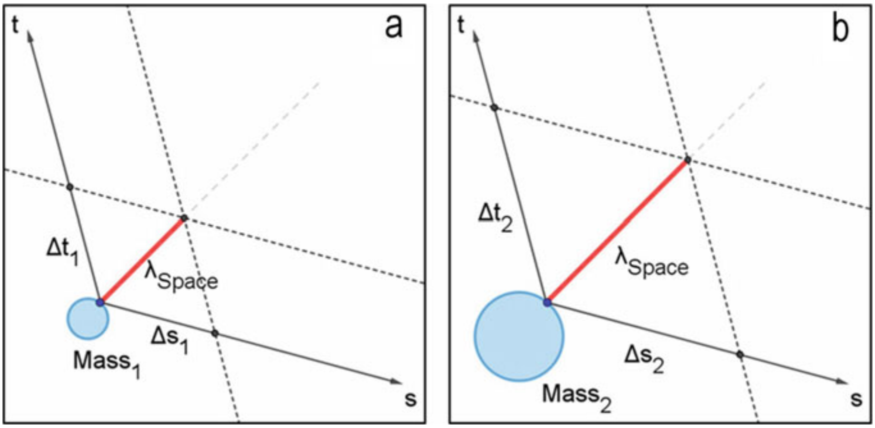

Fig. 11.17 Wavelength of space wave λ depends on the velocity of the mass. **a**, **b** Show the same mass at different velocities. Adapted from [29] under a Credit: © T. Lajtner

without additional energy, without other mass, and without gravity. The changing wavelength of the space wave has an action on mass. This is followed by a reaction of the object: it moves faster. This is followed by a reaction of space: the wavelength of the space wave grows; therefore, the mass goes faster, and the wavelength of the space wave grows.

Accordingly, there is an important interaction between matter and space. Let us call it Force I (pronunciation: force the first). Given the interaction between mass and space, Newton's first law of motion is arguable. Today's academic physics accepts Newton's first law as fact. This is not a fact; it is actually Galileo's 400-year-old opinion. It is disputable [34]. Moreover, the inertial frame of reference also needs a new definition because of the existence of space waves.

Force I

Force I (pronunciation: force the first) is the interaction between matter and waving space. Force I permanently exists as long as there is matter in space. According to Eq. 11.3, this force appears as changes of time and spatial distance; therefore, Eq. 11.3 works and the paper wheel rotates. That is, Force I can create the electromagnetic interaction. The electromagnetic force and the weak nuclear force have common roots. They are called electroweak interactions [35]. The asymptotic freedom [36, 37] makes it possible to join the electroweak and the strong interactions at high energies. So, these three interactions can be seen as one interaction. Force I creates electromagnetic force; therefore, it creates these three interactions [2]. Gravity is created by Force I, as described above. Summarizing the above-mentioned, Force I generates every known fundamental interaction (Fig. 11.18).

Fig. 11.18 Four fundamental forces we know and the hidden Force I. Force I is the only and ultimate force that appears as fundamental interactions. Adapted from [34] under a Credit: © T. Lajtner

Light and Particles Can Travel Faster Than c

Mass travels in its space the same way light travels in light's space, i.e., with velocity c. These spaces are different. What if they travel in the same space? Each will travel here as a fast wave, i.e., faster than light. In which space can both travel so fast? It is a fast space made of matter. Here, we present a space made of matter. But what is the matter, and what is space? The simplest definition of them is as follows: space is what matter uses as space, and matter is what space allows existing as matter in the given space. In some cases, space can be made of an object that we know as matter (short: matter-space), e.g., via tunneling. A barrier is an object with mass, and it acts as a matter-space. The given space determines the form of the appearance of matter, e.g., electrons can be particles with mass in space, but they cannot be massless fast waves in space. On the other hand, they can be massless fast waves via tunneling in a matter-space, but they cannot be mass particles.

Tunneling: Space Made of Matter (Fast Space)

Quantum tunneling refers to the quantum mechanical phenomenon where a particle (with or without mass) tunnels through a barrier that it normally could not surmount. In experiments, many particles are sent to the barrier, and only part of them get through the barrier. They are tunneling particles. In tunneling, the *group velocity* is important, but if we examine the tunneling effect as the behavior of a given particle, we can analyze *this* single-particle, i.e., *its* velocity, since the particle does go through the barrier. In the forthcoming parts of this study, I analyze the behavior of a "single" tunneling particle because I want to point out the metamorphosis of this particle, which is a common attribute of particles.

Particles travel with superluminal (faster than light) velocities in tunneling; therefore, they will be called fast waves in the forthcoming parts of this study. Nimtz et al. [38], first measured superluminal tunneling velocity with microwaves in 1992. The tunneling particle has an undetectable condition. Tunneling takes time, which can be measured. In Nimtz's experiments, tunneling particles are photons and electrons. Every electron has a mass. There comes the big riddle in tunneling. Experiments show [39] that tunneling particles, i.e., electrons, are faster than light, and these facts are *not* compatible with the mainstream physics theories and with special relativity. According to the theory of relativity, the growing velocity of particles with a mass (e.g., an electron) causes growing mass, and if $v \rightarrow c$, then mass $m \rightarrow \infty$. Since the mass m (of the electron) is never ∞, and the tunneling is a measurable fact, we have to suppose that $v = c$ never occurs from our point of view. There is a discrete jump at velocities of the electron, and $v < c$ becomes $v > c$ without $v = c$. The particle with velocity $v > c$ on its own is immeasurable as yet.

The barrier is a space made of matter. It will be mentioned as a fast space where $v > c$ from our viewpoint. In Table 11.1, the traveling particles are photons (light)

Table 11.1 The tunneling velocities v_{fw} and the lengths of barriers in three experiments of Nimtz

Topic	Experiment 1	Experiment 2	Experiment 3	Note
$v_{fw}/c = V_{tunneling}/c$	4.702	8.552	2.565	Superluminal velocities
f_0	8.7×10^9	9.97×10^9	8.7×10^9	Frequency of particle before tunneling (1/s)
λ_0	3.45×10^{-2}	3.01×10^{-2}	3.45×10^{-2}	Wavelength of particle before tunneling (m)
L	1.142×10^{-1}	3.00×10^{-1}	1.00×10^{-1}	Length of the barrier (m)
$h_{kinetic}/h_{rest}$	22.11	73.14	6.58	Motion indicator calculated by Dr. Lajtner

that have no mass. Note electrons with mass are also able to turn into fast waves. Fast waves are massless: the mass of matter seems to depend on the given space where matter travels.

Superluminal Velocities of Light via Tunneling

The three experiments are described in [40–42]. In barriers, i.e., in fast spaces, matter particles travel at superluminal velocities: $v_{fw} > c$. In these cases, the motion indicator calculated by Lajtner is greater than 1.

A Touch of Physics of Thought Force

How Is the "Big" Magnitude of Thought Force Created?

Thought force can rotate a "heavy" paper wheel. How can be thought force be so strong? As summarized in Table 11.1, we can study the same particle in two different spaces. Using the space-matter framework, after some calculation not published here, it seems that there are two parts of the well-known Planck constant *h*. *h* is the most important unit in quantum mechanics; it is the unit action. Suppose that the particle's energy does not change via tunneling. *h* has two parts that work together. They depend on the particle's velocity (wave, fast wave). Look at Eqs. 11.5 and 11.6:

$$h_{rest} = (c/v_{fw}) \times h \tag{11.5}$$

is the rest energy part and

$$h_{kinetic} = (v_{fw}/c) \times h \tag{11.6}$$

$h_{kinetic}$ is the kinetic energy part of the Planck constant h—in the case of light and seen from our space. The motion indicator $h_{kinetic}/h_{rest}$ is made of the two parts of h.

Physics has defined neither Eq. 11.5 nor Eq. 11.6 previously. If $h_{rest} = h_{kinetic}$, then the speed of the light is c; Planck's law remains untouched if $v_{fw} = c$ and the motion indicator is 1. If $h_{rest} = h_{kinetic}$, we speak about a "normal" photon traveling with c velocity. If $h_{rest} > h_{kinetic}$, we speak about particles with mass, i.e., fermions, where the motion indicator is less than 1. If $h_{rest} < h_{kinetic}$ we talk about fast waves. Both photons and fermions (e.g., electrons) can realize the tunneling process. We cannot measure their fast waves via tunneling yet, nor can we measure either h_{rest} or $h_{kinetic}$.

According to the space-matter framework, h_{rest} and $h_{kinetic}$ depend on the particle's velocity. Saying this, it seems to be a good idea to create an electron in a fast space. To create a particle in a fast space needs only a small h_{rest} because the big $h_{kinetic}$ comes from itself. If the particle leaves the fast space, its h_{rest} grows, while its whole energy remains untouched. The thought force can be generated this way; therefore, it can be as strong as the measured values show. This strong thought force will be placed in space waves and appears as a modified space wave.

Thought's Feedback Mechanism

In Model 1 and Model 2 of Fig. 11.19, thoughts express force on the small object. Model 1 shows the phenomenon without feedback: no thought force communication. The wavelength of the space wave is unchanged. The thought force communication works in the case of Model 2, where thought force gives feedback. The wavelength of the space wave is changed. The paper wheel and the submarine experiments prove that Model 2 is correct.

As mentioned earlier, the working method of thought force presented in Figs. 11.19 and 11.20 cannot be derived from theoretical consideration. It needs experiments and praxis to realize the two-way communication via thought force. This two-way communication via thought force is a discovery.

Now, let us understand the situation shown by Model 2 using the terms of physics. The common picture of a force in physics is a vector. Thought force is a "normal" force with direction and magnitude regarding a frame of reference. Thought force (green) can also be displayed as a vector. Your thought leaves your brain, but it does not lose connection with your brain. The changes of thought appear as feedback your brain perceives. Your brain can sense that the green thought has changed. It tries to restore the green thought to create its intended form. By stating this, we claim thinking is a continual interaction, seeking the balance between thought force and other forces. In terms of physics, our thought force (green in Fig. 11.20) is a force like any other force. If it meets another force (red), they create the resultant forces (blue) in Fig. 11.20. The gray part of Fig. 11.20 shows your brain activity at work, for example, rotating the paper wheel. Your brain can sense the resultant blue force, and your brain tries to increase the (green

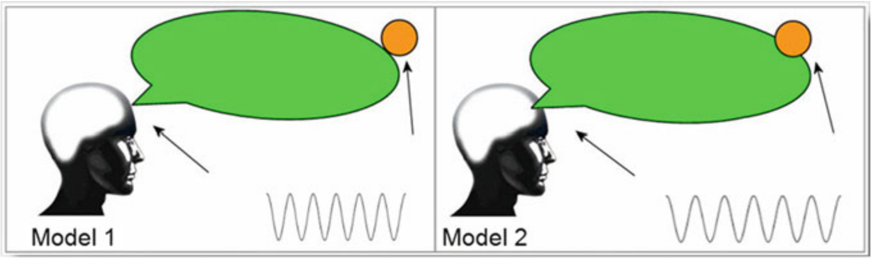

Fig. 11.19 Your thought leaves your head, but it does not lose the connection with you. It gives feedback for you. Adapted from [7] under a Credit: © T. Lajtner

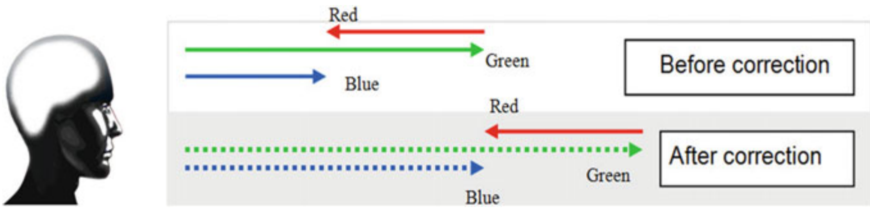

Fig. 11.20 Forces of thoughts. The first part of this figure (with white background) shows that two forces meet. The green one is a thought force; the red one is an external force. The resultant of these forces is the blue arrow. To restore the original effect of thought force to achieve what we intended, we need to generate a new, longer (green dotted) thought vector. Here the blue dotted vector is as long as the first green vector of thought was. Illustration, not proportional. Adapted from [7] under a Credit: © T. Lajtner

dotted) force of thought as long as the new sum of forces (blue dotted) can replace the intended green thought force. The blue dotted force will give you the desired result, e.g., it rotates the paper wheel. You get the result you want, only if you change the force of your thought depending on environmental forces. The method is generally known as a system with feedback [43]. Of course, there is a limit to increasing your thought force. The force of thought has upper and lower limits. The limits of your thought force can be greater or smaller than the other one's limits, but we both have a very small range of thought force comparing the forces of the Universe. But within this range, you can grow or decrease the force you want to send via thought: you can change the length and the direction of your thought force arrow. This is your inborn ability: you use it and make unconscious thought force communication possible anytime and anywhere. This study shows you that you can also do it consciously.

Thought Force Exists as Force I

The feedback mechanism results from the way thought force travels. How does thought force travel? Thought force is embedded in space waves. Thought force is a modification in the wavelength of space waves (Fig. 11.21). Thought force creates an electromagnetic force by changing time and space. Because thought force is not a known fundamental interaction, it must be a new interaction that can create electromagnetic force and create feedback. Force I is a phenomenon like this, i.e., thought force exists as the Force I.

Thought in World, World in Thought

Force I can be created by many objects. Therefore, our thought force can be influenced by many events we do not know at all.

Three Paradoxes of Thought

Your every thought has force; that is, your every thought is an action that generates a reaction. If force reaches your brain from the world as action, your thought or your thought change is the reaction. Thinking is a continuous action-reaction process because each thought of yours has two parts: See the addition below.

Thought$_{\text{Intended}}$ (you want to think this thought)

\+ Thought$_{\text{World}}$ (force given by the world can be sensed as thought)

= Thought$_{\text{Result}}$ (the result of each thought force)

Your intention as force, Thought$_{\text{Intended}}$, and the force of the world, Thought-World, form a resultant force, ThoughtResult, which is not the intended thought but the third thought.

Thought$_{\text{Result}}$ $\neq$ Thought$_{\text{Intended}}$. Figure 11.22 helps to understand the concept.

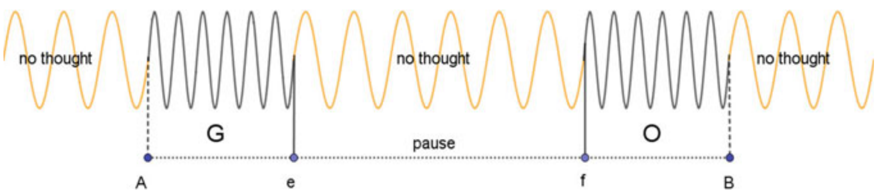

Fig. 11.21 Thought force "GO" embedded in time wave. Model, not proportional. Adapted from [7] under a Credit: © T. Lajtner

Fig. 11.22 $\text{Thought}_{\text{Result}} \neq \text{Thought}_{\text{Intended}}$. Adapted from lajtner.com under a Credit: © T. Lajtner

If you want to think about your intention, you have to correct the impact of the force of the world. If you want to think $\text{Thought}_{\text{Intended}}$, you should think $\text{Thought}_{\text{Intended}}$ and $\text{Thought}_{\text{Correction}}$, where ($\text{Thought}_{\text{Correction}} + \text{Thought}_{\text{World}} = 0$).

$$\begin{array}{l} \text{Thought}_{\text{Intended}} \\ + \text{Thought}_{\text{Correction}} \\ + \text{Thought}_{\text{World}} \\ \hline = \text{Thought}_{\text{Result}} \end{array}$$

In this case: $\text{Thought}_{\text{Result}} = \text{Thought}_{\text{Intended}}$. Figure 11.23 visualizes the process.

$\text{Thought}_{\text{Correction}}$ is part of your thought that keeps changing. It is neutralizing $\text{Thought}_{\text{World}}$, i.e., the thought force of the world. The world changes uninterruptedly; therefore, $\text{Thought}_{\text{Correction}}$ also keeps changing. If you want to think $\text{Thought}_{\text{Intended}}$, you have to keep adjusting to the force of the world: you should always change your thoughts, if you want to think the same thought:

> Your thoughts change even when they do not change.

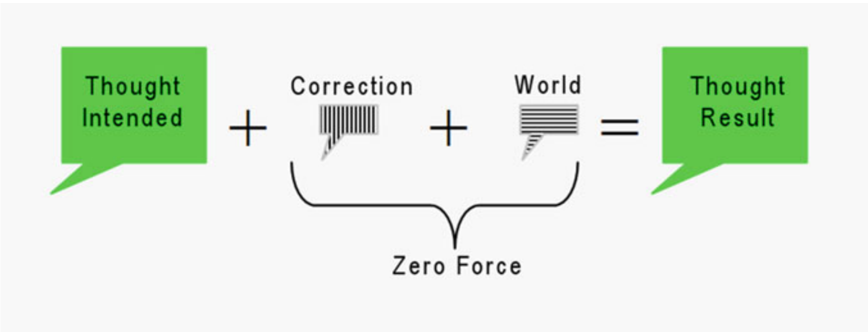

Fig. 11.23 $\text{Thought}_{\text{Result}} = \text{Thought}_{\text{Intended}}$. Adapted from lajtner.com under a Credit: © T. Lajtner

The world is changing, $\text{Thought}_{\text{World yesterday}}$ was yesterday, today

$\text{Thought}_{\text{World today}}$ exists, and they are different. They must be different since the world is changing. If you want to think the same $\text{Thought}_{\text{Intended}}$ you thought yesterday, you have to think

$\text{Thought}_{\text{Intended}} + \text{Thought}_{\text{Correction today}}$ instead of

$\text{Thought}_{\text{Intended}} + \text{Thought}_{\text{Correction yesterday}}$.

If you are thinking today what you thought yesterday, you are already thinking something else.

If the world is always changing, what is the stable point for you? The only stable point for you is your DNA. You can compare your thoughts to your DNA. If the connection between your DNA and your thoughts of yesterday and today are the same, you are thinking the same thing you thought yesterday—according to your DNA but not according to the world. What does the world require?

In order to remain in one place, you should run.

I gave the third paradox in a general form because it seems to be true everywhere. Here is an everyday example: if you have had the same standard of life as those in your surroundings and you want to keep pace with them, you will need to work harder.

And here is a cosmic example: our Earth is traveling about at an average orbital speed of 828 thousand km/h (514 thousand mph) around the center of the Milky Way [44] to remain in the solar system. It follows the Sun that is traveling this way.

The Main Paradox of Thought

i. Thought force has a very big velocity. This result comes from its physics, which is beyond the scope of this chapter;
ii. There are many forces in the world that are in the size range of thought force. The forces act as vectors. If similar forces meet each other, they will be added up; they will have one resultant force.

The thinking seems to be lonely, but it is not. It is just the opposite. You need the entire world to think.

The whole world is in your thoughts,

and your thoughts are in the whole world.

Thought as the force does not require a further search for additional “ancestors” and additional causes. The cause of thought is in the world, and the forces are within it, too.

Our First Thought

What is the first thought of a human being? Everything starts with this first thought. How was this first thought born? If we understand this, we understand how other thoughts were created.

It is supposed we all must have a personal data bank (PDB) [4], somewhere stored in our body and/or in our brain and/or in space. It will always be called upon if we see, hear, or sense something if an input reaches us. For example, if you see a paper wheel, your PDB will offer a lot of choices about what to do with this paper wheel: i, swallow it; ii, lacerate it; iii, ignore it; iv, rotate it with the finger; v, rotate it by thoughts. Your PDB contains the choices, and you can choose one. Our PDB can essentially have information from our personal experiences, memories, and our knowledge sources. This kind of information originates from us.

Some thoughts do not originate from us, and yet they can also be stored in our PDB. So, what is my first thought when I see the paper wheel? It is what I choose from the possibilities generated by the paper wheel as input. This data bank can be in our brain, and it can be stored partly in our body or in space.

A very small embryo has a body and causes changes in space waves, but it has neither brain nor head. But we already get thought forces. And because of the action-reaction, we also send thought force as an embryo. Some experiments show that an adult has something of the embryo time that is unconscious, and you can call it memories. Many experiments show that the 30-week-old embryo already has “measurable” memories [45]. It is possible to go further because we had thoughts earlier already. What was our first thought? It was the very first action-reaction we had. What was the only answer we could give back then? That was: “I am!” We were aware of that right away. “I am!”, this is our first thought, and we have to keep to this status. The first law of nature that comes with our first thought is: Stay alive!

Conclusion

Thought is force. This force is different from the four known fundamental interactions. It is an unknown fundamental interaction. Like all forces, thought force also creates its own counterforce. There is no way to understand how thought works without accepting the human experience on counterforce. If we accept the existence of thought force and its counterforce, we need a new physics theory. The space-Matter framework can describe this new fundamental interaction. Every particle is vibrating. The vibration reacts to space. Space waves connect objects existing in space. Note these waves are not the gravitational waves measured by LIGO [46]. Thought force and its counterforce are phenomena that are embedded in the modified wavelengths of space waves. Space wave makes possible two-way communication. We can create, send, and receive thoughts. Thought force and its counterforce have a given frequency spectrum within space waves. There are also other forces in this spectrum. Brain senses forces in this spectrum as thoughts regardless of the sources of forces. Saying this, there are thoughts that no brain created. Even more, there are ones that non-living things created. But they have been created somewhere, everywhere, and continuously. Thought force is a fundamental and universal way of communication in our Universe.

Core Messages

- The brain can create, receive, and send thoughts.
- Your thoughts change even when they do not change.
- If you are thinking today what you thought yesterday, you are already thinking something else.
- In order to remain in one place, you should run.
- The whole world is in your thoughts, and your thoughts are in the whole world.

Acknowledgements This submission is deposited as an e-Print copy at my website (lajtner.com) and at the viXra.org Archives (https://vixra.org/abs/2007.0047).

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A New Philosophical Paradigm of Thinking for Particular Sciences: Physics, Cognitive Neuroscience, and Biology

12

Gabriel Vacariu and Mihai Vacariu

> *"A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it".*
>
> Max Planck

Summary

We discuss a new philosophical paradigm of thinking, what we called "epistemologically different worlds" (EDWs) perspective (philosophy) in relation to sciences like physics, cognitive (neuro)science, and biology. We show that the oldest paradigm of thinking, the world or the "universe," in the broadest sense assumed by scientists and philosophers, has been a misleading paradigm and that overall has to be replaced with EDWs perspective. Within this new paradigm of thinking, we investigate some essential notions: "theory," which explains particular "entities" (which really exist within their EW or epistemological world) and their "laws." We emphasize that some EDWs really exist (have an ontological background, like the mind-EW), but there are certain

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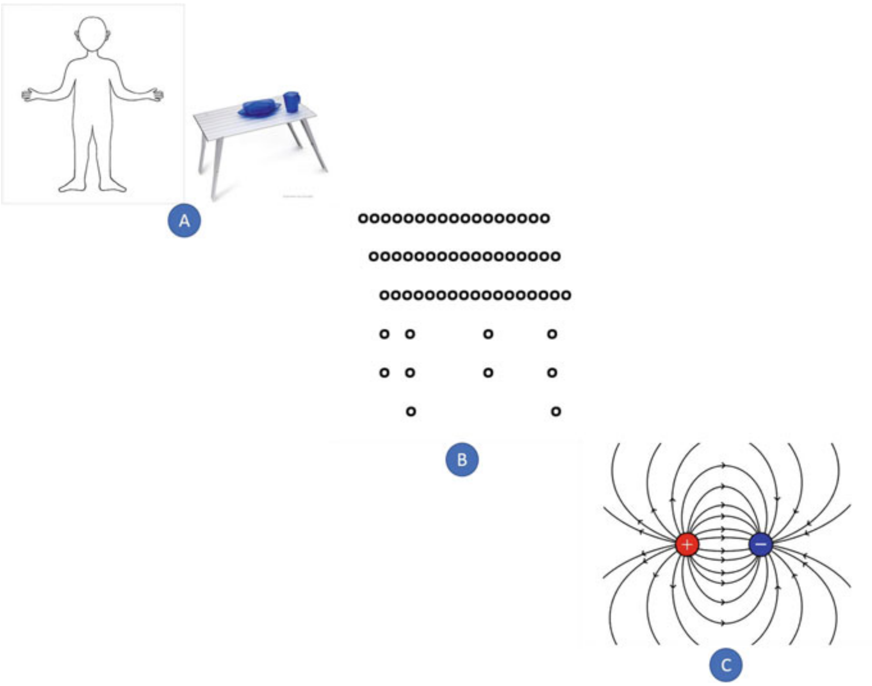
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_12

EDWs (for instance, the macro-EW or the micro-EW) that just denote real entities (microparticles or macro-particles) and their interactions (epistemologically different laws).



The epistemologically different worlds (EDWs): A, the Macro-EW: Brain/body is an entity which belongs to the macro-EW in which there are all the macro-entities like tables, chairs, and planets; B, the Micro-EW: an amalgam of microparticles which represent, for us, a “table” (at macroscopic “level,” i.e., the macro-EW); and C, the field-EW: mind-EW is an EW which cannot be represented. The mind is an epistemological world that does not exist for the brain/body. Also, the brain/body does not exist for the mind-EW. The common rule is that one epistemological world does not exist for any epistemologically different world.

Keywords

Causality · Correspondence · Epistemologically different worlds · Laws · Ontological entities · Paradigm of thinking · Sciences · Theories · Whole-part relationship

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

Based on our previous works, in this chapter, we will indicate that the notions of the "universe" or "world" are quite wrong concepts constructed by human beings during millenniums. We replace this notion of "universe" (with no ontology) with the "epistemologically different worlds" (EDWs, each EW having its own ontology). Some EDWs really have ontologies; some EDWs only denote epistemologically different (ED) entities (which really exist) and their ED interactions ("laws"). There are particular sciences (we investigate physics, cognitive (neuro)science, and biology) which deal with a set of epistemologically different entities and their ED laws. In this chapter, we try to understand the relationship between a general paradigm of thinking in the context of the aforementioned sciences and their theories (which refer to a particular set of entities and their "laws").

The New Paradigm, the "Epistemologically Different Worlds" or EDWs, Replaces the Old and Wrong Paradigm, the World or Universe

The starting point for a philosopher to create a new framework of thinking has to be the main results of the main sciences from her time. However, the philosopher has to go beyond these results to create a new paradigm of thinking, which is necessary given that certain scientific problems (belonging to those main sciences) have not been solved in the last decades. This new framework of thinking has to be available not only for actual philosophers but mainly for actual scientists working in the main sciences. Anyway, this new framework of thinking has to reject any new old philosophical and scientific (sub)framework to solve those unsolved scientific problems. In general, based on an erroneous framework, many scientific approaches and theories had been mistaken (or used mistaken notions). A science contains theories about a set of entities and their relationships (laws). There are different kinds of laws, but usually, we name "laws" the "causal laws" which hold on to the causal relationships between certain particular entities. In general, these scientific theories (which created these scientific problems) have been constructed within the wrong philosophical framework. The role of a philosopher is to identify this wrong philosophical framework and replace it with a new paradigm of thinking which has to explain the main problems of particular sciences and philosophy in a time.

Our previous works elaborated a new paradigm of thinking for different sciences like physics, cognitive science, biology, and philosophy: the "epistemologically different worlds" (EDWs) perspective [1–15]. EDWs are a new paradigm of thinking that replaces the oldest paradigm of thinking for all human beings: "the existence of the universe/world." More exactly, we have shown that the "universe/world" does not exist. There are these EDWs that really exist. We recall that this wrong paradigm of thinking referring to the "universe/world" has dominated the entire human knowledge from its beginning until now. The major error of this wrong paradigm has been that it incorporates all kinds of entities within the same spatio-temporal framework, called the "universe" or the "world." The great thinkers (philosophers, physicists, cognitive neuroscientists, biologists etc.) of all times have considered that macroparticles (chairs, cars, stones, and planets) and microparticles (electrons and protons), electromagnetic fields and waves, bodies (which include the brains) and minds, cells and molecules, etc. exist all within the same "world" or "universe" (or as we called them "unicorn world"). The problem is that the "world" or "universe" does not have any ontological status; therefore, the framework we have included all these entities does not exist. The question is: How has it been possible for all human beings to make such errors during such a long time? Each normal human being has one identity, and the re-projection of this single identity beyond its limits (external environment) created the illusion of a single world/universe. We have believed that all human bodies and other animals are placed within the same "world." During our evolution, we have perceived an external "world," and we have believed that there has been one world in which each individual has been developing. Our perceptual macro-mechanisms have evolved within the same macroscopic environment (the one which we have called the "world"). Because of these mechanics, we have perceived the "macroscopic world," and we have believed we exist in this macroscopic world. We mention that, in this context, for us, these two notions, "perception" and "interaction," have the same meaning. A long time ago, Leucippus and Democritus introduced the idea that the macroscopic entities are "composed" from the microparticles. In the nineteenth and twentieth centuries, physicists discovered that, indeed, the macro-entities are composed of microparticles. The main problem was that physicists placed the microparticles within the same "world" with the macro-entities. Most think that microparticles interact with macroparticles, but this is the main error:

"a microparticle does not interact with a macroparticle," while "a microparticle interacts with an amalgam of microparticles" that, only for us, represents a macroscopic entity. More exactly, macroparticles do not exist for microparticles. The reductionists believe that the macro-entities do not exist; only the microparticles really exist. If we accept this radical reductionism, we have to reject the existence of our brains. If we accept the identity theory (mind = brain), we have also to reject the existence of the mind. However, there are several arguments we cannot accept this reductionism:

- Physicists have not discovered the "graviton" yet, so we cannot accept the reduction of the planets (macro-entities) to a huge amalgam of microparticles;
- There are certain features of the cells/organisms (and minds) that cannot be reduced to microparticles (and brains/bodies);
- The mental image of a green table in front of "me" cannot be reduced to the activation of certain neurons; and
- "Life" cannot be reduced to the functions of certain mechanisms of the body or microparticles.

There are many other arguments against any kind of reductionism, but the topic of this article is not about (non)reductionism. Our question is: if a microparticle (an electron, for instance) sent toward that green table in front of us interacts with that table? We answer that the microparticle does not interact with a macroscopic object, that table, but with an amalgam of microparticles (which for us represents the table). Therefore, the table (and any planet) does not exist for the electron (any microparticle). Since we cannot reduce a planet to a huge amalgam of microparticles (the quantum gravity does not exist, the "graviton" have not been "discovered"), we must accept that both kinds of entities (the macroscopic objects and the microparticles) exist in the same place at the same time. To avoid a strong ontological contradiction, we have to reject the existence of the "world" or "universe" and to understand that the macro-objects and the microparticles are in EDWs. The most general and oldest framework of thinking, for us (the human beings as observers), the "universe" should be replaced with EDWs: the epistemologically different entities and their interactions really exist and "represent" EDWs. In a particular EW (epistemological world), the existence of an entity is given by its interactions with other entities within the same EW. Within the same place, at the same "time," there are ED entities within EDWs. Within EDWs perspective, the main rule is that one EW does not exist for any EDW. So, there are the macro-EW, the micro-EW, the field-EW, the mind-EW (or life-EW), etc. The main notion of our perspective is "correspondence:" an entity from one EW can correspond to an entity or an amalgam of entities from an EDW. We emphasize that the notion of correspondence does not have any ontological status, even if it establishes relations between ED entities which have their ED ontological status. Each mind is an EW; each brain/body is an entity that belongs to the macro-EW. In this chapter, we will shortly investigate several "empirical" sciences (physics, cognitive (neuro)science, and biology) within the framework of EDWs perspective.

Now, let us have a look at physics. A table exists for my body because my body is placed near that table, and both entities belong to the same EW, the macro-EW. The table and the Earth interact due to the force of "gravity." However, in the same place/time, two amalgams of microparticles correspond to that table and the Earth. An amalgam of microparticles is not identical with the table and, respectively, the Earth since there are entities that belong to EDWs, the micro-EW, and the macro-EW. If you consider that a table is identical with an amalgam of microparticles, then, automatically, your body/brain is identical with an amalgam of microparticles. Your body does not exist; therefore, you, who make the affirmation, do not exist! When you have a "pain" of your finger, that pain cannot exist since "your" mind (the self) and "your" body is just an amalgam of microparticles, and at this "level," the pain cannot even exist. We have to accept that a table/planet is not identical to an amalgam of microparticles. Still, the table and the microparticles are ED entities that belong to EDWs (therefore, we can call them "epistemologically different entities"). Within this new framework of thinking (our EDWs perspective), all scientists and philosophers need to reject the notion of the world/universe; moreover, the philosophers need to give up the classical distinction between epistemology and ontology. There is no "God's eye" or a "view from nowhere" [16] just because these notions would imply a kind of "empty world." Both notions are meaningless in our academic approach ("nothing can appear from nothing"!) within this new framework, the EDWs perspective.

How can we talk about the "differences" between these EDWs? Each EW is "epistemologically different" from all EDWs. It means that these EDWs are neither ontological "worlds" (Everett's "many worlds" and "multiverse") nor just "epistemological aspects" (Spinoza, Kant, Bohr or Putnam [17, 18]) of the same "world." These EDWs are represented by their epistemologically different entities and their ED interactions. We repeat that the main rule of this perspective is that "one EW does not exist for any EDW." We cannot claim that one EW is more "objectively" or "more realistic" than an EDW. All these ED entities and their interactions (all EDWs) have the same status of objective reality. For instance, there are "epistemologically different laws" for the microparticles and macro-particles. Also, there are epistemologically different laws for electromagnetic waves and microparticles. Therefore, there are different theories within the same science (physics, for instance), but, in general, there are these EDWs, and scientists working in this science have to deal with all these (external) entities which belong to EDWs. Our verdict is the following: physicists have to be aware that there are ED entities with ED "laws" representing EDWs (for instance, the field-EW, the micro-EW, and the macro-EW) all being placed in the same "place" at the same "time."

Let us have a look at cognitive neuroscience. Scientists working within this science often check for "correlations" between mental states and some neuronal activation patterns. The majority of scientists working in this particular science have accepted the identity theory in the last 50 years. From our viewpoint, the verdict we elaborated for the micro-macro relationship is available for the mind-brain/body problem: since the mind is an EW, while the brain/body is the brain/body is an entity that belongs to the macro-EW, the mind and the brain involve EDWs, therefore, the identity theory (mind = brain) is totally wrong. Again, since the mental states do not exist for the neuronal states, the neurons and their activities do not exist for the mental states, so it would be meaningless to check for the correlations between these two ED states. So, the mind-brain/body problem is a pseudo-problem since it introduces into discussion the direct relationships between two epistemologically different entities which belong to EDWs.

A long time ago, psychology dealt with issues regarding the mind, while neuroscience was scrutinizing our brain. Cognitive neuroscience came into the game as a unification of these two particular sciences: psychology and neuroscience. Scientists from all of these fields embraced the identity theory (mind = brain). However, in our view, cognitive neuroscience is a pseudoscience if we define "science" as a domain in which scientists investigate certain entities and their laws. Cognitive neuroscience is just a mixture of entities that belong to EDWs, and more than this, what can transform this science in "pseudoscience" is that some entities are external (parts of the brain/body), while the other entities are internal (that is, mental states that are the mind-EW) [9].

To proclaim cognitive neuroscience as science, we need to pay attention to the definition of "science" and "theory." From our viewpoint, cognitive neuroscience is a science that includes theories referring not only to the "causal laws" but also to "correlations" between the epistemologically different entities which belong to EDWs. According to EDWs perspective, we strongly emphasize that the main notion from cognitive neuroscience, "correlations," cannot have any ontological status! So, what kind of science could scientists of this domain construct? The EDWs perspective strongly indicates that cognitive neuroscience is a pseudoscience [9].[1] In the old framework, the unicorn world, even in physics, theories (like quantum mechanics) have mixed EDWs. In physics, if a theory refers to the entities from the same EW, that theory can refer to certain entities and their "causal" laws. Suppose the theory refers to the entities which belong to EDWs. In that case, that theory cannot refer either to the "causality" or the "identity" between epistemologically different entities (there are neither "causal laws" nor "identities"). In this case, that "scientific" theory is not scientific at all!

A particular case of the mind-brain problem (an important topic of cognitive neuroscience) is given by the "image representation." Where are these "mental" representations? Let us return to our example: a human being perceives a "green table" placed in front of her eyes. Does the "image" of that green table really exist or not? We cannot reject the existence, somewhere, of this "mental" image; otherwise, we would not be able to survive in our external environment. If we accept the identity theory (mind = brain), then these image representations are in our brains. However, if we look in our brains, we would not see/perceive an image of this green table; we will see only neurons and their activation. Working within the identity theory, scientists and philosophers have not given a clear answer to this

[1] With the same argument constructed within the EDWs perspective, in our previous works, we strongly indicated that all "interpretations" (being constructed within the unicorn world) of quantum mechanics are totally wrong.

problem. From our viewpoint, the "image" of that "green table" is not in the brain but the mind. But where is the mind in relationship with the brain? As we wrote above, the mind is an EW; the brain is an entity that belongs to the macro-EW. Since we talk about two EDWs, the mind does not exist for the brain; the brain does not exist for your mind. Inside the brain, using different "tools of observation," we can indirectly notice just neuronal patterns of activation or detect electromagnetic waves around the brain (two sets of entities which also belong to EDWs, but these sets of epistemologically different entities are not identical with the mind). Based on this simple example, we have to reject the identity theory (the "mind" is identical with the "brain"); these elements are not identical since the image is inside the mind, but clearly, it is not inside the brain. The "identity theory" (constructed within the unicorn world) has been wrongly assumed as a viable theory for decades by researchers working in cognitive neuroscience and "philosophy of mind." We need to change this old and wrong paradigm of thinking (the unicorn world) with EDWs' perspective accepting the existence of EDWs. The mind (an EW) corresponds to the brain/body, a macro-entity placed in a macro environment, i.e., the macro-EW.

Biology is in a similar situation to cognitive neuroscience. Working within the unicorn world, biologists have furnished different definitions of "life" (the main notion in this science), but nobody has thought that life is an EW that does not exist for the organism. Life and an organism mirrors the same pseudo-relationship between two sets of entities/processes that belong, in fact, to two EDW: life is an EW (for us, within the EDWs perspective, life = mind), while brain/body is an entity which belongs to the macro-EW. The relationship between these epistemologically different entities is the same as between mind and brain/body, just correspondence, no more or less, since they are or belong to EDWs. Biologists must be aware that it is impossible to elaborate laws that relate directly (causally) life to an organism. Life is not "produced" by an organism, it is not "identical with/inside" the organism, but it *corresponds* to the organism. Biologists have to elaborate a theory about this correspondence, but not a (biological or physical) law relating to entities that belong to EDWs. Biology is a science which deals with certain "causal laws," but also with "correlations" (like cognitive neuroscience), but not with "identities." Working within the wrong framework and elaborating statements within the wrong framework, biologists can produce strong epistemological-ontological contradictions or empty notions.

We have introduced ten principles of EDWs' perspective elsewhere [5–14]. Based on these principles (Table 12.1), we have constructed a new paradigm of thinking for philosophers (philosophy) and scientists (physics, cognitive neuroscience, and biology). Human beings can observe (indirectly, through correspondence) the ED entities of EDWs using certain "conditions of observation." In some cases, these conditions of observation involve certain measurement macro-apparatus. For instance, a physicist "observes," indirectly, an electron using an electronic microscope. Each entity interacts with the entities which belong to the same EW, no more. It has to be very clear that an entity from an EW does not exist for the ED entities which belong to EDWs. Therefore, both the notion of "causality" and "identity" referring to entities that belong to EDWs are wrong concepts

Table 12.1 Ten principles of EDWs' perspective

Principle ID	Description
1	"Epistemologically different interactions constitute epistemologically different objects, and epistemologically different objects determine epistemologically different interactions"
2	"Any object exists only at "the surface," due to the interactions that constitute it"
3	"Any object exists in a single EW and interacts only with the objects from the same EW"
4	"Any EW (a set of objects and their interactions) appears from and disappears into nothing"
5	"Any EW is, therefore all EDWs share the same objective reality, even if one EW does not exist for any other EDW"
6	"The I/self/mind (life) corresponds to a body (organism/cell). The self does not exist for the body, the body does not exist for the self"
7	"The I is an EW. Therefore, the I is in a temporal framework, while the body exists (in a spatio-temporal framework)"
8	"Having a certain set of components, from our point of view the body corresponds to (but it is not composed of) an amalgam of macro-objects (arms, legs etc.) (or cells) and their relationships. The body and its corresponding parts (or cells) belong to the same macro-EW. Also, a body corresponds to a certain set of microparticles belonging to the micro-EW"
9	"Certain mental states and processes form the knowledge that is the I"
10	"As an entity, the I has unity as an indeterminate individuality (it does not have spatial dimensions)"

("empty notions")! When we refer to the entities that belong to EDWs, we have to use "correlations" or "correspondences" not only for cognitive neuroscience but also for physics and biology.

Particular Sciences (Physics, Cognitive Neuro(science), Biology) and Their Theories (Which Refer to the Epistemologically Different Entities and Their Laws) within EDWs' Perspective

What does "science" mean? Typically, we consider science a domain that deals with certain "entities" and their "laws." Science can contain more theories and approaches referring to different entities which belong to different "levels" (about levels, see below). A scientist must elaborate a theory referring to particular entities and their relationships ("laws"). A particular science (for instance, physics) can deal with epistemologically different entities that belong to several EDWs. Physics deals with waves, microparticles, and macroparticles which belong to EDWs (for instance, the field/wave-EW, the micro-EW, and the macro-EW). Psychology deals with the mind, which is an EW. Neuroscience deals with the brain (part of the body, an entity that belongs to the macro-EW) and its parts. Biology deals with living beings/individuals that presuppose a link between life and organism, that is, a link between an EW (life) and biological elements (different "parts" of the body) that belong all to the macro-EW. Cognitive neuroscience deals with entities that belong to EDWs: the macro-EW (brain) and the mind-EW. Within EDWs perspective, the relationships between mental states and neuronal patterns of activation are the correspondence; we strongly emphasize there is no direct relationship, so any "causal laws" or "identities" between the mind (its mental states) and the brain ("its" neuronal patters of activation) cannot exist! Also, there are no laws between the organism and life: there are only certain correlations or correspondences, but no more. People working in cognitive neuroscience search for "correlations" between certain mental states and neuronal activation patterns, and the framework of thinking is the identity theory. As we emphasized above, from our viewpoint, the identity theory has been a wrong framework. From EDWs' perspective, scientists have to find the correspondences (no ontological status) between certain particular mental states (the mind-EW) and neuronal activation patterns of the brain (the macro-EW) since there are EDWs. We can elaborate new theories based on such correspondences, but we have to be aware the "correspondences" do not refer to "causalities" or "identities." The existences of EDWs reject many "causalities" (pseudo-causalities) and "identities" between certain ED entities just because these entities are neither the same nor placed within the same "world" but are placed in EDWs.

The parts-whole relationship appears in all these sciences. In fact, it appears everywhere! An entity can be composed of parts that belong to the same EW. For instance, a table comprises five parts (four legs and the top). The table and these five elements belong to the same EW, the macro-EW. We can talk about an "organizational threshold" between these five parts and the table as a whole (the philosophical "part-whole" relationship). However, the table is also composed of a huge amalgam of microparticles. The table and the microparticles belong to EDWs. We can talk about an "epistemological-ontological threshold" since the whole, and its parts belong to EDWs. The brain and its parts belong to the same EW, the macro-EW. Since the mind is an EW and the brain/body is an entity that belongs to an EDW (the macro-EW), then when we talk about mind and brain, we talk about the EDWs (and not about certain entities (mind and brain) placed within the same world, the unicorn world). Moreover, the mind cannot be decomposed. Being an EW, all thoughts are the mind-EW, but it is wrong to believe that the mind is the sum of all its mental states. The famous sentence "the whole is greater than the sum of its parts" (constructed within the unicorn world!) is translated, within EDWs perspective, in "the whole corresponds to "its" parts." Again, in science, it can be a "scientific" theory that refers to the epistemologically different entities which belong to EDWs. Still, we have to be aware that such theory can refer neither to the "causal laws" nor to the identity between certain entities.

Common for physics is that all the entities are outside the organism/self. We talk very shortly only about two theories of this science: quantum mechanics and Einstein's special and general relativity, the entities and EDWs involved in these theories. General relativity deals with the macro-particles which belong to the macro-EW. However, as we indicate in our work [13], Einstein's special relativity involves many macro-EDWs (the macro-entities are in "motion" with different speeds). Because of the mixture of EDWs and rejecting the ontology of space-time in our work, using only "motion," we re-wrote Einstein's special and general relativity without "space-time" in our work [13]. As a theory, quantum mechanics deals with microparticles and electromagnetic waves. The main problematic notions are "nonlocality" and "entanglement" constructed within the wrong framework, the unicorn world. In quantum mechanics, there are at least two EDWs: the field/wave-EW and the micro-EW. The physicists have to be aware that they cannot elaborate any scientific theory which includes "causal laws" between the microparticles and the electromagnetic waves since it would imply entities that belong to these two EDWs. With our EDWs perspective, we can talk about the "locality" between two microparticles. With EDWs perspective, we return to a kind of "Einstein's localism," but the "locality" between two microparticles and those two particles (the micro-EW) correspond to an indivisible electromagnetic wave (the field-EW). The "entanglement" of those two microparticles does not have any ontological status in the micro-EW. The entanglement is represented by the electromagnetic wave, which belongs to the field-EW.

In cognitive science, different approaches deal with the relationship between mental states and neuronal activation patterns [19]. The main approaches of cognitive science have been: computationalism, connectionism, and dynamical system theory. All these (and others) approaches have been constructed within the identity theory. Computationalism refers to the mind ("mental representations" and their "computations"); connectionism refers to the brain (distributed representations and their activation); the dynamical system theory refers to brain/mind, organism, and external environment. Working within the unicorn world, almost all scientists have elaborated theories and approaches within the "identity theory" (mind = brain). There are some exceptions; one, for instance, is John Searle, who believed that "the brain produces the mind." From our viewpoint, computationalism refers to the mind-EW, while connectionism and the dynamical system refer to the brain (and the external environment, the macro-EW).

In the philosophy of mind and cognitive neuroscience, there have been some key elements like "“primitives," "levels of analysis," and the "interaction between levels,"; "processes," "structures," "threshold," "self-organization,"; "emergence," "habituation," "tasks,"; etc. Many philosophers and researchers have considered that these notions or elements involve several distinctions like continuity-discontinuity, (state of) motion-(state of) rest, variability-stability, part-whole, and micro–macro" [2, 4, 5, 10]. In his works, Gabriel Vacariu indicated the construction of all these "elements" and "philosophical distinctions" within the unicorn world with various complicated Ptolemaic epicycles.

In cognitive neuroscience (a sub-domain of cognitive science), most researchers have worked under the "identity theory." The main topics of this "science" have been "localization" ("differentiation–integration" in the brain), "binding problem," and "multisensory integration." Our book [10] investigated the debate between "optimism vs. skepticism" in cognitive neuroscience. Our book concluded that cognitive neuroscience is a pseudoscience (if "science" means a domain in which the researchers search either for the "causal laws" or even "identities" between the certain entities). Why? Because cognitive neuroscientists search for "correlations" and not "causalities." Moreover, in our book, we indicated that even "correlations" is a very approximate notion since it refers to ED entities that belong to EDWs (the mind and the macro-EW where the brain is placed). Cognitive neuroscience is just a "science" with many theoretical and experimental data, but this "information" belongs to two particular sciences, neuroscience and psychology. And these particular sciences refer to ED entities that belong to two EDWs. From our point of view, solutions for the main problems in cognitive neuroscience are partially wrong since they are constructed within the identity theory. Within the unicorn world, we "believe that the status of cognitive neuroscience is that of a "no ontology landscape."".

We recall that working within the "unicorn world" ("world"/"universe"), scientists from various particular sciences (physics, cognitive neuroscience, biology) have worked with many wrong concepts and elaborated wrong theories. For instance, a very used concept in these sciences is "levels." From our viewpoint, neither "levels" nor the "ultimate/fundamental level" exist in the "world" because the "world"/"universe" itself does not exist. The "epistemological levels" are referred to as the identity theory (wrong "umbrella" since the ED entities belong to EDWs), while the "ontological levels" produce strong ontological contradictions within the unicorn world (the "universe"). Also, "complexity" or "emergence" are other "Ptolemaic epicycle" in these sciences created so as to reflect, in some cases, the pseudo-relationships between the ED entities which belong to EDWs. These "Ptolemaic epicycles" are heterogeneous models, mixing elements that belong to EDWs. EDWs perspective does not cope with such hybrid models.

For solving the greatest problems of a particular science, a philosopher has to investigate the framework in which

- one or more scientific theories has been constructed; or
- one or more particular sciences have been elaborated.

The old paradigm, the universe/world (the unicorn world, as we called it), has to be totally rejected: the "universe/world" has no ontology. The reader has to be aware that working within the old and wrong paradigm (accepting the existence only of the "fundamental level," for instance) means she rejects the existence of her own body and mind (which takes this decision)! We emphasize that everybody has been working within the "unicorn world" (= all entities are placed within the "world"/ "universe") until Gabriel Vacariu discovered the existence of EDWs!

Conclusion

Our attempt here was to indicate that scientists working within physics, cognitive (neuro)science, and biology (and also the philosophers) should replace the old and wrong paradigm of thinking, the unicorn world ("world"/"universe"), with the new paradigm, the EDWs perspective. Some EDWs have their ontologies (like the mind-EW), some EDWs do not have their ontologies, but their sets of ED entities and their ED interactions (described by the theories which belong to these particular sciences) really exist, i.e., these entities have an ontological background within a particular EW (which may exist or not). For instance, the macro-EW or the micro-EW, as a whole, do not have their ontologies, but these EDWs "denote" the micro-entities or the macro-entities which really exist. Again, to avoid any ontological contradiction, the main rule of EDWs is that "an EW does not exist for any EDW"! Furthermore, we strongly emphasize that each set of epistemologically different entities (and their interactions/laws) have the same objective reality. One main reason for this "objective reality" is that we cannot reduce the brain to an amalgam of microparticles, and the mind corresponds to the brain/body and its external environment; the mind also corresponds to an amalgam of microparticles or electromagnetic waves, but without its correspondence mainly to the brain, the mind would not have existed!

Core Messages

- We introduce a new paradigm of thinking for physics, cognitive neuroscience, biology, and philosophy.
- The "universe/world" is replaced by the "epistemologically different worlds" (EDWs).
- Each epistemological world contains its own entities and their interactions.
- There are only correspondences between the entities/phenomena which belong to these EDWs.

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Indicators of Variation in Thinking Actions and Reactions

13

Trevor J. Tebbs

"A mind is a terrible thing to waste; a mind is a terrible thing to erase".

Donna Ford *[1]*

Summary

This chapter focuses specifically on the global community, or population of children variously described as talented, advanced, exceptional learners, highly able, or profoundly gifted. While sensitivity to prevailing societal dynamics renders all school-aged children vulnerable, the idiosyncratic notions relating to gifted children's educational and psychological well-being are notably influential. Their distinctive traits and assets result in a significant divergence of thinking and actions, reactions and dimensions of thinking among those who touch the lives of these young people. Clearly, the extent to which any child flourishes or fades depends on the degree to which their value is acknowledged or rejected. However, gifted children are particularly susceptible to facing

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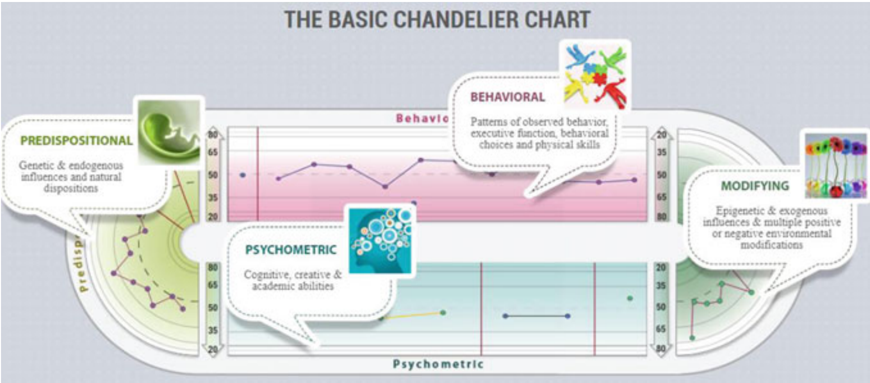
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_13

life-changing judgments, decisions, reactions, and attitudes. Just how academicians, scientists, researchers, politicians, pediatricians, psychologists, school administrators, family members, peers, teachers, other professionals, and, of course, the children themselves think and act is a matter of serious consequence. The narrative is founded on thirty years of personal experience, real-world cases, current literature, and insights gained from the implementation of the holistic 'Chandeleirian' approach to the assessment.



The basic Chandelier chart showing the four sections.
[Adapted with permission from author: Trevor J. Tebbs—The Chandelier© approach with all explanations and other matters pertaining are registered in accordance with Title 17, United States Cod The registration number is TXu 1–799 – 790, March 2012.]

Keywords

Dimensions of thinking · Giftedness · Talent development · Thinking actions and reactions

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

Sternberg [2] wrote: "We need gifted individuals." This 'need' is foundational to the purpose of the chapter. Admittedly, while it is written primarily with 'gifted individuals' in mind, it should not be read as an elitist document. The author understands thinking actions, reactions, and dimensions of thinking of all young people, if positive, acknowledged, and put to good use, benefit themselves, and are of immeasurable value to society. However, there are children whose 'gift,' talent, or potential for creative productivity is conspicuously high. Life for these young people and those who care for them may be challenging, especially when levels of knowledge and understanding vary between sparse at best and mythic at worse. A child's efforts to overcome such obstacles by their own agency, without parental and professional support, puts potential, in whatever way it is manifested, at risk.

The opportunity to draw attention to the contribution this population offers our world is both timely and a privilege. Hopefully, sharing insights gained from three decades of work with gifted young people will enhance understanding of the variance in thinking actions, reactions, and dimensions.

Acknowledgment and encouragement or disregard and discouragement from individuals with whom children interact day-by-day is pivotal. Thinking actions and reactions and dimensions of thinking are influenced either way. Whether we be parents, family members, mentors, psychologists, doctors, scientists, politicians, how we react to gifted children determines the degree to which potential is realized.

Understandings

The following 'understandings' offer a quick 'tutorial' with respect to the author's intentions in writing the chapter and the means whereby readers, perhaps unfamiliar with psychoeducational matters relating to giftedness and gifted children, develop a deeper understanding of the community. Persson [3], citing Wilms [4], wrote: "In an international perspective, intellectually gifted individuals are often seen as the hope of the future." Almost forty years further on, the world is no less in need of enlightened individuals blessed with the ability to think creatively and critically.

For those especially interested in this community, according to Persson [3], in 2008, there were more than 79,000 research papers, dissertations, and books available for personal erudition.

Giftedness

"Perhaps one of the most challenging and debated topics in gifted education is whether a unified definition of giftedness can or should be a goal for the field, or whether a unified definition of giftedness is possible" [5]. True or not, our focus is not to define or argue the case for giftedness; rather, it is to present the most frequent intrinsic and extrinsic, positive or negative indicators of influence on thinking actions and reactions and dimensions of thinking related to giftedness and gifted children.

The Newfoundland & Labrador Education Department reproduced a document [6] designed to provide teachers with a deeper understanding of children considered gifted to the extent they may be challenged in appropriate ways (S.W., Personal communication, August 2020). It remains very useful to the degree it provides insights into the different strengths and proclivities typically associated with students considered gifted and talented.

Explanation of Indicators of Variation and Thinking Actions and Reactions

The chapter is based on understanding the phrase indicators of variation related to personal views that, when expressed, or operated upon, in various ways, e.g., cognitively, verbally, body language, facial expressions, result from some quality of thought. They influence or modify a person's *own* thinking actions and reactions or those of others.

Indicators of Variation in Thinking Actions and Reactions in the Context of Giftedness

Typically, gifted children are distinguished in a learning environment by reason of high but naturally occurring levels of intensity towards various aspects of life and learning. One notable complaint heard from teachers about intensity is focused on a child's strong desire to show or share knowledge by blurting out answers or some fact of special interest. Teachers become quickly aware of how levels of dislike escalate among the child's peers. In turn, this often creates a complex set of variations in thinking actions and reactions involving everyone, including school psychologists and pediatricians [7, 8]. Levels of maturity might determine how conscious young people are of this behavior but depending on whether the perceptions of others are affirming or antipathetic, they may either benefit or suffer in various ways. Input from colleagues, clients, parents, teachers and fellow professionals worldwide, research, and thirty years of personal experience in the field provides abundant empirical and other evidence to support this phenomenon.

Antipathetic Perspective

Negative attitudes, judgments, decisions, application of thinking based on unfounded notions, ignorance of true facts, paucity of professional training, and a bias towards a deficit view of behavior—all are potent enough to influence how a child thinks and acts in ways potentially unproductive, hazardous, even to the point of suicidal ideation and completion [9, 10].

Affirmation

It is also potent in that it may be realized, for example, by invitation to share time and ideas with those who think and act in similarly critical and creative ways or being a recipient of wise judgments based on sound knowledge and understanding, Baring some unanticipated problem, children are likely to think and act more wisely in these situations and on into the future.

Back Story

Traditional and non-traditional conceptualizations of high or extraordinary ability have been responsible for identifying and developing individuals, not only considered capable of extraordinary accomplishment in multiple avenues of human activity but also performing according to expectations. These conceptualizations have also been responsible for the *neglect* of individuals *perhaps capable* of extraordinary accomplishment but, for whatever reason, have remained unidentified and unsupported and therefore denied self-fulfilling opportunities enjoyed by others. This anomaly not only continues to influence the futures of young people whose potential remains unacknowledged but also deprives society of ‘wealth’ however defined.

The situation is exacerbated by a plethora of long-established perceptions *of*, and attitudes *towards,* notions of giftedness. Some are positive; others are not. Whatever the case, significant modifications take place in self-concept, self-efficacy, and self-esteem, even to the degree gifted and, or talented individuals are either motivated to realize their potential or become apathetically indifferent and ‘wither on the vine.’ This is critically important on an individual level through to matters of global significance.

Sternberg [2], recognizing the pressing need for a new generation of young people intellectually and creatively adept at solving problems worldwide, writes, “We need gifted individuals to address … problems of global warming, interminable wars, staggering levels of air pollution … gifted people passionate about solving problems rather than enhancing their own prestige.” His justification prompts the question: "How may people's thinking actions and reactions be directed towards motivation as opposed to witting or unwitting disparagement?"

There follow matters basic to our knowledge and understanding of young people whose potential, if realized, could make a positive difference in our world. Einstein is reputed to have said: "It is the supreme art of the teacher to awaken joy in creative expression and knowledge" [11].

How and What Gifted Children Learn from an Early Age

A correlation between visual attention and gathering information indicates learning begins at a very early age [12]. Smutny et al. [13], referencing work done by Kolata [14], report the "strong correlation between visual attention in the first six months of life and high IQ scores at 4–6 years." Silverman [15, 16] writes: "Children who score in the gifted range on IQ tests in early childhood - as early as 18 months – demonstrate advanced achievement and mastery of skills in later years." Also, Harter [17, 18] notes, "Beginning in early childhood, children start the lifelong process of self-discovery. The emergence of a coherent and positive self-concept is undeniably a critical aspect of social and emotional development … children who come to know and understand themselves acquire an important guide for their behavior and social relationships. As such, they steadily begin to develop a sense of self."

During these early years, the consequences of all formative learning experiences, including exposure to the thinking actions and reactions of others, are lifelong and life-changing. A natural sensitivity to influences, such as neglect or abuse, social acceptance or rejection, success or failure, will impact any child's range of thinking, actions, and reactions. As they mature, dynamic events in the family through to major world events shape their thinking actions and reactions extrinsically and intrinsically. How they think and act will reflect the form and substance of lessons learned. *And* importantly, with respect to gifted children, McCluskey [19] notes wisely: "Learning may well come easier later in life if a solid foundation has been laid through environmental enrichment in the beginning."

Learning and Neuroplasticity

While some say we learn as we sleep [20], 'learning,' in its broadest sense, takes place every moment of our day. Neuroplasticity, from a neurological perspective, is as critical to the development of an early learner's intact brain as it is to the reclamation of a damaged brain [21]. McGarvey [22] writes: "Our brains can change, physically, because of learning …. In a process called "experience dependent neuroplasticity," neural connections grow based on what we are learning. Repeating the same thoughts, feelings, and behaviors increases synaptic connectivity, strengthens neural networks, and creates new neurons through learning."

A gifted child tends to gather more connections in a shorter time. The neurological perspective of learning is especially fascinating when considered in the context of child development, e.g., how social interaction impacts cognitive development, how they think and act, and how others think and act around them [23–26].

How a Gifted Child Might Be Perceived in a Regular Classroom

Returning to the Canadian document [6], consider, for example, how even the first three characteristics might impact a teacher's thinking actions, reactions, and dimensions of thinking day-by-day. She/he is responsible for delivering a meticulously planned lesson to a mixed-ability class of children. Most of them find it hard to *remember* answers or *pose* unforeseen and ask irritating questions. Some teachers are genuinely excited by a child learning more at a quicker pace. Others are so irritated by constant energetic blurting out of answers; they share concerns about attention deficit hyperactivity disorder (ADHD) with the parents, advise a doctor's visit, or some level of behavior modification. Upon hearing such concerns, as Mahoney offers, "Some parents want to let go and hope for the best, while others may cling to their fears and overmanage their child's life. Reaching a balance is complex" [27].

Knowing how quickly their child learns may be disconcerting to parents and others. It is indeed complex yet fundamentally important to a young child beginning to understand the weft and warp constituent to the fabric of life. When various academic, behavioral, or psychological problems become sufficiently apparent to demand careful attention, the necessity of achieving a balance during childhood becomes crystal clear.

Clarity is especially necessary when working with children and their parents in a clinical environment. Years of pedagogical and clinical experience along with academic research associated with parenting in different sectors of society and, or attitudes towards different patterns of behavior [28] confirm how thinking actions and reactions in children are mediated by the dynamics experienced in the home environment. Studies indicate how experiences especially associated with parenting styles, influence the formulation of self-concept and related aspects salient to a child's academic, creative, and social-emotional well-being [29, 30].

Learning and Indications Associated with Parenting Styles

Parenting styles play a determinative role in the early period of development – *and* speaking as a grandparent, they remain powerfully influential over a lifetime [31, 32]: Maccoby and Martin [33] highlight four styles: neglectful, authoritarian, permissive, and authoritative.

While *all* parenting styles make a difference to *all* children, our focus will be on authoritarian and authoritative styles. Each 'style' frames the experience of atypical children in different ways at home, in school, and in other community settings [34–38].

Chaoyi He [39], a student whose childhood experience reflects traditional Chinese authoritarian parenting styles, studied how they might impact a child's development. Her research encapsulates effects indicative of both healthy or harmful thinking actions and reactions associated with each style. Citing many supporting authorities on the subject [39, 40], Chaoyi He concludes: "Authoritarian parents are characterized as being extremely strict … lacking warmth and responsiveness … methods of control … not limited to threats, coercion, guilt induction, love withdrawal, and punishment … authoritarian parenting is associated with many externalizing and internalizing problems in both girls and boys. For example: children who experience perfectionistic pressures from parents are more prone to high levels of perfectionism, rigidity, critical attitudes, and anxiety … internalizing problems … lower levels of life satisfaction … and less engagement in classroom activities."

With respect to authoritative parenting, again citing many scholars [39, 41], Chaoyi found: "Authoritative parents are characterized as making reasonable demands and being highly responsive … ensuring the youngster has appropriate support and guidance to succeed and be independent. They recognize children's rights and individual differences … continually convey caring, love, and warmth … children raised by authoritative parents are more likely to become independent, self-reliant, socially accepted, academically successful, be well-behaved with good emotional control and regulation, and have happier dispositions."

Our own observations or experiences probably confirm how a child's general demeanor and well-being depend on parenting [42]. Ross [43] describes how discrepancies "between the intellectual and social-emotional development of the gifted child often creates stress for the child and parents alike." A recent study was conducted to determine if achievement-related feedback from family *and* school "predicts early adolescents' academic self-concept and intrinsic task values." Feedback from *competent* parents was shown to make a difference in a positive direction [44].

Indications Associated with Perceptions of Giftedness

Giftedness is not a new concept. One may surmise it is a condition celebrated as a naturally occurring element of the human experience for untold millennia. For the most part, we can only speculate on what constituted giftedness in the minds of human beings through the ages. Despite the debate about giftedness, we each might intuit, sense, or react in some way to its presence. Daglioglu [45] writes: "Throughout the history of civilizations, gifted people have been pioneering various developments and changes in the fields of technology, science, knowledge and social and educational fields that changes the human life and that people follow with amazement and surprise."

Way back in time, giftedness was evident in the stunning creativity and ingenuity of human beings as observed in 2000-year-old stone temples in Petra or 4000-year-old structures such as Stonehenge or the 17,000-year-old paintings on the cave walls of Lascaux. A recent visit to the Albertini Museum in Vienna provided a once-in-ten-years' opportunity to stand millimeters away from Durer's exquisite rendering of a hare completed in 1502. How he managed to produce the portrait with accuracy equal to that of a twenty-first century camera is awe-inspiring. *That* was a measure of giftedness hard to mistake! Judging by the crowds moving slowly through the exhibition, Durer's giftedness was appreciated by people from many parts of the world.

With respect to giftedness in twenty-first century children, intuition alone has become increasingly meaningless to officials burdened with the responsibility for making major decisions. In the USA, there are serious discrepancies. The realities of public education mean something far less esoteric is considered essential. Much depends on how giftedness is perceived state to state, even among school districts [46]. In some localities, parental input may be acceptable, but as regards accommodating or encouraging expressions of giftedness, there are no guarantees. Typically, parents face only frustration if they arrive at school demanding special accommodations for their child based only on intuition. All too often, a parent is regarded as 'fussy,' convinced *their* child 'deserves' more attention because he or she is 'gifted.' A principal was heard to say, "Every child is gifted in my school! I treat them all the same!" Sadly, equal treatment is not always equitable. Many factors already complicate the lives of gifted individuals. The way people cling to different perceptions of giftedness adds further complications.

Eagleman [47] regarded perception: "As a construction that does not accurately represent the outside … when we see only what we need to know." As cited in Zigman [48], Metzinger [49] regards perception, as demonstrated by neuroscience, not only the content of our conscious experience "but also an extremely selective way of representing information."

Prejudicial perceptions may be rooted in a lack of knowledge and training, ignorance, disbelief, disdain, unquestioned myth, social class, racial inequality, culture, and bias. They are known to influence not only the thinking actions and reactions of those operating on such perceptions but also those impacted by them

[50]. There are those who, when first encountering individuals who, although being reported as gifted, may not look or act 'the part,' are apt to misjudge them and respond inappropriately to their needs. Such elitist perceptions may easily lead to the preclusion of indigenous, non-white individuals of non-traditional gender and those who speak in languages or accents with which they are unfamiliar.

As an example, while *knowing nothing* about Stephen Hawking, how might we think and act when first introduced to him? How willingly would we be to spend time with one of the world's greatest scientists as he struggled to communicate with us? It may take the *will,* patience, empathy, and emotional stamina to adjust one's thinking and immediate reaction in a positive direction. A former student, theoretical physicist Raphael Bousso, had "to learn to shake off his awe and relax" and understand him as "a joyful and lighthearted person, not to be burdened by excessively respectful and convoluted interactions" [51].

Twice Exceptionality (2e): The Deficit Perspective and Disadvantaged Children

Children considered *twice-exceptional,* or 2e, are described as showing "a pattern of extreme strengths combined with areas of significant difficulty" [52], a perfect description of Steven Hawking.

Bousso's account underlines this fact: young people considered 2e are particularly susceptible to negative perceptions. Reliable estimates of the community of 2e children worldwide are difficult to obtain. As Heuser et al. [53] point out, "Perceptions of giftedness are largely culturally determined, inseparable from the norms, values, beliefs, and priorities of a people, as well as from the socio-historical and socio-political realities of a country or region."

However, for the statistical-minded, it is thought between 2 and 4% of children in the USA are twice-exceptional. The World Disability Report [54] provided an idea of the global 2e community ten years ago. Approximately 120 million children under 14 years of age were considered disabled. Further research is required; however, assuming perhaps 2.5% of that community were 2–3 standard deviations above average in terms of cognitive ability, one might surmise as many as 3–4 million children were treated with a bias towards disability as opposed to their strengths. One might wonder how those children think and act and what difference it would make if their potential were acknowledged and accommodated appropriately?

Regardless of the statistics, as a respected colleague noted, "There are so many precious children, youth, and adult learners who have talents but they are discriminated against and excluded from valuable opportunities in education, the workforce, and life in general" (K.M. Personal communication, August 2020). Dinishak [55] wrote: "Deficit approaches are critiqued for conceptualizing the target individual or group primarily (or even solely) in terms of their perceived deficiencies, dysfunctions, problems, needs, and limitations. In the past few decades, across many fields of inquiry (e.g., psychiatry, psychology, linguistics, sociology, education, disability studies, and anthropology) and outside the academy (e.g., by advocacy groups and practitioners in the helping professions), including autism and other psychiatric conditions … some critics go so far as to argue that a deficit approach to understanding human differences diminishes people's life chances and even their humanity."

To counter the rather dystopian view of 2e young people and their future, a study conducted by Akar and Akar [56] is inspiring. As a truly 2e individual, born with albinism and a 90% loss of vision, Amit (pseudonym) benefited by encountering individuals who, despite his condition, recognized the indications of his potential for giftedness. They focused on his strengths. Amit's mother described him as "sensitive, intelligent, successful, self-confident, hardworking, respectful." Others presented him as precocious, very intelligent, and among the top 1% of the student population in Turkey. Amit succeeded in all his studies without any special support or extra time despite his visual impairment. As a Ph.D., he is working as a senior executive in an international company in Turkey. In a recent e-mail, he wrote: "Rather than giving up, I searched for alternative techniques to speed up my test solving. Used magnifier in one hand and pencil in the other, so that simultaneously I can read and write, luckily found telescopic glass to free my hand holding magnifier, I started to do calculations in my mind instead of by writing" (I.S. Personal communication, August 27, 2020).

The following real-world case is more illustrative of the degree to which gifted teenagers suffer from a *disability bias,* especially at a time when they, as Ragelienė [26, 57, 58] notes: "construct their own unique sense of identity and find the social environment where they can belong to and create meaningful relationships with other people." Nigel (pseudonym) complained of anxiety and depression. His parents had desperately sought help and guidance for him because he had, on numerous occasions, intimated a desire to commit suicide. He explained he was perplexed. He questioned whether or not he was gifted. Even though he recognized his leadership skills, he considered himself 'damaged goods.' This sense of worthlessness pervaded his whole sense of self. His teachers were fully persuaded he was not 'gifted' but quite unintelligent, behaviorally disordered, a candidate for special education services, and at risk, not only of failing to graduate but, more troubling, doing himself harm.

Despite evidence of his giftedness, the reaction of his teachers, their judgments, and subsequent decisions based on mythical perceptions and a strict, reinforced authoritarian view served only to exacerbate the situation. It was not until he left school and was supported by a caring, more authoritative mother did he begin to explore his strengths, grow in confidence, and move forward. In a recent conversation, Nigel's mother (P. O. Personal communication July 2020) expressed great pride in her son. She spoke of her relief as he slowly but successfully took charge of his own destiny.

Misdiagnosis

It is important to realize young people, despite conspicuous levels of ability or talent, are human and thus subject to all the usual conditions experienced by human beings. Kaufmann, Kalbfleisch, and Castellanos [59] issue a caution: "A child whose behavior causes him/her to be impaired academically, socially, or in the development of a sense of self, should be examined from a clinical/medical perspective to exclude potentially treatable conditions, even if the behavior may be similar to the traits typically ascribed to creativity or giftedness."

However, misdiagnosis is a major concern. Webb and his colleagues [60], all experienced professionals in psychology, psychiatry, and pediatrics, make it abundantly clear, classifying behaviors otherwise deemed normal in gifted and talented people is known to be "significant and widespread problem." They tell how clients with such diagnoses as attention deficit disorder (ADD)/ADHD, obsessive-compulsive disorder (OCD), autism spectrum disorder (ASD), oppositional defiant disorder (ODD), and bipolar disorder (BD) were often brought to their offices for second opinions. Many were not only found to be wrongly diagnosed but also healthy, gifted individuals "who were in situations in which the people around them did not sufficiently understand or accept behaviors … inherent in people who are intellectually or creatively gifted" [60].

Susie provides a perfect example, not only of misdiagnosis but also how a paucity of knowledge among professionals leads to poor judgment and decisions despite clear indications of giftedness. The case illustrates the potential disruption of an otherwise healthy journey from school to university. Susie's story is no less significant than discontinuing an unnecessary and potentially harmful medicine or terminating an unwarranted surgery.

When in 5th grade, Susie presented poor behavior at home and school. Her parents were puzzled by an unusual decline in academic achievement and motivation, difficulties controlling her emotions, sensitivity to criticism, anxiety, uncharacteristic tantrums and outbursts, poor self-esteem, and a willingness to *discourage* friendships. Susie's teachers added complexity by reporting how other children considered her 'weird,' how she discussed feeling 'burnt out' and her sense of not being 'liked' by her teachers. In the school psychologist's professional opinion, Susie struggled with a disability, i.e., non-verbal learning disorder (NVLD) [61]. She advised Susie to be retained for a further year in 5th grade. She recommended an Educational Support Team (EST) be assembled to focus primarily on troubling behaviors such as missing facial cues and body language, a lack of awareness, and behaving inappropriately in social situations. The EST was asked to develop a plan to deal with problems and oversee weekly visits to a counselor to help Susie learn pragmatics. Susie's parents sought a second opinion.

Few of the reported concerns were apparent in the clinical setting. Observations and other data provided zero support for the diagnosis of NVLD. Susie's behaviors appeared rooted in something other than disability. She was well-mannered, courteous, mature, and respectful of others. She was fully able to hold a sensible conversation and articulate the nature and seriousness of her own problems, identify and analyze her own emotions and monitor the reactions of others. She was also able to joke and understand *even* the subtle humor of others.

Other information indicated Susie was a very ‘intense’ individual. Observing her behavior through the lens of Dabrowskian *Theory of Excitability* (OE) [62–64], her intensity was evident in all five psychic abilities Dabrowski considered typical in gifted children, i.e., intellectual, imaginational, emotional, psychomotor, and sensuality. Reports from those who knew her confirmed her enthusiasm, empathy towards others and an unusual capacity to care, “endless” emotional and intellectual energy, intense periods of concentration, intense curiosity and an insatiable love of learning, a vivid imagination, and a passion for fantasy.

A cognitive ability test revealed an intelligence quotient (IQ) level three standard deviations above average. In conjunction with her intensity and other behavioral factors, it was clear Susie had the extraordinary potential for gifted behavior or high performance. Ultimately it was agreed that whatever was troubling Susie was ‘environmental,’ most probably caused by conditions and stress experienced in the school setting. It was also decided that she should be accelerated [65] rather than be retained [66, 67]—a very significant and important life-changing decision!

A few years later, Susie graduated from college and went on to study at a highly regarded university. Once she graduated, she was offered the opportunity to travel and live in Jordan for two years. What would her future have been if the thinking actions, reactions, and dimensions of thinking, had resulted in special education services and a second humiliating year as a 5th grader? Thankfully, at that time, the attitude and critical thinking of her teachers and other professionals changed dramatically, underlining the imperative to become familiar with indications of giftedness. Her mother expressed her appreciation this way: “We’ll be forever grateful that we connected with you and had your assistance” (T.B., Personal communication; June 2020).

Myths and ‘Put Downs’

A widely respected proponent of gifted education worldwide, Donald Treffinger [68] commented on the stereotypical fiction associated with giftedness obstinately remaining in circulation over the years. After studying the issue, he wrote: “We learned all fifteen of the 1982 myths remain with us today… In addition, several new myths emerged, resulting in a total of nineteen myths.” The myths noted at that time by the National Association of Gifted Children [69] included:

- *gifted students will do fine on their own*;
- *gifted programs are elitist*;
- *teachers challenge all the students, so gifted kids will be fine in the regular classroom; and*
- *that student can’t be gifted; he is receiving poor grades.*

Once becoming familiar with the propensities of these children, meeting professionals who adhere tenaciously to such harmful misconceptions is mystifying. Imagine a parent acutely aware of her child's level of giftedness. She searches desperately for suitable resources to help her offspring succeed. She encounters only those who lack empathy, think and act according to a belief system contrary to her own, lack knowledge, understanding, and adequate professional training. In the USA, it is not uncommon. It takes very little imagination to grasp how the situation might be for children in countries with little or no provision for their needs, academic or social-emotional.

A recent study conducted in Kazakhstan [70] provides insight into the confusion among educators who are expected to provide for their academic needs, although receiving no preparation to teach gifted children. Perceptions established during the Soviet era-initiated thinking actions and reactions based on a rigid "criterion-referenced, performance-based assessment" [71]. Sergaliyeva [70] notes, "Olympiad ratings are strongly seen as the main feature for giftedness identification."

Personal experience of opinions widely held by fellow educators and administrators comes to mind. For example, an experienced colleague asserted, "*Real* gifted kids are gifted in everything *and* they are all tall!" Recently, a colleague responsible for designing a course focused on preschool education was asked how giftedness and the needs of gifted children would be handled. He retorted, "They will learn about gifted children if I do my job teaching a Special Education course!" Sadly, where there is no mandate to prepare teachers to address the needs of atypical, highly able individuals, the emphasis is on deficits and how to identify, modify and accommodate them. Where this is the case, there is little to negate thinking and actions based on myth, resulting in disturbing levels of witting or unwitting ignorance. After thirty years of experience in the field, it is clear mythological thinking exists, and it is *truly* mythological [72].

Genius, Sense of Belonging, and Attitude

Thinking and acting based on such myths can result in an enormous waste of human capital. Heller [73] warns: "The following dangers are usually associated with labeling problems, social isolation, development of egocentric attitudes and behaviors, endangering or disturbing the personality development and self-concept through extreme achievement pressures or too much responsibility."

Following Heller's comments with respect to "egocentric attitudes," if a child appears atypical compared with those of the same chronological age, the term 'genius' may become an issue. It is a word that may reveal genuine respect or a derisory attitude. It is important to differentiate between the two because, as noted, either way, it can affect change in significant ways.

Whether it is a parent, a teacher, or even children themselves referencing genius, e.g., "She is a genius!" or "I *am* a genius!" the authentic sense of self may be at risk. According to Kerr [74], a genius is someone possessed of "great intellectual ability" recognized for their "*potential.*" In other words, the *realization* of potential is not guaranteed. It is something which, given the right circumstances, *may be accomplished*. The second meaning is associated with someone acknowledged for some extraordinarily valuable contribution in a field of human endeavor. When associated with a child yet to realize his or her 'genius,' it is likely to influence the listener's attitude immediately and thus also behavior [75, 76].

Attitude is something we are able to sense in a number of ways making it exceptionally relevant in the context of thinking action and reaction in parents, teachers, other professionals, and not least, in terms of a young person's own reactions and perceptions of self. To consider oneself a genius, or be promoted as a genius, has an unmeasurable impact on personal reactions to perfectionism, fear of failure, being found out as an imposter, procrastination, anxiety, and depression. A negative attitude serves to separate rather than nurture a *sense of belonging. Belonging* is an essential relationship formed by "complex conscious or unconscious feelings, beliefs, ideas, interests, goals, values, and skills relevant to the environment." To *belong* is contributory to one's self-identity as a productive and healthy, highly skilled individual [77].

Indications Associated with the Process of Identification

When Kaufman [78] tried to share the results of a cognitive test, the child's parents greeted him anxiously: "We can't take the suspense any longer! Will he get into Harvard or not?" Kaufman believed human beings are neither defined by a number nor a test powerful enough to guarantee entrance into Harvard! He writes: "The magical IQ … that sums up a person's mental ability … immutable and eternal … well it's a crock" [78]. Sternberg [2] agrees. He writes: "There are several reasons why intelligence tests no longer should be used as … even as the primary means of assessing giftedness." He continues: "Conventional intelligence tests are not going to predict people's ability to solve complex problems such as these" [2].

Even so, an IQ is relied upon wholly or partially as an identifier of giftedness in many countries worldwide [79, 80]. Bergold, Wirthwein, Rost, and Steinmayr [81] lament the fact gifted individuals are infrequently identified via "reliable and valid intelligence tests but instead via teacher, peer, or parent nominations." Amplifying this view, they write: "Intelligence can be reliably assessed … many sound intelligence tests are available, whereas measures of … creativity and motivation often suffer from lower psychometric properties and poor validity … Thus, the use of intelligence test scores (IQ > 2 SD above the mean, i.e., 130) to define giftedness has prevailed in the empirical literature."

A colleague working in a Swiss school with a seven-year-old first grader (M.R. Personal communication, June 2020) provides an example of a linear approach to teaching a gifted child. Sympathetic teachers have provided the temporary provision of accelerated learning with 4th graders. The boy is anxious to move forward. However, despite high mathematical and verbal comprehension skills, this can not happen unless he is officially tested by a state-licensed psychologist and achieves a full scale intelligence quotient (FSIQ) score of 130 and above. No funds are available if a child is not determined to be 'gifted.'

Official acknowledgment of 'giftedness' is inconsistent. Some locations demand an FSIQ of 130; others do not. This case draws attention to how such a stressful dilemma impacts decision-making. It may not only alter the thinking actions required of his parents but influence the boy's future. All parties involved in the matter will remain stressed as he matures and begins to take his productive place in society.

This case also illustrates how highly able children are susceptible to potentially harmful perfectionistic thinking. He has already shown a distinct desire *not to be wrong* nor, therefore, *a failure.* Fear of failure causes him to take the 'easy' way through a test designed to estimate his IQ. This thinking pattern is potentially harmful in so many ways particularly if 'failure' is misconstrued as 'inability' or 'disability' by unprepared professionals. Referring to the past work of experts in the field [82–84], Manning [85] writes: "sensitivity to the attitudes and perceptions of others may cause gifted students to fall into the perfectionism trap or to fear failure. These feelings can lead to unfinished work, procrastination, or underachievement." The thinking actions and reactions observed during interviews with gifted young people in a clinical environment underline the fear of making mistakes and the potential for self-harm [86, 87]. Risky behavior and self-harm are not out of the question. Apistola [88] notes: "research does indicate that suicide occurs among the gifted population. It is also apparent that suicide is occurring among the gifted at a rate, which necessitates future research to have (a) the ability to recognize risks and (b) to deploy the most efficient and effective suicide prevention methods."

Pause for Thought

Although they are not 'measures' in a sense used in other sciences, indicators discussed in this chapter are equally important. A child's social, emotional, and academic well-being is at risk if those with whom he or she interacts day-by-day react in disingenuous oppositional ways. Conversely, if the potential of a gifted child is acknowledged in genuinely helpful ways, the prospects of thousands, even millions of highly able, potentially creative individuals will be greatly improved both personally and as providers of "exceptional scientific and technical human capital" [89].

Holistic Assessments, Chandelier, and Dimensions of Thinking

Acknowledging and valuing [90] the potential of gifted children implies gaining knowledge and understanding of their strengths, values, and other aspects important to them as productive human beings. In this context, a holistic approach to the identification of their resident strengths in order to develop the whole child is critically important. Tirri [91] wrote: “in education, spirituality means education for the whole person by acknowledging the importance of social and affective domains in addition to cognitive development.” In the same vein, Jane Goodall, in an interview with Krista Tippet [92], added a beautiful dimension to the notion of appreciation of the whole self, regardless of high ability. It is especially appropriate when considering the holistic identification of giftedness and the needs of gifted children. She noted: “I truly believe, only when head and heart work in harmony can we attain our true human potential” [92]. Webb [93] wrote: “historically, research on gifted individuals focused on the intellectual and academic aspects. Only recently is there focus on personality factors that accompany high intellect and creativity, with even less attention given to the observation that these personality factors intensify and have greater life effects when intelligence level increases beyond IQ 130.” Sternberg [2] asks, “If what we need is “gifted” people who can cut through the failure to solve the serious problems of the world today, how would we identify and then nurture the talents of those gifted people?” Later he wrote: “We need to be more holistic, especially in recognizing that there is no easy formula for predicting who will produce gifted performances.” In this context, he also notes: “I think the Chandelier model of the author is a good step forward” [2].

The Chandelier model noted by Sternberg [2, 94, 95] is a system combining methodology and technology. The methodology relies on assembling a rich array of data from four major areas pertinent to human development, i.e., behavior, emergenics [96], epigenetics, cognitive, and academic ability (Graphical Abstract.) Ambrose called the Chandelier software system “a highly creative, easily understandable approach to holistic diagnostics” [97].

Using Chandelier as part of the assessment process, the author has found the visual display, and careful placement of holistic data draws attention to previously unnoticed but significant interactions between the data. Information gleaned from these patterns initiates the use of the often-neglected dimensions of thinking, i.e., essentially critical and creative thinking, directed towards obtaining a deeper understanding of a child’s concerns and needs [98–102].

Acknowledgment

Acknowledgment has several definitions. The most pertinent is “to accept, admit, or recognize something, or the truth or existence of something” [103]. Holistic assessment is important in this respect. It contributes to establishing truth. When all indicators point to the existence of potential and, or some need, the question is raised regarding how one might acknowledge the truth, most prudently accommodate the need and help a child realize that potential. Alma's story offers insight.

Twelve years ago, Alma was constantly feeling sick, anxious, and stressed. Her teachers, despite her advanced mathematical ability, demanded she continues with 2nd/3rd-grade math. After a holistic assessment helped determine Alma's strength, one teacher recognized her responsibility to think and act differently. She acknowledged the need for developing Alma's higher-order thinking skills [104] and agreed to work with her. The difference was remarkable. Recently this note arrived from Alma. She wrote: "I am truly thankful every time I think of all the work we did, you taught me that it's okay to think the way I do … be curious and harness it At my internship I'm doing a lot of analytics and research work … every time someone tells me my brain is so analytic … it is thanks to you for encouraging that" (A.P. Personal communication, June 2020).

Whether at home, school, community, attending university, or completing an apprenticeship, *acknowledging or valuing strengths* empowers young people. This should not be understood as simply *praising* their strengths. With reference to the work of other experts in the field [104–107], Henderlong and Leper [108] wrote: "praise can create excessive pressure to continue performing well, discourage risk-taking, and reduce perceived autonomy." Henderlong and Leper [109] also found the possibility of praise "damaging because it conveys a message of low ability," especially in older children. *Sincere acknowledgment*, as opposed to insincere praise, encourages positive thinking and action while helping to eschew the influence of negative reactions and emphasize deficit thinking. Establishing a structure at home or hopefully in school provides opportunities for expressing preferences, enhances executive function, trust, a sense of authentic satisfaction, high-level thinking, desire for challenge, personal decision-making, and the development of rubrics, especially in the context of independent study. Over the years working with gifted individuals from four years to post-secondary students, the most practical and unfeigned ways of acknowledging strengths included mentoring [110], pre-testing, curriculum compacting, acceleration, posing new challenges, independent study [111], and the opportunity to share knowledge gained.

Many books and other publications are available, which will facilitate further study concerning the matters mentioned above. A selection of articles, papers, books, and other relevant links to this chapter are provided; see the reference section and reading list following this narrative.

Conclusion: Dimensions of Thinking

It is easy to blithely refer to some undefined range of thought in very general terms while maybe overlooking specific meanings and implications. Changes in attitudes are needed to overcome the cultural ambivalence as well as to achieve more support and acceptance for gifted youngsters in developing their abilities. In this context, thirty years ago, Marzano [112] acknowledged the need for a more precise framework for an educational curriculum and instruction to be used in education generally. He compiled a list of words and terms used in thinking actions he called Dimensions of Thinking. One particularly important example from Marzano's list, often associated with the thinking action and reactions of gifted children, is critical thinking. Recently Meneses [113] compiled a list focused only on critical and creative thinking and condensed it into five subsections (see below). The partnership offers an essential means whereby dimensional thinking in gifted children may be revealed and developed:

i. Thinking skills dimension: e.g., higher-order thinking, logic and rhetoric reasoning and argumentation skills; focus on individual development and ability to detect bias and defects in reasoning;
ii. Disposition: e.g., readiness to apply the thinking skills dimension;
iii. Ethical (perhaps equivalent to wisdom from Sternberg's perspective): virtues, human values, morality, fair-mindedness, attitudes, self-awareness, and concern for others;
iv. Civic: civic skills, virtues, social awareness and consciousness, concern for the public good and human/civil rights, willingness to participate in civic and political activities or social activities; and
v. Cultural: awareness of thinking traditions and values in contexts other than their own.

The purpose of bringing the list compiled by Meneses [113] to the reader's notice is that it focuses on avenues of thought that will enrich the learning and, thus, the potential of gifted children. Inimical thinking actions and reactions will most likely restrict the optimal development of potential. Supportive thinking actions and reactions will most likely promote full developmental potential in children. As a member of the passing generation, it is exciting to envision millions of young people worldwide encouraged and allowed to think critically and creatively – *wisely*.

Today, there is an incompatibility associated with various attitudes towards giftedness. If tomorrow, thinking actions and reactions in our community and field of work reflect more positively-skewed attitudes towards understanding and servicing the needs of these young people, their strengths, talents, and skills rather than simply 'fixing' their deficits, we all will benefit, and, writing and reading this chapter will have been worthwhile.

Core Messages

- This chapter focuses on the distinctive assets of youth described as advanced, talented, or profoundly gifted.
- We hope these young people are enabled to serve the needs of tomorrow's world.

- Young people's development depends on thoughtful support during their formative years.
- Young people's potential, when recognized and implemented, realizes the largess of human capital worldwide.
- Lack of acknowledgment or rejection becomes a matter of serious consequence.

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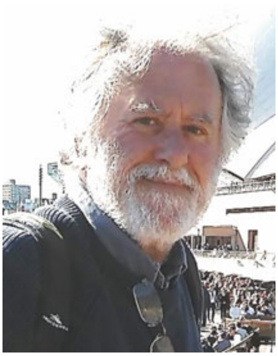

Trevor J. Tebbs , Ph.D., is a veteran educator with almost half a century of experience in regular, special, art, and post-secondary teaching and learning environments. Trevor's fascinating journey has included a watercolor exhibition at the International Monetary Fund (Washington, DC) and settling in Vermont. In the UK, with qualifications from the Universities of Bath and Bristol, he taught a wide range of young people. In the USA, an advanced Educational Psychology degree engendered interest in the special needs of highly able children. Trevor created a holistic assessment system known as Chandelier. With the Institute of Gifted Child and Ukrainian software engineer's support, field-use of Chandelier furthered a deeper understanding of the g/t population Trevor shared as the assistant field editor of the WCGTC journal (GTI) and, presently as associate editor of the International Journal for Talent Development and Creativity (IJTDC), board member of the Junior Academy of Science of Ukraine, member of Editorial Board of Junior Science and member of Universal Scientific Education and Research Network (USERN).

14 Multidimensional Thinking: Economizing Thinking and Maximizing Outcomes

Leander Penaso Marquez

"Ignorance is servitude, because as a man thinks, so he is; a man who does not think for himself and allows himself to be guided by the thought of another is like the beast led by a halter".

Jose Rizal

Summary

The history of humankind can be described as the summation of good and bad judgments. Good judgments lead to progress, whereas bad ones result in disasters. Thinking plays a central role in creating these judgments. Superior thinking often arrives at good judgments, while bad judgments often arise from inferior thinking. Unfortunately, the results of bad judgments usually exact a great cost from humankind. This essay claims that instances of these bad judgments can be mitigated by improving the quality of thinking. Further, to achieve significantly improved thinking, a reflective inquiry approach that aims to develop multidimensional thinking is proposed. Finally, this paper argues that for optimal results, the focus and starting point of improving the quality of thinking ought to be the children.

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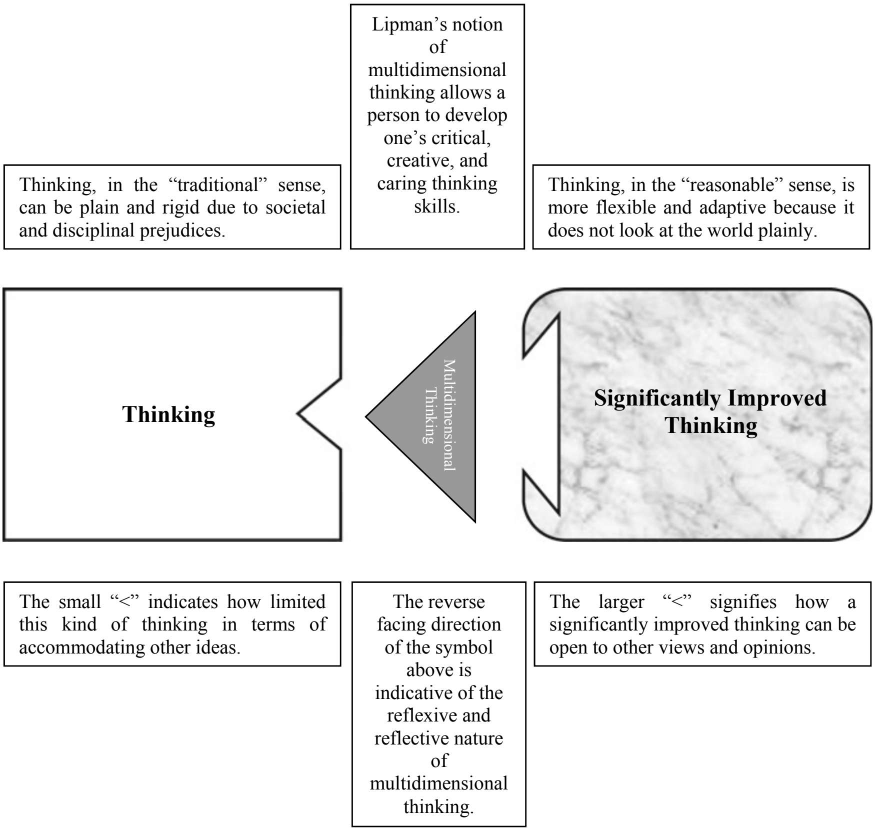
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_14



Economizing thinking and maximizing outcomes through multidimensional thinking

Keywords

Children · Dialogue · Multidimensional thinking · Reasonableness · Reflective inquiry

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

As rational animals, thinking permeates almost every aspect of human life. Many of our greatest discoveries and inventions were products of careful and elaborate thought processes. Conversely, numerous disasters and failures that have befallen us can be attributed to mediocre or poor thinking. It is as if we witlessly allowed ourselves to be led by a halter to slaughter in the hands of a butcher that is our own creation—a creation of our ignorance and faulty thinking. If this is the case, then it appears that the rational thing to do is improve the quality of thinking, thereby improving the quality of the results of thinking.

Improving the quality of thinking may result in two things—economic thinking and maximized outcomes of thinking. Economic thinking implies arriving at efficient and effective judgments or performing decision-making quickly and with fewer mistakes. Meanwhile, maximized outcomes of thinking imply inconsequential instances of failures or do-overs due to superior thinking results. Thus, improved quality of thinking is, without a doubt, a sure-fire way to escape the halter. With this in mind, the following discussions will look into Lipman's notion of multidimensional thinking as an avenue to economize thinking and maximize outcomes. To bring the conversation closer to home, I will also include examples of experiences from my own context.

Multidimensional Thinking

Multidimensional thinking can be described as a multi-perspectival approach to thinking. It is "more advanced thinking which has more dimensions than linear thinking, it has at least one unit more" [1]. It is "not linear, or even circular, but spherical plus a time dimension" [2]. In other words, it is thinking (about something) from different (multiple) aspects. Multidimensional thinking is being able to see the whole picture while going beyond the limits of any disciplinal framework.

Interestingly, the term "multidimensional thinking" was used by educator and philosopher Matthew Lipman to refer to the synergy of "critical, creative, and caring thinking"—resulting in significantly improved thinking. I would dare say that if science and art can be bioengineered in terms of thinking, one of its results will definitely be multidimensional thinking—critical thinking is represented by science, creative thinking is represented by art, and caring thinking is represented by the passion and concern for humanity and the world that drive these two disciplines together to discover things that are beneficial. This, of course, is a very general way of putting Lipman's multidimensional thinking into perspective compared to how he actually puts it, "*multidimensional thinking*—as I understand it —aims at a balance between the cognitive and the affective, between the perceptual and the conceptual, between the physical and the mental, the rule-governed and the non-rule-governed" [3].

For illustration purposes and with cognizance to the limits of illustrations, I have provided a visual representation of my take on Lipman's notion of multidimensional thinking (Fig. 14.1). Multidimensional thinking (symbolized by ◄) is the overlap among critical thinking (represented by □), creative thinking (represented by ◇), and caring thinking (represented by ○). Despite the differences among these kinds of thinking (as signified by the different shapes), multidimensional thinking allows one to transact with these differences to produce what is deemed to be significantly improved thinking—the precursor of reasonableness [3]. We can better appreciate the innovation presented by this notion of multidimensional thinking by juxtaposing it with Bloom's taxonomy.

Bloom's Taxonomy and Multidimensional Thinking

Bloom's taxonomy was devised to assess the progress of students' learning in relation to set objectives. In Bloom's [4] version of cognitive domains, the taxonomy is comprised of "knowledge, comprehension, application, analysis, synthesis, and evaluation." Eventually, it was revisited by Anderson and Krathwohl [5] and transformed the nouns into verbs. The revised version features "remembering, understanding, applying, analyzing, evaluating, and creating, as cognitive domains."

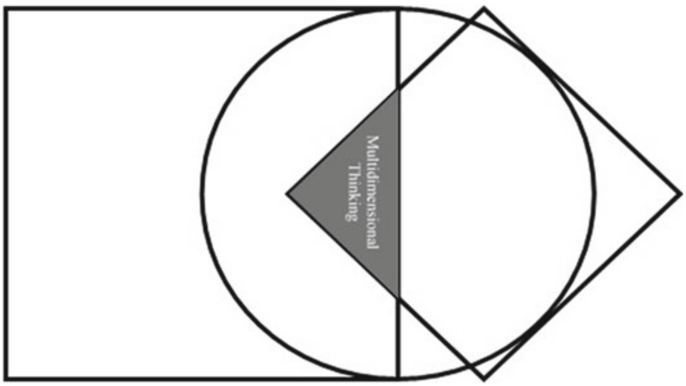


Fig. 14.1 Multidimensional thinking

Krathwohl pointed out that the taxonomy was designed to pave the way for "the exchange of test items among faculty at various universities in order to create banks of items, each measuring the same educational objective" [6]. One might notice the absence of critical thinking from this taxonomy. Krathwohl argued that critical thinking could not be classified under a single category [6]. In addition, critical thinking may be operational in both lower-order and higher-order thinking skills. The same can be said about caring thinking and, to a certain extent, creative thinking.

Lipman discussed in succinct detail in his work, *Thinking in Education* [3], each component of significantly improved thinking—multidimensional thinking—namely, "critical thinking, creative thinking, and caring thinking." I shall attempt to provide a general overview of these components in the succeeding paragraphs.

There is an abundance of literature that describes what critical thinking is all about. Lai [7] provides a comprehensive summary of these descriptions. From my point of view, it is "a questioning attitude directed at a thorough reconsideration, clarification, and validation of propositions, beliefs, or systems leading to a personal acceptance, rejection, revision, or development of the same" [8]. For Lipman, critical thinking is defined as "thinking that facilitates judgment because it relies on criteria, is self-correcting, and is sensitive to context" [3]. These value principles alone show how difficult it is to pinpoint where critical thinking is exactly in the aforementioned cognitive domains of the taxonomy.

> Critical thinking aims at reasonableness. This means that it is not just rational, in the sense of a thinking that is rule- and criterion-governed, but that it is also a thinking that accepts the fallibility of its procedures, that engages in self-corrective practice, that takes the contextual differences into account, and that is equitable, in the sense that respects the rights of others as well as its own [3].

In this light, critical thinking is not simply analyzing, evaluating, or creating, but an act of good judgment, an act of reasonableness. Hence, for Lipman, the model for the critical thinker is "the professional, the expert, the model of good judgment" [3].

With regard to creative thinking, it may be argued that "creating" (or synthesis in Bloom and creating in Anderson's) is an integral part of the taxonomy of learning. However, Lipman's notion of creative thinking is different from the one conceived by Bloom and Anderson in their respective categories. Lipman points out that creative thinking is "exemplified by the thinking that goes into the making of art … It is the discrimination of or the fabrication of relationships, patterns, and orders producing in us the shock of unfamiliarity" [3]. More than simply putting parts together, creative thinking pertains to "thinking how to say what merits saying, how to make what merits making, how to do what merits doing" [3]. For this reason, unlike mere synthesis (Bloom) or creating (Anderson) that can produce a generic outcome, "[c]reative thinking (as contrasted with the psychological disposition to creativity per se) is that minimal element of idiosyncratic judgment in every artist's work" [3]. Thus, for Lipman, the model for the creative thinker "is the artist" [3].

Last but not least, the notion of caring thinking is perhaps what can be considered as Lipman's innovative contribution in the collection of literature on thinking. "Caring thinking involves a double meaning, for the one hand it means to think solicitously about that which is the subject matter of our thought, and on the other hand it is to be concerned about one's *manner* of thinking" [3]. Caring thinking is derived from an individual's passions and emotions. For this reason, thinking is not merely a cerebral activity, but also a passionate one. As Lipman illustrates, "a man writing a love letter writes *lovingly* to the person to whom the letter is addressed, while at the same time he is anxious about the letter itself" [3]. Finally, some of the models for the caring thinker for Lipman "are the solicitous parent, the considerate environmental planner, the thoughtful and concerned teacher" [3].

Given this, it is not difficult to see that the current taxonomy of cognitive domains does not give justice to what is being offered by Lipman's notion of multidimensional thinking, that is, reasonableness. Reasonableness as "rationality tempered by judgment" [3] requires adeptness in critical, creative, and caring thinking. It goes beyond what can be measured by items from a test bank. To arrive at reasonableness, we must first significantly improve our thinking (Graphical Abstract); to do this, we must become the professional, the artist, and the thoughtful and concerned teacher. Ultimately, reasonableness "entails the cultivation of multidimensional thinking" [3].

Economizing Thinking and Maximizing Outcomes

I mentioned earlier that improving the quality of thinking can lead to economizing thinking and maximizing its outcomes. I want to add to this by stating a claim that appeals to common sense: if thinking is what we do, then we should be very good at thinking. To achieve this, I offer one possible recourse that has proved to be effective for millennia—do philosophy. Sciences were borne out of philosophy, and it is philosophy that gives meaning to art. Science and art—two disciplines that have greatly steered humankind, not only in terms of progress but more so in terms of thinking, were (and still are) significantly driven by philosophy. If this is the case, then we must seek the help of philosophy to improve the quality of our thinking.

What Is Philosophy?

Philosophy is not popular. In my context, Filipinos can be considered "young" or "newbie" when it comes to dealing with philosophy: "philosophy isn't very popular in the Philippines. Culture usually means pop culture there—Beyonce will always trump Barthes, and Rihanna rules over Ricoeur any day. Philosophy is even linguistically associated with foolishness or glibness in the national language" [9]. For this reason, one may be wondering what philosophy means in the context of this essay. Thus, it is important to characterize what philosophy is all about for the sake of clarity. For this particular purpose, it will be beneficial to borrow the ideas of Bonifacio in his paper, *Three Concepts of Philosophy* [10]. Bonifacio points out that philosophy can be characterized into three: intellectual presuppositions, reflection, and reconstruction.

As intellectual presupposition, it is where an individual's ethical, metaphysical, and epistemological notions or personal philosophies are rooted, which serve as a basis for one's personal judgments, beliefs, and actions. "To be sure, this philosophy does not, as a rule, surface to the person's consciousness, but just the same, it provides shape and directions to his beliefs, actions, and expectations" [10]. One may, as an example, look into Filipino indigenous philosophy of *pakikisama* (smooth interpersonal relationships), *utang na loob* (internal debt), and *Gulong ng Palad* (Wheel of Fortune), among others [11] that guides how most Filipinos conduct their affairs. It is worth noting that these presuppositions are not intentionally formed and collectively make up what can be considered a person's life philosophy. "Every human being has a personal life philosophy. It was formed by a complex lifetime mix of genetics, environment, and learning over time … Most people's personal philosophy is created and evolves from experiences and just living, not from conscious reflection and design" [12]. In this light, a person may have a personal philosophy—an intellectual presupposition—that guides one's action that she/he may not even be aware of unless called out by someone or subjected to reflection.

As reflection, it is aimed at the examination of our personal philosophies. It is where we objectify and analyze our intellectual presuppositions. "In fact, some philosophers incline to the view that the activity of objectification and analysis is what philosophy is all about. My own view is that to objectify and analyze the foundations of our values, including the roots of our metaphysical and epistemological beliefs is to engage in philosophy …" [10]. Van Seggelen-Damen et al. write that reflection is essentially a Socratic activity. "Superficially, it resembles a dialogue and could be called discursive … On a deeper level, we suggest that reflection resembles the actual content of what Socrates presented to the docile slave [in *Meno*]. Socrates gave him rhetorical questions, that is, answers phrased as questions to which the obedient slave could only answer with a 'yes' or, depending on the question, with a 'no'" [13]. In this sense, even the simple reflective act of asking oneself questions that are answerable with "yes" or "no" such as "Did I do the right thing when I gave some change to the beggar?" or "Was I rude when I talked louder than what was appropriate inside the library?" can be considered as philosophy.

Finally, as reconstruction, it aims to question, analyze, and, if needed, revise belief systems. "Our activity of reflection finds broader meaning not merely in showing the errors of our ways, the implausibility of our ordinary beliefs, but putting things together in the proper perspective" [10]. It is somewhat seen as a rewriting of idea/s that becomes part of the history of ideas—of philosophy itself. "We take a text to be philosophical only when we can perform an act of re-writing it, an act of reconstruction. The history of philosophy is a reconstruction in this sense" [14]. It is through reconstruction that it may be possible for us to come up, if possible, with an encompassing philosophy that "would serve as the unifying frame of all our knowledge, beliefs, and actions" [10]. Candidly, one can even say that even Dewey's critique of traditional western philosophy in his work, *Reconstruction in Philosophy* [15], and his suggestion on what direction philosophy should go is, in itself, an attempt to reconstruct nature and point of philosophy.

Although this essay recognizes that philosophy cannot be precisely defined, with this characterization of philosophy, I hope that it has somehow established a common ground in understanding the notion of philosophy. This is important since, at this point, this paper will raise a question that is central to the purposes of my discussion—why should we revert to philosophy to improve the quality of our thinking? As a response to this question, I will lay down three points, namely, because Philosophy is:

i. a conduit for multidimensional thinking;
ii. a key for the emancipation from the tyranny of custom; and
iii. an *organon* (tool) for the actualization of human reasoning

Philosophy Is a Conduit for Multidimensional Thinking

While it does not have a monopoly on multidimensional thinking, philosophy is a multidimensional enterprise by virtue of its very nature.

> [T]he meaning of philosophy is best revealed in its speculative and critical functions. Since in its speculative concern it takes the broadest possible perspective, we must not look for too specific a content. Philosophy is not about atoms and electrons, plants and animals, the history of states and the structure of governments. Yet all these are the concern of philosophy insofar as they have bearing upon man and his purposes. Similarly, philosophy is not merely a criticism of this or that specific subject, but assumes to itself the right to judge of any subject and to evaluate all things that come within human knowledge … As speculation, it may arrive at the insight that the world is both divine and good, as analysis and criticism it may limit itself to a prolonged consideration of the meaning of the word "good" [16].

Since philosophy interests itself with the foundation of things, it virtually deals with everything that concerns humans. Nonetheless, the approach utilized by philosophy in addressing these concerns is not too specific or specialized as in the sciences. Neither is it dependent on faith nor revelation, as in religion. Nor is it as open to almost limitless interpretations as art. The approach used by philosophy is both speculative—it looks at things *sub specie æternitatis*, i.e., under the aspect of eternity—and critical, that is, under the lenses of logic. Thus, its approach is characterized by a balance between reflective curiosity and rational inquiry. In this light, we can see that we cannot proceed with doing philosophy without engaging in speculation and criticism. Consequently, the students of philosophy are compelled to open their minds to the existence of possibilities, however far-fetched or improbable they may be, but at the same time, criticize these possibilities to arrive at the truth.

Most, if not all, students of philosophy consider the discipline as an end in itself, but there is no need to deny that philosophy can be used as a means to other ends [cf. 17]. For our discussion, philosophy must be used as a conduit to inculcate multidimensional thinking in us. For instance, it would be difficult to imagine how the sciences, mathematics, art, and technical education can teach us how to elect into public office honest and competent leaders or teach someone how to value human rights or question the status quo.

Since philosophy thrives in questions and outside-of-the-box thinking, it will enable individuals to think of other better possibilities apart from what the status quo offers. Thus, it can pave the way for creative solutions to traffic congestion, flooding, urban planning, equal opportunity for quality education, and so forth. But to accomplish this, they must first free themselves from the constricting chains of bad habits and personal prejudices—and in accomplishing this objective is where philosophy is most instrumental.

Philosophy Is a Key for Emancipation from the Tyranny of Custom

Traditionally, philosophy is defined as a "love of wisdom." Bertrand Russell [18] described Philosophy, in terms of wisdom, as comprehensiveness and emancipation from the tyranny of custom. By comprehensiveness, he meant to include "a certain awareness of the ends of human life" [18]. By emancipation, he argued that "the essence of wisdom is emancipation, as far as possible, from the tyranny of the here and now" [18]. Meanwhile, for Lipman, wisdom is the "exercise of good judgment" [3]. Nonetheless, despite the need for change to happen in the world, many of us are fond of our old ways—many are slaves of custom, many embrace habits, and many are averse to change. This is especially true in our context in the Philippines [19–21] and perhaps in other parts of the world as well. Take, for instance, the mediocre requirements to run for public office, the patronage system in both the public and private spheres, exploitation of popularity or celebrity status to win electoral votes, and master-slave morality, among others. Here lies one of our problems.

A glance at the status of the current global politics shows just how feverish politicians argue with each other, not for the sake of rational debate, but to prove themselves better than their rivals and deserve to be re-elected for another term. How they criticize one another (and not necessarily each other's opinions) gives the impression that these politicians value their opinions so much that they do not give an ounce of care on the validity of the other's arguments. It is in instances like these lie another problem.

It appears that "this dysfunctional political dialogue, which stems from the iron certainty we grant our opinions, is the most pressing problem confronting [the] twenty-first century … In fact, it is a crisis. For without the ability to carry on a useful dialogue, we cannot solve our greatest challenges, or even our smallest ones" [22]. Training in philosophy helps us to overcome this by teaching us how to be reasonable. To be reasonable "is primarily a social disposition: the reasonable person respects others and is prepared to take into account their views and their feelings, to the extent of changing her own mind about issues of significance, and consciously allowing her own perspective to be changed by others. She is, in other words, willing to be reasoned with" [23]. And further, "the open-minded study of different philosophies at least opens one up to the possibility that one is wrong" [22]. This helps the person accept and respect other people's opinions, especially when it involves matters of culture, faith, and religion.

It is crucial to understand that it is wrong to hold on to whatever knowledge (or opinion) that one has with an unyielding conviction for fear that one might be regarded as ignorant, intellectually inferior, or not be taken seriously. Knowledge can only take someone so far, and the person must realize that knowledge is not certain. Philosophy opens our minds to this: "studying philosophy cultivates doubt without helplessness, and confidence without hubris" [24]. Correct thinking and proper reasoning entail the acceptance of the fact that people may be mistaken in their knowledge and beliefs and to not be open to the possibility of yielding to other ideas that may prove to be more valid than theirs is a cause of erroneous thinking and manifests just how enslaved they are to their personal prejudices. "Our society is dysfunctional because we have forgotten how to think if we ever truly knew how to think at all … To study philosophy is to learn how woefully ignorant we are, and this knowledge can perhaps teach us humility, can perhaps suggest to us that the other side may have some value after all" [22]. And we can arrive at this realization once we accept that, as human beings, we must always persevere to be rational and that philosophy is an effective tool to actualize our nature as rational beings.

Philosophy Is an Organon for the Actualization of Human Reasoning

What differentiates us, humans, from other animals is our capacity for reasoning. However, thinking does not necessarily translate to reasoning. There are many forms of thinking, and reasoning is just one of them. When we imagine, memorize, or remember, we can say that we are thinking but not necessarily reasoning. Though innate to us, our reasoning aptitude must be developed as early as possible to achieve a credible level of multidimensional thinking skills.

Experience shows that human development, with respect to every aspect of human life, begins while one is just a child. As children, humans are introduced to many things by their families—culture, traditions, language, social conduct, and religion, to name a few. At a certain age, they are set up to continue their education in schools. However, it is very seldom that we encounter school-age children who are introduced to philosophy early. Why is this the case? Such question was first raised sometime in 1557 by the French philosopher Michel de Montaigne, to wit: "Since philosophy is that which instructs us to live and that infancy has there its lessons as well as other ages, why is it not communicated to children betimes?" [25]. One may argue that philosophy, a difficult field of study as it is, is not an appropriate discipline for children to study at such a young age. They may insist that studying philosophy requires a certain degree of cognitive skills for its thoughts to be appreciated. Nonetheless, available research provides evidence to the contrary:

> Young children's experience is already replete with philosophical meaning. They have strong, even visceral, intuitions of what is beautiful and ugly, fair and unfair, right and wrong. They enjoy playing with language and are intrigued by logical puzzles. They are given to metaphysical speculation and frequently engage in epistemology: asking how we know what we think we know [26].

In introducing children to philosophy at a young age, they are not only taught how to think, but they learn how to think multidimensionally. Giving children the opportunity to engage in philosophical dialogues is very important because children should learn how to think from different perspectives while they are young for them to grow up to become intellectually mature individuals.

In this light, efforts to actualize human reason go beyond the "I think" but, in fact, look into a person's very core as a human being. Computers and robots can "think" to the extent that their respective programs allow them to, but it is not the same as humans' way of thinking. Humans are not programmed to think; rather, it is their nature to think. Thus, human beings must develop the skills that would help them be good thinkers and communicators of their thoughts, and they have to start doing this at an early age: "the reasons most often given for engaging young children in philosophy have to do with strengthening their cognitive and communicative skills, and introducing them to formative ethical and political ideas" [26].

The importance of studying philosophy and our endeavor to actualize human reasoning cannot be further underscored, but I would like to follow the example of Sowey as she quotes Alex Pozdnyakov, who in very succinct words described the importance of studying philosophy: "I have this strange phrase I use when people ask me why I chose philosophy. I tell them I wanted to become a professional human being" [24]. There is, perhaps, no better statement than this that could effectively capture the thought that this essay is trying to get across.

Philosophy for Children and Multidimensional Thinking

I mentioned earlier that science and art alone could not teach us how to choose good and effective leaders. Since bioengineering aims to create or modify products to improve or augment processes, bioengineering science and art in terms of thinking —particularly multidimensional thinking—entails that what we must strive for is an education for democracy. Education for democracy implies that we are free to think. However, having the freedom to think requires us to be good thinkers, lest we fall into erroneous thinking. Interestingly, "in order for democracy to work, the people must be educated" [27–30]. This is because, in a democracy, its constituents must be able to engage each other in a reasoned debate or, better, a reasonable dialogue. Thus, thinking, education, and democracy must be pursued together. For this reason, bioengineering of science and art cannot and must not start with adults. It must begin with minds that are pure enough and free from societal or disciplinary biases. Therefore, it must start with the minds of children:

> Philosophy has always been preoccupied with good thinking, logic being one of its oldest branches. While formal logic is beyond the ken of young children, they are very capable of the informal logical operations that constitute basic reasoning, including giving reasons, considering evidence, agreeing and disagreeing, giving examples and counterexamples, and making comparisons and distinctions … Reasoning, as just described, is one important method. Another is attempting to discover a wide range of ideas and points of view relevant to the question under consideration, so that our judgments will be well-informed as well as well-reasoned [26].

The tools of philosophy can help these students develop their multidimensional thinking skills early in their lives only if they are trained to philosophize from the onset of primary education. Further, it must also be utilized to make them realize that there are other ideas out there that they can make the most of to improve their way of life and upgrade their living standards.

Looking at the training provided by philosophy, it is not difficult to arrive at the realization that if we want global citizens who are multidimensional thinkers, then it is our obligation to train them in the discipline of philosophy while they are still young. Indeed, “we have to create a society in which excellence flourishes in diversity and abundance. Upgrading the reflective element in education is a reasonable place to begin” [3]. Starting philosophical training from a young age is a pathway that allows children to develop their higher thinking capacities from the onset, which the current traditional education only begins to focus on during the latter part of the education process when students are more “mature” while lower-order thinking skills are given priority at the beginning. In fact, “the extent to which higher-order thinking skills are taught and assessed continues to be an area of debate, with many teachers and employers expressing concern that young people ‘cannot think’” [31]. Furthermore, the development of reasonableness and multidimensional thinking does not receive the attention it deserves from the current education system that lacks philosophy education. This is what the philosophy for Children (P4C) movement is trying to address.

During the late 1960s towards the early 1970s, it can be argued that the first seeds of P4C were sown when “Matthew Lipman became dismayed at the quality of argumentation employed by presumably well-educated citizens. Convinced that the teaching of logic should begin long before college, he tried to figure out a way to do this that would stimulate the interest of 10–11-year-olds” [32]. Drawing from children’s already philosophically rich experiences, Lipman, Sharp, and the other advocates of Philosophy for Children wrote short stories and novels that explore the ideas that can be found in children’s experiences. In this sense, they did not really introduce a subject that is foreign to the children, but they only built upon what is already there.

> Elementary school philosophy, therefore, is not about imposing an unfamiliar, ancient and highly intellectual discipline on children, in hopes it might be good for them, but about giving them the opportunity to explore ethical, aesthetic, political, logical and other

> philosophical aspects of their experiences that are already intensely meaningful for them, but that are not often given attention in schools (or elsewhere) ... Elementary school philosophy draws students' attention to philosophical concepts like fairness, person, mind, beauty, cause, time, number, truth, citizen, good and right – concepts that are already implicated in children's experience, and that children need to make their experiences more meaningful, in both senses of that word: more understandable and richer, more worthwhile. The content of elementary school philosophy, therefore, is not the traditional philosophical problems and arguments that are the stuff of high school and college philosophy courses, or the traditional philosophical sub-disciplines of ethics, aesthetics, metaphysics, political philosophy and logic, or even the important figures in the history of philosophy – though some of this may become meaningful for older children who have some experience with philosophy. An important objective of elementary school philosophy is to help children become conversant with philosophical concepts, and to discern them wherever they arise – sometimes referred to as developing "a philosophical ear" [26].

In my context, P4C was introduced in the Philippines during the early 1990s [33]. Faculty members from the Department of Philosophy of the University of the Philippines Diliman, some of whom trained under the Institute for the Advancement of Philosophy for Children in Mendham, New Jersey, started training public school teachers in Metro Manila to include the approach in their teaching methods. The results of the training were very promising as the teachers became more critical and reflective about what they were teaching [34–36]. They became more open to questions from their students.

Nevertheless, without a real place in the basic education curriculum, on top of the highly bureaucratic administration of schools, teachers found it hard to incorporate the approach in their own materials [36]. Furthermore, perhaps the greatest challenge that they faced was the fact that Philippine basic education was, and still is, very much attached to the method that is insufficiently informed by P4C. In particular, the challenges in implementing P4C in the Philippines were identified to be the following [37]:

i. "Implementation of thinking skill and reflective inquiry program in colleges of education";
ii. "Best practices, models, and paradigms of schools using the Philosophy for Children";
iii. "Developing instructional materials"; and
iv. "Training public school teachers in facilitating philosophical dialogue."

Given that philosophy education is not a staple for school-age children in many countries, it is safe to assume that similar challenges also persist in other contexts. This is a considerable hurdle to any attempt to develop children's multidimensional thinking skills through philosophical training.

One may argue that it is possible to develop one's multidimensional thinking skills in any discipline. Nevertheless, if one aims to be an expert in legal matters, one is expected to study law; if one intends to become a doctor to diagnose illnesses and cure them, one is expected to pursue medicine; and if one aspires to have extensive knowledge about the past, one is advised to study history. Suppose a student is expected to spend time in a discipline in order to become well-versed in its area of specialization. In that case, it is only reasonable that a student devotes time to philosophy, specializing in critical, creative, and caring thinking if one's goal is to develop as a multidimensional thinker.

Furthermore, for the ancient Greek philosophers, philosophy is not merely a field of study, but more importantly, it is a way of life. Russell asserts that "[i]f all men were well off, if poverty and disease had been reduced to their lowest possible point, there would still remain much to be done to produce a valuable society; and even in the existing world the goods of the mind are at least as important as the goods of the body. It is exclusively among the goods of the mind that the value of philosophy is to be found; and only those who are not indifferent to these goods can be persuaded that the study of philosophy is not a waste of time" [38].

If we look at it closely, the argument for including philosophy in the classroom has a very significant practical value. Amongst other things, philosophy puts more depth and meaning in whatever we study—as in science and in art—and with what we do with our lives. But most of all, philosophy trains us to become "professional human beings." [24] If the goal of education is to produce good citizens; if we are to define a good citizen as a professional human being, that is, as someone who is critical, creative, caring, and collaborative—a multidimensional thinker—then philosophy ought to be more utilized since it is geared towards the production of such kind of citizen. In this regard, education institutions should consider either requiring their students to take courses in philosophy or training their teachers to use the tools of philosophy in the conduct of their classes. An ideal scenario would be to adopt both suggestions, but at the end of the day, one cannot deny that philosophy, either as a discipline or as pedagogy, is indispensable in improving the quality of thinking.

Conclusion

Today, it is common to encounter challenges such as alternative facts, post-truth, and anti-intellectualism. Failure to respond to these challenges due to poor or fallacious thinking has proved to bring most of us more harm than good—the rise of authoritarian leaders, militarization of the West Philippine Sea, and the continual increase in COVID-19 infections, to name a few. This is a shortcoming of education—a failure to teach thinking, that is, multidimensional thinking, in schools. Since education aims to produce good citizens in its broadest sense, it is paramount to develop a more responsive education—one that develops multidimensional thinking and not just linear thinking.

Nevertheless, suppose we truly want a more responsive education for the challenges that we are experiencing today. In that case, we should begin to accept that we need to educate the youth in the ways of philosophy. "By inviting students to reflect on relationships among different areas of inquiry and to make sense of their educational experiences as a whole, philosophy can add to the meaningfulness of students' education as a whole" [32]. This is where P4C can come in. Through this pedagogy—a pedagogy that focuses on significantly improved thinking—education can go beyond merely achieving a set of learning objectives but puts more reflection and meaning into it.

At the beginning of this essay, I borrowed a passage from the national hero of the Philippines, Jose Rizal. He advised us to think for ourselves lest we want to be like beasts led by a halter. I believe that it would only be fitting, as a complement to Rizal's counsel, to end this work with a counsel of my own:

> *Ignorance is only servitude if a person chooses to remain ignorant, for ignorance can lead to wonder, then wonder to questions, questions to thoughts, and thoughts to insights. Ignorance is neither good nor evil. It is what a person does with one's ignorance that matters. Ignorance is but a stage. It is the first stage of thinking.*
>
> *Leander Penaso Marquez*

Core Messages

- Education must focus on significantly improved thinking through teaching for thinking.
- Bioengineering science and art in terms of thinking can result to multidimensional thinking.
- Multidimensional thinking requires striving for education for democracy and reasonableness.
- Economizing thinking can be achieved by introducing philosophy in the classroom.
- Giving children opportunities to philosophize help maximize the outcomes of multidimensional thinking.

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How You Know What I Know that She Said About You: Theory of Mind, Intentionality and the Evolutionary Roots of Artistic Practice

15

Dustin Hellberg

> *"Whenever I try to become sensible of my thinking activity as such, what I catch is some bodily fact, an impression coming from my brow, or head, or throat, or nose. It seems as if consciousness as an inner activity were rather a postulate than a sensibly given fact, the postulate, namely, of a knower as correlative to all this known; and as if 'sciousness; might be a better word by which to describe it. But 'sciousness postulated as a hypothesis' is practically a very different thing from 'states of consciousness apprehended with infallible certainty by an inner sense'. For one thing, it throws the question of who the knower really is wide open again."*
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> William James [1]

Summary

This article discusses the role of second-order intentionality in artistic practice and aesthetic evaluation. Second-order intentionality—and third-, fourth-, fifth-, etc.—is an extension of the Theory of Mind, itself an evolved neural capacity found in humans and primates. Though this article puts forth spatiotemporal processing and exaggeration as two other foundational mental abilities for aesthetic capacity, its focus is on the relations of second-order intentionality (or n-order intentionality) to artistic practice. Without these neural processes, artistic practice and evaluation would simply be impossible. Demonstrating the various relationships between evolved abilities and artistic ones will help bolster future interdisciplinary research and inquiries that span the sciences and humanities.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_15

Sympathy: a girl with cancer and her friend
[Adapted with permission from the Health and Art (HEART), Universal Scientific Education and Research Network (USERN); Painting by Fatemeh Ghasemi Nezhad.]

Keywords

Ethology · Evolution · Evolutionary aesthetics · Theory of Mind · Second-order intentionality

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's

keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

In his foundational text quoted at the beginning, *Psychology*, William James laid a philosophical framework to the inner workings of the mind, trying to explain them physically, not metaphysically. One could imagine him, were he alive today,[1] hard at work in the neurosciences, peering into the networks of neurons and their electrochemical web, which is the foundation of the human mind and self. What James explores here is how self-consciousness works. Tuning one's mind on itself does not quite allow one to 'see' one's mind in action, one's self-consciousness laid bare. James' neologism, 'sciousness,' is intended to address this issue. If we cannot be sure of our own minds in a way that should make something like self-consciousness or free will apparent, then how can we ever quite be sure about other people?

Given the theme of the present volume, 'bioengineering,' we should keep in mind the ways that evolution has 'engineered' our present selves. Evolution provided the basic blueprints upon which free will, blind luck, migration patterns, and culture have developed. So, how do we move from the stochastic, eons-long processes of evolutionary forces to human artistic practice? I posit here that sui generis artistic practices in human culture are emergent properties that build on previous cognitive capacities in the human brain. I fail to see how it could be otherwise. Spontaneous generation of universal patterns and practice in homo sapiens (such as art and appreciation thereof) would be bafflingly rare if not impossible, lacking a shared evolutionary heritage. Art exists in all cultures in some form. As far back as we can tell in the archeological record, the aesthetic practice has been found. From the harvesting of ochre and seashells, presumably for body painting/modification, to the magisterial 'cathedrals' of paleolithic cave paintings, human beings evidently have always been artistic.

If we think of some of the core aspects of aesthetic appreciation, it can be traced back to a few core tenets. For the purposes of this article, I envision three: spatiotemporal cognition, second-order intentionality (SOI), and exaggeration.[2] Spatiotemporal processing allows for storytelling, plot, narrative, group organization, and shared purpose. All cultures have origin myths, ritual myths, and eschatological

[1] Or Aristotle for that matter.

[2] Of course there are more than just this. The holistic web of human cultures, history and artistic practice is overwhelmingly complex. I would add to this list abstract symbolic representation (language), mother-infant dyad bonding and a host of others.

myths. Where did we come from; what do we do while we are here; where are we going? All human beings engage in storytelling, and the past/future mental projections are framed in this spatiotemporal constellation. But when we think about the ability to project the self (or the group) into the unknown future, we see how powerful this ability is despite its commonality. Children do it once their minds have developed enough to comprehend distances across time and space, rather abstract ideas when seen objectively. Adults do this rote routine as a matter of fact: I shall take a vacation next year; I need to save money for my retirement; I shall never die.[3]

Exaggeration is an intentionally broad concept, but in my formulation, it comes from the mind's ability to abstract outward from experiential data to generalized categories of understanding. The human mind is a pattern-hunting organ, and the ability to perform this act has an immense evolutionary survival advantage. The ability to collate observational data into proleptic (future-oriented) inferences allowed our ancestors to make stable predictions about weather, animal behavior, out-group friendliness/hostility, and a range of other patterns.[4] Further, and this is far more speculative, exaggeration allows for such aesthetic practices as metaphor, symbolism, character archetypes, and pictorial representation, among others.

SOI is, in my opinion, more foundational to the other two listed here than they are of it. Hence, for the present purposes, I shall focus on this alone and expand on this aspect in the next section. SOI is basically mind reading. It is an extension of Theory of Mind (ToM), something found in our primate cousins.[5] TOM is the cognitive ability to understand conspecifics as having mental states of their own such as pain, fear, and happiness. SOI is a bit more complex as it relates to states of intentionality that an individual can infer about conspecifics' actions. Imagine a stranger walked up to you, put out their hand, and offered you a $100 bill. Immediately you would wonder what their intention is. Is this person supremely generous? Are they insane?[6] What does this person expect of me should I take the proffered money? This last example is technically third-order intentionality, but I will deal with that definition later.

Intention of this sort is foundational to artistic practice and understanding. It is the reason why we value an original piece of art versus a copy or reproduction. The copy/forgery has a far different intention (based on that of the forger) than the original. Intention is why we love or hate characters in the stories we tell. It is what helps to make sense of characters' relationship to plots, of the gods' motives in our

[3] Right?

[4] These three 'precursors' will naturally overlap in places. Exaggeration lends itself to the spatiotemporal understanding of patterns happening through time. My point is that these mental capacities are foundational to artistic practice.

[5] Other species demonstrate ToM at least to a rudimentary level, but none to the extent of humans and primates.

[6] Note, too, that this overlaps the other 'precursors. You might think, 'In my past (spatiotemporal) experience people don't just offer money for no reason unless they are (general categorical exaggeration) inveterate philanthropists or crazy'. A glance at their clothing might yield further generalized inferences. If the person is wearing a garbage bag versus a bespoke suit, we couldn't be blamed for coming to different conclusions about their intentions.

mythologies, of how we should ‘read’ aesthetic objects. It is the foundation (as we will see) for morality and dignity, for justice and punishment, for law and ethics. The next section will trace the evolutionary roots of this phenomenon and explain its relationship to the arts and aesthetics.

Monkey See, Monkey Duality[7]

Human cognitive abilities have correlates found in our great ape cousins. This should come as no great surprise since our common ancestors with chimps broke off approximately 6 million years ago. Human DNA is approximately 98.4% identical to chimpanzees. Ethologists have been teasing out similarities in great ape behavior to human behavior for nearly a century, finding more and more similarities when it comes to sociality, sexuality, and survival strategies. But apes do not just spontaneously create art or grab a crayon and start scribbling away on a piece of paper as human children do. Where shall we look to find correlates in our primate cousins that reasonably suggest a proto-aesthetic drive that could lead toward something like human artistic practice? ToM is a good place to start.

ToM is the cognitive ability to intuit that other creatures around you have mental states other than one’s own. This begins in preverbal human infants fairly early in life. As Robert Sapolsky says: “Nine-month-olds look where someone points (as can other apes and dogs), knowing the pointer has information that they don’t. This is fueled by motivation: Where is that toy? Where’s she looking? Older kids understand more broadly that other people have different thoughts, beliefs and knowledge than they, the landmark of achieving Theory of Mind … Thus there are stages of gaze following, followed by primary ToM, then secondary ToM, then perspective taking, with the speed of transmissions influenced by experience (e.g., kids with older siblings achieve ToM earlier than average” [2].

Humans share the ToM ability with, at least rudimentarily, other social animals. It confers survival chances to be in tune with other members of your group. But where does this come from? The answer lies, at least for mammals, in the combination of brain function and social group sizes.

There appears to be a correlative connection between neocortex size in mammalian brains and the size of the social group in which they operate. The more neural processing power available to intuit the mental states of others, the larger the possible group sizes tend to be. This is really remarkable. As Leonard Mlodinow notes: “To be precise, the size of a species’ neocortex—the most recently evolved part of the brain—as a percentage of that species’ whole brain seems to be related to the size of the social group in which members of that species hang out. Gorillas form groups of under ten, spider monkeys closer to twenty, and macaques more like forty—and these numbers accurately reflect the neocortex-to-whole-brain ratio of each of these species” [3].

[7] Yes, I am aware that monkeys are not the same as apes.

So, ToM is crucial for group cohesion and social interaction. Further, it leads to more advanced mental processes like second-other intentionality (SOI). As Mlodinov also notes, as the human neocortex size is very large compared to the whole brain, our social groups tend to be around 150, "just about what the neocortex size model predicts" [3]. Humans have evolved to be incredibly sensitive to our social environs, and thus we have but to turn to a function of language to demonstrate the relation between SOI and artistic practice.

First-order intentionality has to do with personal states of being and desires: "It's cold outside so I should wear a sweater. I have a lot of deadlines coming up so I should get them done." SOI builds upon this: "I believe that these deadlines will warp my sanity. This weather intends to kill me." Here, even non-human entities can be given agency and intention despite having none. Humans dollop intention and agency on practically everything around them, but especially on each other. Third-order intentionality builds further: "I know that Susan believes she's more qualified for that job that Billy wants. Susan thinks that Billy thinks that I think he's distinctly unqualified for." This can go up several more levels of complexity, but it is not hard to see how humans, set in incredibly complex social interactions, require this type of thinking to get through the day. Even teenage romance and drama bears this hallmark: "Billy said that Susan said that Sally would totally date him, but I think that Sally was lying because she's totally into Steve even though she knows that Steve knows that I like him, etc." While convoluted, one can pick out the intentional states readily.

This n-order of intentional comprehension forms one of the bases for artistic practice and is something that we use to peer into the minds of our Paleolithic ancestors. Take Chauvet Cave and its paintings. We may gaze at the indescribable beauty of these[8] and note the stunning quality of line and form, of relation to the inner space of caves, of the remarkable modernity of the representations. Yet, it is not long until we ask a simple question: Well, what are they for?[9] In asking this, we want to understand what these artists intended these paintings to do, to represent, to symbolize, to communicate to others. To take a general example from life and literature, when a person or character does something unexpected, we immediately ask, 'well, why did they do that?' We can expand this into critical comprehension: what does the author intend me to understand about this character's hidden motivations when she said/did X? Too, think of the way that irony works in relation to n-order intentionality. I have to understand that the author has a character say one thing but mean another. This is no small mental gymnastic feat. I have to comprehend that the intentions of both the character and the author are counter to the evidence presented to me and then read that into the overall fabric of the general story's meaning. Lacking this capacity, I might believe that Jonathan Swift really did call for Irish babies to be tossed into a stew pot. I might miss the joke if a friend

[8] I admit here my complete fascination with Paleolithic art if it wasn't obvious.

[9] The very fact that we can formulate questions at all about cave paintings that are 32–45 k years old should speak more to a core commonality in the human species than about a 'cultural refraction' which states that human selves are merely constructed by their cultures/languages as many in the humanities claim.

says, "The weather is just lovely" during a hurricane. ToM yields n-order intentionality, which then yields the human capacity to have art, stories, characters, or plot at all (among others).

An interesting side note is just how n-order intentionality allows humans to have theories about theories. If we examine the meta-X concept (metafiction, metareference, metatheory, etc.), we should note that to have a theory X about theory Y follows this same pattern: "I believe theory X intends to explain theory Y in such and such a way."[10] Hence, to drum up an easy example, the characters in Samuel Beckett's *Waiting for Godot* literally wait for nothing in a play in which not much happens, which intends to ironically demonstrate the existential crisis of the human self in relation to a godless universe while still, itself, being a self-referential play about the nature (or futility) of the play (and art) itself. If I am watching a movie in which a character turns and looks directly into the camera and addresses their own role as a character, if I lack n-order intentional comprehension, this might strike me as odd. In fact, were I lacking that mental capacity, it is doubtful I could even watch a movie, read a book or navigate the vagaries of human life at all.

But, if n-order intentionality is important for humans to navigate our tricky social lives, why do we spend inordinate amounts of time producing, consuming, and pondering stories, myths, movies, sculptures, paintings, video games, music, music videos, and so on? Why do we indulge in the obviously fictitious and become emotional at what we know to be unreal because it is art and therefore artificial? If we leave off those different epochs, cultures, and languages that have differing poetic forms, for example, and traditions, we can see that there is a universal tendency in our species that extends back as far as we can examine. That universal tendency is artistic expression and consumption. At times, this was interpreted as the gods or muses communing with the artist and, thereby, with us. Later, it became, as with Homer, the self-realization of the artist as artist, of the poet as moral, cultural, and aesthetic arbiter. Turn to Vergil, and the Homeric thrust is laid bare in the first three words: Arme virumque *cano*. 'I sing.' Skipping a few millennia, even the surrealists and dadaists, eschewing 'sense, reference or meaning,' still had as their contrapoint sense, reference, and meaning. In all this, we produce art and consume it because we seek something through the activity. It may be the resolution of a moral question, the exploration of faith versus doubt in scripture, for legal equality between the sexes in feminist poetry, the struggle for human recognition and dignity in slave narratives. Comparative analysis into popculture might say that we venerate 'the canon' and its 'dead white men,' but the point I make here is that all this art, all this consumption of it in whatever form, has its roots in a shared evolutionary adaptation (or exaptation) which is why it is universal. Due to this, an aesthetic theory that ignores the evolutionary factors while

[10] It is this same sequence that we see in the postmodern stance that 'everything is a text deferring/referring to another text', put forth most famously by Jacques Derrida. The premise is that to interpret something is to create a new, wholly separate 'text' which itself becomes a new text upon further examination. Therefore, nothing has any 'fixed' meaning in any real or discernible sense. It might sound strange, but this view still has traction in many humanities departments.

focusing solely on the historical/cultural/linguistic factors misses a broader, more comprehensive picture. In fact, I believe that the arts are exaptations of social skills that evolved with human's increasing neocortex size, and we can perhaps see some of these as emergent characteristics building on these evolutionary permutations. It is true that humans seem to consume aesthetic objects (generally), and these need not always be 'high art,' but they are consumed nonetheless. We can laugh at Aristophanes, Dostoevsky, Chaplin, a puppet show, the Coen Brothers movies, or the latest rom-com, but in doing so, we engage in a type of aesthetic valuation.

Combining the three 'causes' of art, I named earlier for a moment may render this notion in a better light. Humans are caught in the bind of having self-awareness and free will[11] while being highly socialized animals who evolved to be so. Hence the need for a moral sense of the self within the moral framework on the community. Non-human animals need not be moral in the same sense as humans. I cannot fine the raccoon that upends the garbage can at night and spreads trash through the yard. I cannot call the police on a deer that bumbles out in front of my car. I cannot prosecute a grizzly bear for mauling a hapless hiker. This is because humans have a different sense of morality than what other animals possess. Some animals absolutely do demonstrate advanced forms of conflict resolution and remediation. This is clear in our chimp and bonobo cousins. So if we find the roots of things like ToM, SOI, proto-morality, and the like, we should expect that these would be far more elaborate and have more permutations in ourselves. Art, taken broadly, combines the spatiotemporal (narrative, relation to past/present, relation to environment/group history), exaggeration (symbolic representation, metaphysical categories, abstraction, token/type distinctions), and the n-order intentionality, which, as will be shown in Michael Tomasello's work, to be foundational to our moral reasoning as well as, I hope to have shown our aesthetic reasoning.

The Moral of the Story Is That Stories Are Moral: Seeing, Reading, Acting

Our aesthetic engagement is invariably reflexive, iterative, and proleptic/analeptic.[12] The piece of art conveys the artists' sense or meaning, the characters' sense or meaning, the book's sense or meaning, the culture's sense or meaning, the language's sense or meaning. One could not hope to write, with deference to Thomas Nagel, a book from a bat's perspective because the bat is a framing device used to convey human desires, motivations, and fears. It is a fact that bats communicate, but even if we had some computer that could translate ultrasonic mammalian squeaks into a human language, how much of our own

[11] Save the debates on free will, please. I will go with William James when he says, "My first act of free will shall be to believe in free will" [4].

[12] Prolepsis and analepsis come from narratology, meaning (respectively) flash-forward and flashback as temporal narrational framing devices.

human intentions would we then pile onto ‘Pfledermaus-ese’[13] to be able to make sense of it? As noted, humans impose intentions on objects and things that do not have intention. To have intention is to have both agency and an intended outcome. To have these is to have the workings of a system by which others may judge the outcomes of the intended action. Here we see the inception of moral judgment. As Roger Scruton notes: “Persons are moral beings, conscious of right and wrong, who judge their fellows and who judged in their turn. They are also individuals, and an account of the moral life must begin from the apparent tension that exists between our nature as free individuals and our membership of the communities on which our fulfillment depends” [5].

When we mentally translate a work of art into its constituent ‘meanings,’ we engage in a type of storytelling. We read into the work of art levels of intentionality (via the person who made it, via the characters’ behavior), exaggeration (via the themes, symbols, etc.), and the spatiotemporal staging of the piece (and its relation to our own spatiotemporal existence). We come to a kind of major or minor moral judgment thereby. We could decide that the artwork is ‘timeless’ or ‘trash,’ that it makes no sense or speaks across time, culture, and language.

Humans are mimetic to an uncanny degree. The next time you find yourself at a social gathering with friends, note the position of your hands and arms. Hold that position for a while, and soon you will see others around you (if they like you) adopting the same pose. We yawn when we see others yawn (as well as when we see primates yawn). Fidget with your phone on a crowded bus and note that those in your vicinity will start grabbing for theirs. We evolved to be hypersensitive to our environment but also our social, human environment as well. We must be wary of danger, of strangers and outsiders, too, of the errant hungry tiger waiting in the canebrake just beyond the clearing by the watering hole. Why is it that children show such fascination with animals, or that the things we most commonly see in clouds and natural formations are faces and animals? How is it that preverbal children also are attuned to moral action and transitivity when they cannot yet form the words good or bad, let alone the metaphysical ramifications of Good and Bad? It should again be clear that these mental capacities, which are foundational to the arts and moral reasoning, are present in these children not because they have learned them culturally but because they have been hardwired into the neural substrate by evolutionary forces. Therefore, these clearly would have conferred on our species survival advantages based on group cohesion, individual/community balance, and proto-moral reasoning.

Stepping back for a moment, John Searle’s chapter, ‘How the Mind Works: Intentionality’ [6], discusses the nature of intentionality and the ways that the mind works in concert with the social, linguistic, and physical environments. He discusses what he calls ‘world-to-mind’ and ‘mind-to-world’ directions of fit and how these relate to intentionality. He says, “Beliefs, perceptions and memories have the mind-to-world direction of fit, because their aim is to represent how things are; desires and intentions have the world-to-mind direction of fit because their aim is to

[13] Thank you, German, for the word ‘Pfledermaus’.

represent not how things are but how we would like them to be or how we plan to make them be." Searle notes that intentions do not even have to be necessarily conscious. Thirst, as he states, is an unconscious intention of the body to remain hydrated, and the same goes with hunger. These intentional states can also be understood as world-to-word/word-to-world fits which nest within the 'mind' designation. Since we have individual motivations which are tempered by the constraints or possibilities outlined by our environments (social, natural, linguistic, etc.), we can project our intentions on the world via words just as easily as we can with our minds. As I have noted, this is the shape that aesthetic valuation takes. Conscious, intentional evaluation (world-to-mind) of artwork frames the piece within the balance of the personal/individual and the social/cultural. Without the interweaving of n-order intentionality, exaggeration, and spatiotemporal processing, we, again, have no artistic practice nor criteria with which to evaluate them.

There are moral judgments then, major or minor, when evaluating aesthetic works. In a way, because we are (more or less) programmed to be attuned to moral/immoral action, we simply cannot help but be morally evaluative. This should be clear from the three criteria I put forth as foundational to our aesthetic senses. A moral question cannot be posed about something that has no bearing on human lives. If I hold out a large diamond ring and give it to you, there is no moral judgment to be made about the thing itself. However, you might consider why I am giving it to you. Are we getting married? Am I bribing you? Am I just the kind of person who hands out diamond rings? And further moral evaluation may result: where did this diamond come from? Were human beings exploited in its procurement or manufacture, or transportation? All of these considerations require n-order intentionality, exaggeration, and spatiotemporal comprehension, just as stories and artwork require these three factors for us to produce and understand and judge them. While there is clearly a cultural component to this process (how could there not be), it has its roots in our shared evolutionary past. We see the beginnings of moral reasoning even in capuchin monkeys. As Sapolsky says: "other primates also show the beginnings of moral judgments … A human gives [the capuchin monkeys] a mildly interesting small object –a pebble. The human then extends her hand palm up, a capuchin begging gesture. If the monkey puts the pebble in her hand, there's a food reward. In other words, the animals learned how to buy food. Now there are two capuchins, side by side. Each gets a pebble. Each gives it the human. Each gets a grape. Very rewarding. Now change things. Both monkey pay their pebble. Monkey 1 gets a grape. But monkey 2 gets some cucumber, which blows compared with grapes –capuchins prefer grapes to cucumber 90% of the time. Monkey 2 was shortchanged. And monkey 2 would then typically fling the cucumber or bash around in frustration" [2].

Though Sapolsky lists several experiments showing moral evaluation in human infants, the primate research is more compelling because it demonstrates the very deep roots and connections that we share with our primate cousins with whom we share an evolutionary past. How could ethological parallels such as this exist in capuchins and humans without having its antecedents in a shared evolutionary history? Monkey 2 may not be consciously thinking, 'That's totally unfair to me,' but the monkey's reactions demonstrate it just as clearly. Fairness (or moral action) in this sense retains the three-part structure. The monkey comprehends that in the past, grapes were given out in exchange for pebbles. It has a sense of the exaggerated 'fairness' category. Also, it shows at least SOI faculty: 'I gave you the pebble intending that you would give me a grape.' A violation of these factors, albeit unconsciously in the monkey, are moral reasoning and valuation.

So, just as aesthetics pervade our thinking, too, does morality and moral judgment. As Tomasello says: "All of modern humans' cultural interactions were structured by collective intentionality, underlain by a sense of cultural common ground. The trsult was conventional cultural practices—everthing from making a spear to raising children—which, in theory, were effected in the same ideal way by any culturally competent individual … This new way of operating created the conditions for individuals to construct a fully agent-independent, objective and impartial view of the world, which resulted in, among many other things, an objectification of role ideals into the right and wrong ways of doing things" [7].

This objectification of role ideals finds its way into the stories we tell, the religions we look to for explanation, to the laws we make to govern, to the taboos we place on certain actions, to the ways we raise and educate our children, to the ways we treat the disposed and excluded, to the ways that we entertain ourselves be they 'great art' or a guilty-pleasure TV serial.

Let us take a piece of 'great art' as an example. Sophocles' immortal *Oedipus Tyranus* [8] is lauded as a masterpiece of world literature and speaks to us 2500 after its writing. Rather than summarizing an already familiar story, I want to point to the qualities of the work that best exemplify intentionality with a few words on exaggeration and spatiotemporal reckoning. Rather than cast Oedipus' plight as something thrust onto him by the feckless gods, Sophocles casts the blame squarely on Oedipus. The blame, so to speak, is not in our stars but in ourselves. The audience feels the deep and growing conflict inherent to the main character because his intentions were never to marry his mother and sire children by her but rather to uphold his duties as king and to uncover, despite the pain produced, his role in his own fate. Contrast this with Homer's books or with the Book of Job. In those stories, the fates of the characters are predicated on the whims of the deities involved, often with little regard to the subjects' worthiness of praise or blame. Odysseus fails to pay proper homage to Poseidon, who then punishes him with a ten-year return voyage to Ithaka. Job is punished for no other reason than a wager between deities. In both cases, the punishment does not quite fit the offense.

Oedipus, 'blind' as he is at first to his role in his own undoing, becomes an active and willing participant in the self-discovery that is also his own self-destruction. While we may feel pity for Odysseus when we first find him crying on the ocean shore, missing his wife and son and home, and while we may feel pity for Job at that moment he finally cries out 'why,' we also know that the stories are intended to represent the capriciousness of our fate and fortune in a capricious, dangerous world. Yet we know, as he does not, that Oedipus is guilty of two heinous acts, tabooed in nearly every culture and time. We know that the punishment must meet the violation, and it does. But it is tragic to echo Camus, only in the moment that

Oedipus becomes self-aware of it. It is not the gods' fault. It is his own. There is no inherent tragedy to Odysseus' story. He finally goes home, kills the suitors, spends time with Penelope, and is, because the gods will have their way, sent back on another quest in the last chapter of the book. Job suffers through great loss and indignity but is rewarded in the end because he returns to servile faith and never will question the motives of the gods again. Not so with poor Oedipus. His self-aimed intention to understand and unearth his participation in his fate is both his making and undoing. It makes him tragic and worthy of pity as his story unfolds in its spatiotemporal way. He becomes a symbol, an exaggeration, of the instinctual struggle of the self versus the moral sensibility of the citizen or member of the community. As translator Robert Fagles says, "the catastrophe of the tragic hero thus becomes the catastrophe of the fifth-century man; all his furious energy and intellectual daring drive him on to this terrible discovery of his fundamental ignorance –he is not the meaure of all things but the thing measured and found wanting" [9]. Again, we could not begin to find the irony, the tragedy, the pathos, the love, the loss, the justice, or anything of any human importance without that evolved ability to share and understand each other's intentions, which is why I list this as fundamental to artistic practice and evaluation.

Conclusion

To make this clear, I do not intend to say that science and art can fully reconcile or that one can fully encapsulate the other without losing something in translation. Both endeavors could be called 'beautiful' in their own right. What is lost in translation from one to the other, to paraphrase Robert Frost, is the very essence of each discipline as it is carried over to another theoretical frame of reference. Mathematicians often describe an equation as beautiful, perhaps because of its elegance or the odd ways that even abstract mathematics lines up with the physical world. Take the strange case of the Fibonacci Sequence and logarithmic spirals in nature.

The Fibonacci Sequence was posited by Italian mathematician Leonardo Bonacci, known as Fibonacci. The sequence is as follows: 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 610, 987, etc., in which we add the first two numbers to get the third: 1 + 1 = 2 … 21 + 34 = 55 … 233 + 610 = 987. But, if one takes the ratios of successive numbers, we see something odd, almost mystical, begin to take place: 1/1 = 1. 2/1 = 2. 3/2 = 1.5 … 55/34 = 1.617647 … 987/610 = 1.618033. The further one goes through the sequence and calculates the ratio of successive numbers, the closer and closer the number begins to resemble φ. φ is mathematical shorthand for the golden ratio, given the Greek letter in deference to the Greek sculptor and architect Phidias who (apocryphally) used the golden ratio in designing the Parthenon, among other works. φ is equal to 1.61803398875… an irrational number. I will return to this. The golden ratio is about proportions relative to one another such that each seems 'harmonious' when taken as a whole. It shows up in art, geometry, architecture, music. When charted out as a quadratic equation, it looks like this: $x^2 - x - 1 = 0$. If we graph the golden ratio and logarithmic spirals onto one another [10], the connection becomes clearer. The rectangle, subdivided into perfectly proportional smaller rectangles within itself, maps out perfectly the logarithmic spiral as it winds in on itself. Yet, that spiral shape should seem perfectly familiar. As Mario Livio says: "examine again the series of nested Golden Rectangles obtained when you snip off squares from a Golden Rectangle … If you connect the successive points where these 'whirling squares' divide the sides in Golden Ratios, you obtain a logarithmic spiral that coils inward toward the pole (the point given by the intersection of the diagonals … which was called fancifully 'the eye of God'" [11].

That we can derive a logarithmic spiral from an ostensibly unrelated formula about proportionality in art and geometry is interesting. Yet, it is more interesting that this spiral shows up in nautilus shells, flower petal growth, pineapple skins, and galaxy formation, among many other examples. So, Fibonacci's original sequence, when seen in ratio, yields an irrational number that very closely approximates another irrational number taken from Euclidean geometry that had been applied in ancient Greek architecture. My point here is to demonstrate that overlaps can happen in unlikely places, even in unrelated mathematical instances.[14]

How could it be that there is an overlap between n-order intentionality, morality, and the arts? Here, the evidence is far more linear and far more clear. We evolved from earlier hominin species. We share common ancestors with our great ape cousins. We see analogues in behavior between them and us. Ours is a far more advanced, though not wholly separate, set of behaviors. Instead of simple SOI conflict resolution, humans can extend this out into n-order intentional generalities. If two chimps are made to reconcile by a hierarchically dominant female, we see this as a kind of socially stabilizing act. Humans can abstract this outward in time through the establishment of laws, through religious mores, through cultural taboos, through literary and artistic exemplars. We use our spatiotemporal cognition to say that events in the future should not mirror the past because people should not do X (being a crime or injustice in which the intent of person Y is to cause some harm to person Z) as it is not Just (exaggeration) to do so. And humans take this all a step further in codifying these practices into artistic representation of great or minor import. It can be the basis of entertainment, of serious sermonizing, of meta-referential criticism, of a limerick or cartoon, or a 1500-page Russian novel. The point here is that the relationship between n-order intentionality can be seen as undergirding many practices we engage in daily. We are aware of ourselves as individuals, deserving of dignity and fairness in the communities in which we find ourselves. That constant tension—that constant push-pull we encounter at work, in literature, in family, and in relationships—has its inception in our hominin ancestors also having to learn how to get along in a scary and unpredictable world.

[14] Livio's book, cited here, provides a far clearer and comprehensive account of the history of the Golden Ratio and its applications through the ages. I am probably quite convoluted in my explanation above as I am not a mathematician.

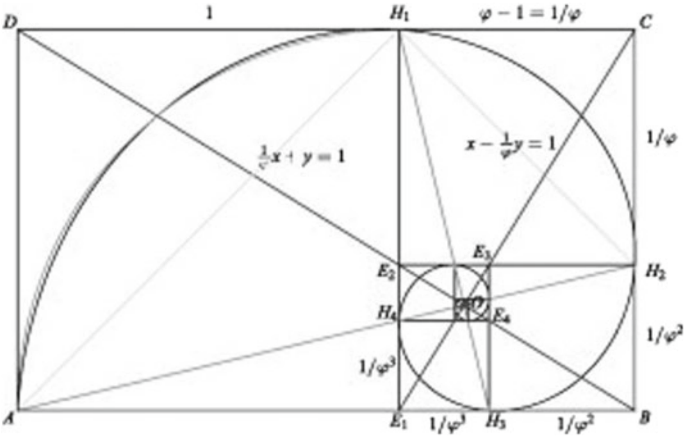

Fig. 15.1 The golden rectangle and logarithmic spiral (Available under Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0); [10])

In some ways, we have come far as a species, but when seen in this way, we may humbly admit that we could do with a little more fine-tuning if we were so able. If we can figure out the relationship between seed arrangement on a sunflower and the spiraling arms of a galaxy, or the proportional arrangement of a rectangle to a thought experiment equation about rabbits, then it stands to reason that we can figure out how to treat each other a little better (Fig. 15.1).

Core Messages

- Universals in human culture point to shared traits that evolved in our species' development.
- These universals may take any number of cultural variations.
- Second-order intentionality and Theory of Mind are neural processes that allow for aesthetic practice and evaluation.
- Cognitively, the arts would be impossible without N-order intentionality, exaggeration, and spatiotemporal comprehension.
- Artistic practice has clear evolutionary origins despite difficulties in determining its chain of preceding distal causes.

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A Philosophical Perspective on the Bioengineering of Art: Ethical Shifts in Mimesis

16

Amine Harbi

"Is it true, prince, that you once declared that 'beauty would save the world'?"

Dostoevsky in The Idiot [1]

Summary

Advances of bioengineering might be an opportunity to reconnect humans with nature as a manifestation of beauty, and thus, to reconnect thinking with the intellect, beyond materialist reason and psychological subjectivity. Beauty in art has become a controversial topic for our modern and postmodern art philosophies are based on individual subjectivities. However, beauty's contemplation is a key for artists to renew their role as translators of beauty. Mimesis is today both an aesthetic and ethical issue. Indeed, the destruction of nature can be fought through the renewal of contact with nature's beauty as a vital spiritual element of life, not an aesthetic commodity.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_16

The daughter of the Sultan (204/75 cm) *(Oil Painting on Canvas; Made by Amine Harbi).*

Keywords

Art · Beauty · Bioengineering · Mimesis · Thinking

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

In this chapter, we will discuss thinking in its relation to the bioengineering of art while reflecting on the art of bioengineering. We will specifically delve into the ethical shifts of mimesis as first discussed by Plato in his *republic* [2] and commented by Plotinus in the *Ennead* [3] by analyzing how artists used to use the intellect as a means to translate the beauty of nature to their fellow humans and how they shifted into mimicking nature through subjectivities. Furthermore, we will tackle mimesis through the concepts of contemplation, action, and reaction in the philosophy of art.

Thinking is the domain of both reason and intellect [4]. The two are different on many levels, but we will focus here on the operational level. Whereas reason operates on the level of deduction and induction, the intellect operates on the level of intuition [4]. Reason is limited to the senses, while the intellect transcends the senses. We live today in a world heavily influenced by postmodern thinking, which is itself the offspring of "reason" that dominates the modern world. Whereas the modern world witnessed a zeitgeist of favoring reason over the intellect, the postmodern world is a world in which reason is often replaced by subjectivities.

However, the current general withdrawal from the intellect does not mean that the intellect seized to exist or lost its importance. On the contrary, the intellect is the strata of thinking that is most useful in reinvigorating thinking in times where artificial intelligence (AI) outruns and even shapes human intelligence and thinking. Moreover, postmodern thinking, in many instances, begets so many contradictions that it ends up betraying the very promise of its modern foundation: reason. Like the monster created by the materialist scientist Frankenstein, the unreasonable is, in many instances, the ironic outcome of reason that freed itself from the intellect.

The Art of Bioengineering and the Bioengineering of Art

First of all, an important distinction should be made between the art of bioengineering and the bioengineering of art. In the art of bioengineering, the word "art" is used in the pre-European renaissance sense. Art, in the traditional sense, is simply a craft. A physician used to be someone who mastered the art of medicine, just as a painter used to be someone who excelled and lived through the art of painting. Hence the art of bioengineering is the art of engineering within the domain of biology or in accordance with models observed in the biosphere combining advances in both engineering and biology. Here, thinking, whether relying on its supra-rational capacity (the intellect), reason, or on its irrational capacity (or what replaces reason), namely subjectivities, makes a difference. In the first instance, humans engage with nature, learn from it and partake in its beauty, the intellect being the key element in the amazement that makes the human observer and actor within the biosphere a student of nature by the very fact of being a lover of wisdom. One must recall here what Aristotle says in his *Metaphysics* about knowledge and how one becomes a philosopher; that to be amazed and puzzled is to recognize one's ignorance which is the way leading to wisdom. In the second and third instances, reason and its sub-products, namely emotions and subjectivities that often act with the "authority" of reason, might easily lead to a situation where humans position themselves as masters of nature instead of being its students, using nature wherever the wind of whims may blow, and we are already living the devastating results of these paradigms in nature. Philosophy, historically, went from the discipline of reason aiming to reach:

- to the intellect, through which the lover of wisdom attained wisdom;
- to a discipline of reason, through which reason itself became the main goal as a form of morality, not wisdom; and
- in the last phase, which is the current state of affairs, to the discipline of subjectivity through which the lover of subjectivity justifies the morality of its existence.

Whim, taste, opinion, and customs become what makes something moral, reasonable, and beautiful. Taking into account these paradigms is crucial in determining where we are heading with the art of bioengineering. If the craftsman is using his reason within the framework of the intellect and using his art to learn from nature its beauty, rediscovering the infinite, then the craftsman can save himself and nature at this crucial point of human history as the destruction of nature is rampant. But if the craftsman will follow his whims of using nature to satisfy his illusory and never-ending consumptive needs (as most of these needs are created superficially by fashion and trends), destruction seems inevitable both for nature and for its self-appointed master. Of note here that humankind can only claim to be a master of nature by mastering his own nature, and this can only be achieved through the intellect, and that is why overcoming the reductionisms of the senses is a discipline that is shared by all traditions and pearls of wisdom across world civilizations [5].

With regard to the bioengineering of art, like many emerging fields, bioengineering as a branch of science is increasingly influencing art. Art here is used in its post-European renaissance sense, namely as the discipline that addresses aesthetics with regard to the senses and the psyche. We will specifically focus here on how advances in bioengineering can renew the encounter with nature in art, given that the beauty of nature can renew artists' interest in beauty as a universal and non-subjective value.

Although art after the European renaissance deviated from its function as a traditional medium between the sacred and the profane, it continued despite its shaky reliance on subjective and humanist aesthetics to use the intellect as its main faculty, and that is what enabled art to play a crucial role as a counterforce to the discipline of modern philosophy where reason dominated in the absence and/or denial of wisdom or, at the least, in the absence of the love and aspiration for wisdom from the renaissance and the enlightenment onwards. In other words, renaissance and post-renaissance artists replaced the ancient philosopher in using the intellect to love wisdom and attain truth, but in the case of the artist, to attain beauty, which is yet another name of truth [6]. This continued as long as subjectivity was not taken as the reality by artists or as long as artists were aware that beauty is an objective reality for which the artist and his subjectivity are wandering students, lovers, and aspirers. At some point, however, with the profane replacing the sacred, the symbol, the tool, the statue became an idol, and subjectivity was taken as the primary criterion of beauty as truth itself was no longer sought and was thought to be relative and man-made. It is at that precise point of events that artists lose their role as a counterforce to a dominating reason that neglects and even ignores the intellect.

Let us briefly present some examples of what we mean by the artist as a counterforce of the intellect to the reason of modern philosophers. One example is the renaissance painter Botticelli who might be regarded as the champion of beauty to manifest wisdom. His work can be seen as a counterforce to the renaissance philosophy of reason championed by Machiavelli. In the same avenue, Rembrandt's flamboyant celebration of beauty was to a great extent the counterforce to the *cogito ergo sum* and Descartes' philosophy based on rationalism. Botticelli and Rembrandt, although very different in form and outcome, yet sharing the same principle of thinking through the intellect, used subjectivity as a starting point to the center and not as a goal or a center in itself (we will go back to these two painters with further detail on how the work of Botticelli, for instance, played a major role in translating transcendent beauty in the next section). A third illustrious example is Dostoevsky's novels, where the intellect often erects beauty as the *savior* against an evolutionary scientist's reason that is, in its finality, destructive [7]. His novels were a counterforce to his contemporary Marx, whose philosophy was based on reason in its most reductionist form: scientific materialism. One can object that despite Dostoevsky's *devils*, communism thrived in Russia. Indeed, Marx and his scientific reason won the first round. But we must keep in mind that the dialectics of art and reason ought to be taken within a long-term perspective, and the influence of Dostoevsky's work within a remerging orthodox Russia after decades of totalitarian communism must not be underestimated.

The Artist as the Champollion of Beauty

> But if anyone despises the arts because they produce their works by imitating nature, we must tell him, first, that natural things are imitations too. Then he must know that the arts do not simply imitate what they see, but they run back up to the forming principles from which nature derives; then also that they do a great deal by themselves, and, since they possess beauty, they make up what is defective in things. For Pheidias too did not make his Zeus from any model perceived by the senses, but understood what Zeus would look like if he wanted to make himself visible.
>
> Plotinus

The intellect used to be the *rosetta* stone of beauty that helped the Champollion, the artist, decipher beauty and translate it to the language of his fellow humans. Beauty is universal, and there is nothing remotely subjective about it. If the artist has done his translation work well and did not betray the initial form, for there is no *traduttore, traditore* in this domain; the beauty of his work will unify subjectivities, and his art will be regarded as beautiful across time and space, despite differences of customs, culture, and tastes. That is why one can disagree with Dante's views or Rumi's doctrines, but their respective monuments, the Divine Comedy and the Mathnawi, cannot be seen other than beautiful. The same could be said for the Taj Mahal or Isfahan's Shah Mosque or any work of art that is vertical [8], for the subjective opinion that does not recognize the beauty in them simply did not purify the heart to receive their beauty.

Since the European renaissance, art gradually shifted from the translation of divine forms of beauty to the expression of aesthetics through naturalistic beauty and then introspective subjective experiences of beauty [9]. However, renaissance artists, and to some degree, modern artists, though changing from mere artisans to a new intellectual class of society and gaining more importance in terms of influence, kept it in the heart of their work the initial craftsman duty: namely translating divine forms of beauty to fellow human beings. With the removal of the sacred and the mystical from life and the replacement of the metaphysical by the materialist and the cult of reason, this central function of art was gradually neglected. For instance, Notre Dame de Paris, a central masterpiece of medieval gothic art, was transformed to be "the temple of reason" by French revolutionaries and profaned by the festival of reason in 1793 where a Goddess of Liberty replaced the Virgin Mary and Antoine-François Momoro's wife who "dressed provocatively"(in a kind of an avant-garde postmodern art performance) played the role of the goddess of reason) [10]. The Cathedral was eventually restored to its sacred function by Napoleon in 1801 [11]. However, the original meaning that Notre Dame conveyed to the viewer and the sacred beauty became gradually unintelligible, and only its aesthetic dimension is still largely appreciated.

Thus, through neglecting the intellect, a general tendency of forgetfulness crept into art, to the point where some artists forgot the purpose of their craftsmanship altogether; that art is an action manifesting contemplation, a translation of an objective, universal beauty, and that is why Marcel Duchamp's nonsense makes sense. The latter is a turning point in the history of art for all contemporary and conceptual artists are, in a sense, his progeny (Fountain was selected as the most influential artwork of the twentieth century) [12]. Everything about subjectivity is there, from identity questions through his Rrose Sélavy to his five-way portrait, which is a striking prophecy of selfie and self-worship that the internet will bring forth (photography being a nontraditional medium unlike painting that allowed Rembrandt to transcend the self while painting the reflection of the self). Duchamp's art came to remind artists how art and art adoration became absurd as people no longer admired *Mona Lisa* because it translated the trace of divine beauty and mathematical perfection to them but because it became a cultural icon, a curiosity. If the average viewer stood in awe before it, it was neither due to the Christian beatitude nor to the beatitude tied to the esoteric cult of Isis or the Pythagorean doctrine. The symbol, the means that translate divine beauty, becomes an idol and needs to be destroyed. Thus, a copy of Mona Lisa was either bought or made by

Duchamp and then vandalized by his own hands by adding mustaches, goatee, and a ribald pun. If Duchamp sells signed readymade urinals relabeled "fountain," it is, perhaps, to point to the idolatry of art in the sense that it no longer translated objective and universal beauty. Seeing that his message was not taken seriously in that it was taken seriously, Duchamp left the art scene for chess, a traditional Indian art, finding in it the beauty that 20thcentury art no longer reflected. He will only come back to art for once with *Étant donnés* as a last drink before death. In a sense, Duchamp's work is Andersen's tale of The Emperor's New Clothes. The awe before the clothes continued and still continues despite the fact that the kid in the story already observed the naked truth, for in 2016, a teenager put a pair of glasses on a museum's floor to mock the grotesque parade of art, and yet people kept admiring the depth of the artistic performance [13]. While the author of the joke persisted that it was a joke, people thought of him as an artist just like Marcel Duchamp's joke was taken seriously and became the cult of the mind [14], or the cult of subjectivity, replacing the revolutionary cult of reason.

Western art flourished after the renaissance from naturalistic masterpieces to baroque, neoclassic, romantic, impressionist, cubist, abstract, and finally, contemporary art. It is fair to say that Duchamp's message was about a loss of meaning in art as aesthetics, hence his disinterest in Matisse's "retinal" art [14]. What makes renaissance masterpieces beautiful is not their aesthetics but their continuing, despite their naturalistic tendency, to translate divine beauty through symbols aesthetically presented to the viewer. However, one of the most eloquent translators of beauty during the renaissance did not really progress to naturalistic art from medieval traditionalist art. Indeed, Botticelli, in a sense, did not move and progress but rather stood in eternal awe before a visual Beatrice, his model Simonetta Vespucci. In a later stage of his career, contrary to the general progressive tendency of the renaissance, he even regressed (if one may venture to say) to the gothic. Whether Simonetta served as a direct model or not for Botticelli is a second matter [15], for clearly, it is the mythical dimension of her beauty as a manifestation of the truth that is central in the artist's work. Simonetta's beauty served as a symbol of divine beauty, the beauty that is universal and objective, recognized by all, and that lies not in the eye of the beholder but in the heart of the lover. Thus, the young woman though married to a notable man from the Vespucci family, was painted by the artist as Pallas Athena with the motto *La sans pareille* [15] for the jousting Giuliano di Medici, who won the tournament under the banner of the Greek goddess, the beautiful patroness of the city of Florence. At her death, her open coffin was carried throughout the city for the Florentines to bid farewell to the human face that reflected the myth, the divine beauty that used to shine in the streets of their city. People adored Simonetta, like the Psyche of Apuleius, who was adored in her city to the point of rivaling Venus herself in beauty [16].

Two main currents influenced the Italian renaissance, a Promethean and progressive humanism and an epimethean return to antiquity. The depiction of Simonetta, though changing from a painting to another in Botticelli's work, and sometimes in the same painting (sisterly resemblance can be found in one of Botticelli's inspirations: the poet Politian) [17], can be traced as a form that changes reflecting an essence that does not change, but rather change the beholder who rediscovers, through the eye, the dormant beauty in his heart. The same face and beauty are manifested in mythological, religious, and poetic figures such as Athena, Venus, the Virgin Mary, and Beatrice. Curiously, the same Simonetta was also used by Botticelli to represent the vice of perfidy with a stern facial expression while representing with a slight variation truth in the same painting (The Calumny of Apelles). Likewise, we find the same face as Flora, with a suggestive smile (as opposed to the innocent smile of Venus) and one of the three graces in the same painting of the *primavera*. This indicates that the human beauty, the naturalistic, is just the instrument toward the real beauty, the objective beauty, for the same instrument can be used to depict the vice of perfidy as well as truth, the celestial Venus and the earthly Venus (Flora) that Plato discusses in the *Symposium*.

The epimethean return to antiquity in Botticelli's work is not a return to the past, but rather a return to the eternal, for the myth, is not what happened in the past, but an event that transcends time as it deals with the sacred and the divine. It might be related to a historical event such as the birth of Jesus (despite the debate among historians about Jesus' historicity), for instance, but its main reality transcends human reality to a reality beyond the contingent, material, psychological, and historical. In his Madonna paintings, Botticelli makes this clear to the beholder through the eyes of the Madonna. The courtly love that Botticelli most probably had for Simonetta was the means to attain the divine love expressed in the Virgin Mary's face as well as the angels who are in a state of ecstatic contemplation of the divine presence (i.e., the Virgin and Child with Saint John and an Angel, Madonna with Lillies and Eight Angels, Madonna of the Magnificat, and Madonna of the Pomegranate; see Fig. 16.1).

Fig. 16.1 Madonna of the Pomegranate (Painting by Sandro Botticelli; Adapted from Wikimedia Commons, the free media repository https://upload.wikimedia.org/wikipedia/commons/0/04/Madonna_della_Melagrana_%28Botticelli%29.png)

The return to the eternal beauty manifested in the beloved Simonetta, which is a renaissance for the artist himself, does not quite reflect the renaissance tendency of returning to classical antiquity for humanist reasons, for it is still, to a great extent, a work rooted in the middle age's tradition. The golden crowns, halos, hair, and shining light that constitutes Botticelli's landmark are a clear affiliation of the artist to the medieval Christian art, and through it, to the Byzantine artistic tradition (Botticelli was himself a goldsmith). Indeed, Botticelli did not really fit the linear and evolutionary progress of art [18] and was much forgotten for centuries before interest was renewed in him in the nineteenth century by art historians such as Aby Warburg.

Furthermore, Botticelli's faithfulness to Simonetta is rooted in the same tradition of Dante's esoteric love for Beatrice. In the drawings made by Botticelli to illustrate the Divine Comedy, Simonetta is, in fact, Beatrice. Most of the drawings are in early stages but provide great insight into Botticelli's admiration for Dante and how the early renaissance master, though using a different art medium, was the disciple of the *Sommo Poeta*. Indeed, like medieval miniaturists used to devote their art to illustrate divine and sacred texts, Botticelli undertook the illustration of the *divina comedia*. However, Vasari criticized Botticelli for his interest in book illustration [18]. For the art historian, a great painter should not preoccupy himself with such trifles. He also criticized Botticelli for being overly religious to the point of wasting his talent, and this led him to rank Botticelli within the second category of great renaissance artists, far behind his contemporary Leonardo da Vinci and the later Michelangelo di Buonarroti. However, although today considered a renaissance icon, Botticelli resisted the renaissance zeitgeist and its Promethean penchant. He continued within the spirit of the medieval tradition, following a hierarchy of values without compromising his talent or his creative possibilities in the least. His artistic model Dante is considered to be the acme of medieval poetry and yet is also an innovative poet on all levels: linguistic, stylistic, and even theological. For the theological level, for instance, Éliphas Lévi saw Dante as a Martin Luther before his time, a rebel, an enemy of the church [19]. So, artists like Dante or Botticelli escape modern categories of progressive and conservative artists. If one may venture to use an analogy, Dante is the Vergil who takes Botticelli on a journey filled with anguish and sufferings, from political uncertainty under the Medici clan to the fanatical millenarianism of Savonarola. A journey crowned by the return of the diseased Simonetta through his paintings, just as Beatrice would return to Dante through his sacred poem. In the same vein, in Arabic poetry, Leila of Majnun passed to the Sufi poets, not as a muse, but as the manifestation of truth, her beauty is not the subjective beauty that an individual sees in another individual but the presence of objective beauty and the majesty of truth. Debate among Islamic scholars whether Majnun was a heretic or not is rooted in a literal reading of his poetry that has been only fully grasped by the Sufis who saw in him a precursor of Sufism, for Majnun, in a sense, cannot be religious if he is not worshiping divine beauty, and divine beauty has manifested itself to him in Leila. Simonetta that we can study in

Botticelli's paintings is a key to understating how a finite form is a means to the infinite. His art can serve as an intermediary to medieval and sacred art that we can no longer grasp directly and for which we need a reflection of reflection.

Mimesis of Nature and Mimesis of the Contemplation of Nature

Art is, by definition, a spiritual endeavor because it is the manifestation of inspiration. As Coomaraswamy reminds us, etymologically speaking, inspiration is to have the spirit within [20]. From the dawn of civilization in ancient Mesopotamia to the medieval world, artists contemplated nature not only through the psyche but through the spirit. This continued to a certain extent during the renaissance and after it, but the psychological gradually overcame the spiritual to the point where art became literally devoid of inspiration, inasmuch as no traces of the spirit is there to be found, for inspiration became a romantic and psychological phenomenon. Of course, there is plenty of spiritualism in contemporary art but no spirituality, for the devil lay in the details left by the angels that used to inhabit each detail of a traditional work of art. Serious scrutiny, let us say, of contemporary Islamic calligraphy-based graffiti that does not follow the strict spiritual and traditional rules of the art of calligraphy reveals that the contemporary form, though it might be pleasing at first sight, does little to convey the striking awe that is communicated by traditional calligraphy, no matter how skillful, technically speaking, the artist is. In that regard, it is not about being a conservative, for there is no such a thing as conservatism per se in art, and artists know this very well for every art-making is a renewal. Indeed, artists have been able, within the strict rules of each artistic tradition, to display a dazzling level of diversity for the spirit that is the heart of any artistic work is the key to the infinite. On the contrary, it is our contemporary understanding of art that is built upon a conservatism of a proud ignorance of inspiration. The very paradigm of contemporary art is limited in its scope in the finite; it does not bother to contemplate the infinite, for however shapes and colors may change, the purpose is the same: make people think, participate, through irony, provocation, performance; displaying subjectivity as the main thing and that is why the glasses joke of the kid from our contemporary tale of *The Emperor's New Clothes* was largely perceived as an art performance. Our art is global but not universal, in the sense that what is universal is a work of the intellect contemplating the spirit. In our contemporary art, there is no transcendental journey from the psyche to the spirit or a patient return from one's subjectivity to an objective beauty; subjectivity is self-sufficient for artists are artists after all.

One of the major tenets of today's art is indeed breaking taboos. But what is really taboo is to confront the enormous heritage of art left by human civilizations across the globe; it is their infinite diversity and yet sharing a common transcendental beauty based on a contemplation of the infinite. When we go to the museums to see them, we should wonder how these objects, however inanimate they may be, see us, for we have lost contact with nature by losing our contact with the spirit; we lost inspiration.

There is a difference between the mimesis of nature as it is perceived through the senses and the mimesis of nature as perceived through the senses and contemplated through the intellect. Contemplation is the spiritual state that leads to action, which is a spiritual duty, a ritual. However, the relationship between the two is not linear but rather circular, for sometimes, it is the ritual or action that leads to contemplation. It goes without saying that with contemplation, we do not mean a "new age" exercise of the psyche to fool itself to believe in a parody of spirituality and attain, within a couple of yoga classes, what a traditional yogi may never attain despite years of ascetic life and meditation [21]. Instead, contemplation is when the psyche is aware of the spirit, and the metaphysical is read throughout the physical or the senses, just as one reads through physical letters a text and is overwhelmed by the spirit of that text. In the artist's case, the action that follows contemplation is the conscious act of faithfully translating that spiritual state or beauty into a physical or a sensible object which is what we call a work of art. The nuance lies between what is solely psychological and what is psychological and more than that. The first provides art for the eye, the aesthetic or retinal art from which Duchamp departed to create art that is sensible and psychological, that does not rely upon aesthetics, and that addresses the mind instead (but not the intellect). The second regards the senses and the mind as tools. The missing link is that spiritual state that makes the psychological go beyond the sensible, so both the eye and the mind are only windows to the soul that contemplates through the artist's action, or work of art, the trace of the spirit. The people who died for sacred icons, a work of art that represented the divine, during the iconoclastic period of the byzantine empire such as St Theodosia, were not only religious fanatics but saw in those icons the trace of the metaphysical for which death was worthwhile [22]. Similarly, we are sometimes eager to conclude that Van Gogh simply went mad because we lost contact with what is sacred in art and that Van Gogh perhaps captured through his contemplative relationship with both natures around him and within him.

This constant back and forth movement from contemplation to action and from action to contemplation is perhaps what is lacking in our contemporary art that is made "for the mind," as Duchamp puts it, and not for the spirit. It is an easy bet to predict that AI will soon be producing art installations, artwork, and art performances to make us think about social questions or to point to the irony of the relativity of mind that could be either biological or engineered. However, a difficult bet is to say that soon AI would bring forth a Divine Comedy or a Mathnawi. The metrical precision would be there, the *terzine* or the couplets, the rimes, the number of syllables in each meter would match mathematical perfection, but the spirit would be lacking. Art for the mind might be an interesting avenue, but it is not rooted in the contemplation and action process of traditional art (and to some extent, renaissance art), but rather rooted in reaction to most of its influences. By reaction, we mean an idea that does not flow from the process of contemplation and action but comes as a reaction to a previous action, a rather psychological than spiritual movement. This concept may need an extensive analysis of the different phases of the advent of contemporary art and how a chain of reactions is often a unique feature of modern and postmodern western art in contrast to medieval and world civilizations' traditional art. That said, we will briefly touch upon it in the following section by addressing key millstones in art movements.

Contemplation, Action, and Reaction

Our contemporary art, although very different from modern art, is still within the same concept of reaction. Whereas modern art constituted a reaction to aesthetics embedded in the external to express the internal, providing aesthetics of the internal impression itself, contemporary art is a reaction to aesthetics themselves challenging them and, in a sense, mocking their idols. This is a crucial ethical shift from the artist's role as translator of beauty and philosopher in the platonic sense that beauty is truth. Modern artists shifted from the spiritual to the sensible or the purely aesthetic; then, postmodern artists went from the aesthetic to the psychological. In this regard, what Gustave Courbet wrote in his Realist manifesto is of significance: "I no longer wanted to imitate the one than to copy the other; nor, furthermore, was it my intention to attain the trivial goal of "art for art's sake." No! I simply wanted to draw forth, from a complete acquaintance with tradition, the reasoned and independent consciousness of my own individuality" [23].

Considered to be "the father of the new painters" by the poet Guillaume Apollinaire in his book on cubism [24], Courbet represents a radical shift from what has remained of traditional sacred art in renaissance and post-renaissance painting. Of course, Courbet is a complex painter, and his art is more complex than the materialist and individualist lenses through which he is often regarded. Nonetheless, by rejecting the tradition of imitating "the one" or "copy the other," he sets an archetypal departure from the process of contemplation and action, which is a supra-materialist process that needs mimesis of the trace of the spirit, both through contemplation of beauty in nature (including human nature) and previous sacred artwork. It is to a great extent, through contemplating the art of antiquity, that renaissance artists found inspiration, or the trace of the spirit, that helped them create a religious artwork that conveyed both Christian abstract beatitude and Greek sensibility of perfection in natural forms. Although Courbet's realism was opposed to romanticism, it shared with it the same principle of reaction. Courbet's realism was, in a sense, a reaction to the romantics' new spirituality of emotions and celebration of spontaneity which was itself a reaction to the industrial age and the rationalism of the enlightenment. However, through its emphasis on the medieval and the oriental rather than the classical, romanticism revived, to some extent, the interest of artists in inspiration. Therefore, it is neither with the realists, the impressionists who stressed the sensible impression, or the following cubists who celebrated introspection that we find this interest in the sacred dimension of art renewed but in the romantics, who rediscovered it probably not through their own contemplation, but through contemplating the art of those who have contemplated. Thus, a scent of Hafiz can be smelled in the Diwan of Goethe, and some of the religious serenity that an ancient Greek might have felt before the temple of Juno (Fig. 16.2) is conveyed in the nostalgic melancholy of the painting of Friedrich (despite the fact that the latter never visited the temple in Sicily). It is worth mentioning here that Botticelli, with his strange, unrealistic style, may as well fit a certain aspect of romanticism, although he came much earlier. However, a major difference that makes Botticelli closer to sacred and traditional art is that he grew in an environment though radically changed from the medieval period, yet that kept some of its essential traditions alive, and his goldsmith craftsmanship helped him merge neo-platonic philosophy and Christian spirituality into his art. What is of interest here is that the romantic movement is a hybrid movement in the sense that it shared the common concept of reaction with other modern art movements while sharing an interest in inspiration, or the spiritual dimension of art, beyond the aesthetic and the physiological. One important implication of this is that if contemporary artists today would at some point react to the information and consumption age as the romantics reacted to the industrial age, they would be the romantics of the romantics, and through that, an interest in inspiration might be revived through the dazzling heritage of world civilizations art that is often the area

Fig. 16.2 The Temple of Juno in Agrigento (Painting by Caspar David Friedrich; adapted from Wikimedia Commons, the free media repository https://upload.wikimedia.org/wikipedia/commons/a/ac/Caspar_David_Friedrich_022.jpg)

of interest of art historians, anthropologists and other academics. This dormant giant is often seen by artists as an "aesthetic" source of inspiration, while it should be a source of reflection on the output of inspiration.

Conclusion

The myth (i.e., illusion) of progress still make art history appear as a succession of developments, and the ancient heritage that we have in museums may appear as a period in a linear development of art, while in fact, there is no linearity but a constant return to an objective beauty that defines the history of art and that is universal. This constant return is vital in the literal sense of the word. The ecological crisis that the world is witnessing is deeply connected to our consumptive life, and only through a deep revival of that objective beauty manifest in nature will artists make a significant impact against the ugliness of nature's destruction. Advances in bioengineering might be a source to reconnect with the beauty of nature and shift from subjectivities that are often the morality of a consumptive and destructive way of life. It is not through making a *terracotta army* made of plastic bottles and placing it within a beautiful piazza in Italy in defiance to the aesthetics of the renaissance that the ecological battle will be won. Rather it is by stressing the fact that terracotta art is both useful and beautiful and that drinking from clay or ceramic artwork is itself beautiful. The Minoan Greeks used to break millions of ceramics and make others that are as beautiful in a celebration of the renewal of beauty as the leaves on a tree [25]. Similarly, traditional cloths from any tradition on earth, with all the diversity taken into account, are beautiful for the same reason: it is a work of art that is the action following contemplation, clothing that is beautiful and respectful of nature is a huge step forward in the ecological crisis as we will go beyond addressing the mind and the eye, but all the senses will come back to lead the soul to the beauty of the spirit. The Hegelian remark about the death of art [26], despite some magnificent episodes that followed it, is still a bitter truth to learn from, but that needs perhaps a side note: art is dead, beauty is not. Therefore, a renaissance is always possible for beauty, which is wisdom, is alive, and waiting to be reunited with her lover.

Core Message

- Artists are the translators of beauty; they make the ineffable trace of the spirit present in a sensible object.
- If the consumerist and barbaric way of life is to be fought, contemplating previous civilizations' art is a must.
- Artists must reconnect with objective beauty as a manifestation of truth and a savior of nature.

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Thinking Through the Body: Art and Philosophy in Dialogue

17

Louise Mackenzie and María Antonia González Valerio

> "*Todo puede suceder, porque nadie sabe nada, porque la realidad rebasa siempre lo que sabemos de ella, porque ni las cosas ni nuestro saber acerca de ellas está acabado y concluso, y porque la verdad no es algo que esté ahí, sino al revés: nuestro sueño, nuestras esperanzas pueden crearla*".

Summary

This chapter results from a knowledge-producing experiment through the intertwining of art practice and philosophy via the exchange of letters in the time-lapse of two months during the 2020 pandemic. A body of artwork by Louise Mackenzie, consisting of laboratory explorations with living entities, installations, and artifacts, is interrogated with philosophical concepts by María Antonia González Valerio to provoke a different understanding of the category of life than that suggested within contemporary biological knowledge. The outcome is a reframing in which life appears in a broader context, where

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_17

contemporary art practice and philosophical questions are fundamental to the understanding that what is at stake is not only matter but also subjectivities and worldviews.

Evolution of the Subject (Photography by Jason Revell, Gallery North Project Space, *Northumbria University, UK, 2018)*

Keywords

Aesthetics · Art and science · Bioart · Biotechnology · Ontology

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

There is no consistent methodology for building communities of knowledge that work in the intertwining of disciplines. Most of the time, the approach has to be experimental and even casuistic. And that is precisely what has been done here, a one-time experiment. María Antonia González Valerio and Louise Mackenzie, philosopher and artist, respectively, engage in correspondence to think collectively about the intercrossing of art and science, or more exactly, about the appearance of life in current artistic practices merged with biotechnology and biological knowledge practices. The point of departure is Mackenzie's work as an artist inside the laboratory, generating living entities manipulated through technological interventions. Mackenzie narrates her experience and presents her artwork as the outcome of research undertaken at the Institute of Genetic Medicine, Newcastle, UK, where she learned how to translate cultural information—specifically, the question which sparked her doctoral research project—into physical material (deoxyribonucleic acid, DNA) and then inserted this within the living bodies of the bacteria, *E. coli*.

Through a series of letters, González Valerio's voice appears in the narrative as an interruption and provocation that brings forward philosophical concepts that pierce Mackenzie's work. This exercise shows how art practice triggers and influences philosophical meditations concerning the status of the category of life in the contemporary world. Through this correspondence, art becomes an interlocutor of biology, epistemology, ontology, and even our own existence as biological entities.

Newcastle, UK, May 19, 2020

Dear María Antonia,

I am grateful to you for your participation in this project.

As discussed, I am writing to you to initiate a dialogue on *thinking through the body* within my practice and within biological art practices more broadly. The idea is to use our exchange as a form of experiment in producing knowledge through interaction. We met initially three years ago at the conference, Taboo, Transgression and Transcendence in Art & Science. Since then, we have touched upon ideas of liveliness in biological material: I from within my perspective as a practicing artist with a background in psychology and you from your perspective as a philosopher of aesthetics with interest in biological art practices. More recently, since the political and social impacts of COVID-19, we have exchanged comments as part of an online academic group, Viral Culture,[1] and it was the seed of our conversation there that prompted me to contact you regarding this project. I had mentioned the phrase 'molecules with intent,' based on my experiences regarding the liveliness of biological material that I had worked with in the laboratory. You had pushed me to consider further what I meant by this.

The body of work that prompted this phrase arose through my doctoral research project,[2] *Evolution of the Subject: Synthetic Biology in Fine Art Practice* (Graphical Abstract), where I developed "a fine art practice that uses performative strategies to *think with* the act of using life as material." [1]. During this time, I was based between my studio and a laboratory at the Institute of Genetic Medicine (IGM), Newcastle University, where I learned how to genetically modify organisms. My idea was to learn how I might store a thought physically as biological information and ultimately within my own body—perhaps a willful attempt to circumvent my (at times, erratic) memory. I was interested in humanity's appropriation of DNA as a storage medium, initially inspired by Joe Davis' *Microvenus* and Eduardo Kac's *Genesis* and also intrigued by what I felt was our human arrogance at making use of life in this way—we understand DNA to be inert but what happens when this DNA enters the body of a living organism, does it become lively? Does it have the potential to act in the body (here I am considering philosopher and artist Manuel DeLanda's discussion of an object's capacity to act [2])?[3] I was also interested in more fundamental questions such as where does thought reside, or where do the origins of our actions reside? When I have a feeling or an intuition, it does not always feel to me that this resides in my head, for example.

The works that I started to make at this time fell into three broad categories (my thesis research website [3] indicates four, but the last two began to bleed into each other over the course of my work). The first I called *viral poetry*, where my encounters with DNA and the genetic code led me to consider how language and evolution are linked. The second I called *microbial sensing*, where I was making active attempts to engage with and relate to micro-organisms, at this point primarily through sound and vision. The third category, *curious animals,* is the body of work that is most relevant to our discussions. This explored my situated encounters in the laboratory, through which I stored a thought inside the body of a micro-organism. These actions led to a focus on my growing relationship to *laboratory life* itself - not in the Latourian sense, but in the sense that I was beginning to question the ontology of the vast array of micro-species and larger order organisms that exist solely for the purposes of laboratory research. Whilst making these works, I was

[1] Viral Culture—Bioart and Society is an online forum with over 175 members, formed by academic, Claire Nettleton at the outset of the 2020 pandemic, following the earlier Viral Culture symposium in 2018 held at Pomona College, California.

[2] It can be found here https://core.ac.uk/download/pdf/196579093.pdf.

[3] Whilst I am more interested in events than objects, if we are to consider (and indeed use) DNA as an object, then it is surely also useful to be mindful of the capacity of a given object to relate to other objects in complex ways.

reading texts that broadly sit within a vital or new materialist framework, including Marietta Radomska's thesis, *Uncontainable Life*, Jane Bennett's *Vibrant Matter*, Lyn Margulis' *Symbiotic Planet,* and several works by Donna Haraway (*Staying with the Trouble, When Species Meet* and *Situated Knowledges* were particularly relevant).

Returning to focus on my encounters in the laboratory, I think a good starting point for our discussion would be my first act, where I developed a synthetic DNA plasmid to hold my thought. This thought, translated from my head into speech, then phonemes, then codons, was designed to be held within a circle of synthetic DNA plasmid. I designed the plasmid with the assistance of Dr. Steve Laval from IGM and then learned how to transform this plasmid into the bodies of *E. coli* bacteria, which I grew within the Institute's cloning room—work which I ultimately documented in the video diary, *Lively Material* (Fig. 17.1).

The plasmid became, in effect, the first artwork that I made. It was both cultural and biological. I worked in the laboratory as an artist, constructing DNA just as a scientist might, but in my case, the content, the genetic makeup of this DNA, was (to the best of our knowledge) not found 'in nature.' Thus, what exactly was this object that I had made? I termed it, *BioAssemblage #1* (Fig. 17.2)*,* in an attempt to break down disciplinary boundaries in making with living material. There are already terms defined through art practice that describe aspects of biological material modified by humans, e.g., transgenic art [4] and the semi-living [5], as well as terms used within science that are culturally read as standard: 'genetic modification' and 'tissue culture' being obvious examples. I wanted to discuss the practice of piecing together lively material, whether genetic or otherwise and my aim was for this term to apply across disciplines. Thus, with *bioassemblage,* I made no

Fig. 17.1 Viral experiments (Photography by Dominic Smith, Lively Material, Queens Hall Arts Centre, Hexham, UK, 2018)

Fig. 17.2 BioAssemblage #1. Thought translated into DNA and assembled in a plasmid DNA vector, Eppendorf tube (Photography by Louise Mackenzie, 2016)

distinction between lively material assembled in science, art or any other subject of study. *Bioassemblages* are therefore simply "biotechnological constructs that include a human actor in their assemblage" [1].

So *Bioassemblage #1*, this tiny object, DNA in a vial, was a combination of my own thought, biological material, and technological material, and as such, I saw it through my readings of Haraway and Deleuze as a nature cultural machinic assemblage. *Bioassemblage #1* is inert DNA, and as far as I could ascertain, it has no biological meaning, yet culturally, it is encoded with a question that I intended for the organism (although I have no way of knowing how the organism would 'read' this) and when added to the body of an organism, it has a capacity to act. Both the *bioassemblage* and the resulting assembled organism have no capital value, only naturecultural value. They were brought into existence to test the boundaries of our biotechnological desires. Therefore, the idea of *Bioassemblage #1* is as much a concept as it is an artwork. My thought, held in coded form within a DNA plasmid, is a bioassemblage, in the same way that the *E. coli* which carry my thought within their bodies are bioassemblages, just as DuPont's '*OncoMouse*' (the trademarked genetically modified laboratory mouse) is a bioassemblage [6, 7]. The bioassemblage is defined through the intersection of humanity and molecular biology (regardless of discipline) as the material properties of cellular matter and DNA are further explored. Here, my intention is, however, to focus on the process of working with lively material rather than the isolated entity. The practice of physically locating thought within a body allowed me to consider the bioassemblage as both living commodity and infectious idea.

Mexico City, June 1, 2020

Dear Louise,

I am glad to be part of this project *thinking through the body* as an experiment in dialogue and exchanging ideas. As you recall, we met at a conference in Greece some years ago. I remember very vividly how we were walking on a narrow street, going somewhere for lunch, and we started chatting about your projects. The memory is particularly significant right now because in the middle of the pandemic, having an international conference is something that is just not going to happen in the foreseeable future. This brings along some questions about the production of knowledge and about our experiment itself.

During this period, we have experimented with an urge to transform our activities into online and digital activities. There has been an attempt to translate or even transmute the physical presence into "digital presence." With this transmutation, a lot is at stake in terms of the phenomenology of the bodies and what we mean by a body. Instead of having countless meetings via zoom or something similar, we decided to begin with a telephone conversation to see if we could work together on this. Second, we decided to try an ancient way of communicating, exchanging ideas, and producing knowledge: to write letters.

Philosophy and art practice are being summoned in this experiment. The crossing of these disciplines is what has moved us forward to think together about life, nature, and living entities. For me, the experiment is very exciting because of the kind of philosophy that I am trying to advance [8]. One of my main questions is how materiality can be brought forward in the formation of philosophical concepts.[4] How to deal with and treat materiality in the production of philosophical concepts? How can matter be philosophically analyzed? The realm of aesthetics and art practice is, of course, of paramount importance for these questions since it is by itself a kind of performativity of concepts and materiality. Therefore, it opens up the theoretical space in which I can see philosophical concerns transformed in artworks. Let me be clear with this, I am not stating that one discipline has preeminence over the other, neither chronologically nor epistemologically, but I am trying to search and to produce the intercrossing of concepts, disciplines, questions, methodologies, etc.

The question about life is central for me, how it has been transformed with the emergence of biology specifically and life sciences more broadly. Your art projects give me a peculiar chance to see how art is appropriating and experimenting with a certain understanding of life, which is neither "natural life" nor the result of epistemologies. What is life in the midst of current art practices? What is the idea of life that appears there? I will go through your text and your questions in order to reflect upon what you are stating and asking.

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[4] I recognize in Catherine Malabou's attempt to think with, through and beyond the philosophy of Kant a lucid effort to reconcile the transcendental realm with what is contemporary known as "new materialism". In her proposal, subjectivity is reframed with epigenetics. Malabou, C. (2015). Avant demain: épigenèse et rationalité. Paris: PUF.

The first idea that struck me—again—is the 'molecules with intent.' It made me consider the difficult task of bringing forward frameworks of interpretation that are not anthropological. Since modernity, we have been used to interpreting the world according to the subjective categories that produce it. In that respect, the world appears as an object, as the image of our own reason and understanding. The world appeared as rationality, as order. But nature, at a certain point, stopped being considered as that realm of sensuous order and rationality, to become an irrational force and an outburst of creativity. Nature as other of the rational subject. How then to think about nature beyond anthropological categories? This has been one of the principal quests against the Anthropocene era. Critical thinking has been trying to think about nature beyond subjectivity, beyond humanity. It is not clear what that could mean, how we could really listen to the other, as other.

To experiment with living entities or with biological material (how to establish the borderline between life and biology?) inside the laboratory could be a way to decipher what is life, nature, or living entities by themselves. How do molecules act, react, interact? But every word that we use to describe the experiment is completely charged with anthropological meanings, with subjectivity. Are we doomed to see only what we can produce and then to have nothing but the reflection of our own reason instead of glimpsing reality by itself? How can we experiment with life as it is, beyond our intent? But what is subjectivity in this concern, what does the subject mean, who is experimenting inside the laboratory, and what is 'I'?

How does life appear inside the laboratory? What is the laboratory as a place to experiment with biological life as material? There, we encounter ideas of control and dominance—the production of knowledge within the controlled and measurable space of a laboratory. Life appears as something that can be framed within the margins of a certain episteme. It is not life, but life through the scope of biology, let us say. And biology, at least hegemon biology, tends to understand life as a fragment, as a tiny material, as information, as molecules.

This very idea of information that depends so much on the interpretation of the world as a language to be deciphered and the deciphering of the genetic structure that allowed genetic engineering is dependable of that world vision. What is life beyond biology? Sometimes I wonder this, and I try to balance between fieldwork and laboratory work. How do we experiment with life? And there, of course, the question of our own life, our own body, and our own diseases are always at stake. Inevitably. How to understand ourselves as biology, as biological conformed entities? In what respect do we act and interact as biological conformed entities?

Then I thought about your question concerning memory and its physicality and the attempt to store it in DNA sequences. Why do we believe that everything that exists has a physical space? And if not, what is it then? For, let us say, 'mental realities,' this is such a problem. Where are the sensations, the feelings, the memories, the thoughts? The brain has appeared now like a topological metaphor of a place where functions are. But, to think about our spirit in terms of brain functions for me is something bizarre, something that does not fit in the world vision that I want to help to generate. I wonder if hegemon biology as an episteme that promotes a mechanist view of the world promotes this understanding of life and our life as material particles. Does this sound like metaphysics to you? That is why I have been so interested in the question of philosophical concepts and materiality. The concepts are not a translation of materiality; they do not describe certain sensual features. They are something different that relates to matter and the sensory forms, but at the same time, they do not belong to the empiric.

This brings me again to your question about the kind of entities that only exist within the confines of the laboratory. 'Life' is something that only exists within certain limits and circumstances. There is no neutral life that we can refer to. Life is no universal category. It is something that always happens situated. Therefore, it is as important to research and question life as it is to question its conditions. And those conditions are not only material, like food, but also historical, social, and they depend on the epistemes. So, we should ask, life in what circumstance, in what situation, through which interpretation?

What is life within the confines of the laboratory? Something controllable and measurable? Something limited by the artificial conditions that are manipulated there? If living entities only come into being within an environment, could the laboratory be considered as the normal environment for some entities? And then, we have to cope with the migration of organisms from the laboratory to the field, for example, in agriculture. But is agriculture an environment? Or is the life that is technically produced something that lacks an environment? From there on, we could continue questioning the idea of the environment as the space in which life occurs and as the limits in which life can be. Is a factory an environment? And a city?

Bioassemblage #1 made me think about all these questions because you also consider the different disciplines as circumstances in which life comes into being. So, life is not the same when considered from the scope of art, science, biotechnology, or humanities. What is life beyond and within subjectivity? I come back to this question to stress it, not to answer it. Because subjectivity is always questioned and determinant to the occurrence of life within certain circumstances.

Newcastle, UK, June 12, 2020

Dear María Antonia,

Your writing has given me much to consider. Even our distance, presented strongly in our dialogue through dates and locations in the formal letter writing style. We intend for our minds to meet on the page, for readers to share, and yet we are separated by 5,411 miles and 6 h (to say the least of our situated separation in these times of pandemic). In this sense, it is ultimately through the acquisition of the skill of mark-making that this product is made possible.

Firstly, I want to say how encouraged I am by your acknowledgment of this exercise as one where disciplines share an equal footing. Too often, art is understood as an instrument or illustration of another expert culture rather than a field in which knowledge can be developed through practice. Therefore, I will approach your philosophical questions through my material experience as an artist, in the hope that we can weave together, through our differing approaches to knowledge, a form of thinking through the body. You raise many interesting questions and begin by siting our understanding in the rationality since modernity. Yet, I often find while making work that I am governed by an internal logic (or perhaps that is the wrong word, drive?) that arrives before rational thought. Perhaps this is where we can understand ourselves as biology, in the *instinctive* actions, reactions, and intra-actions that are made manifest through our bodies and minds.

In making *Pithos* [9], for example (Fig. 17.3), intuition played a significant role in guiding the outcome of the work. I wanted to bring something of my experience of synthetic biology to a public audience. I had attended lectures and conferences where the bacterial body, commonly used to store and multiply genetic information, is often referred to as a chassis [10]. I had been troubled by this framing, with its allusions to Fordian production lines. A manifestation that is becoming explicit as spaces of genetic mass production are constructed.[5]

Further, I was interested in an apparent contradiction heard commonly in the lab—that bacterial bodies can store and copy DNA incredibly accurately and also that mutations in DNA are incredibly common. Of course, both can be true. When growing bacterial bodies in the laboratory, selective pressures (such as antibiotic resistance) are applied to ensure that the synthetic DNA added to the body of an organism can easily be recovered. Mutations of this DNA may well exist, but they will not be easy to find as the laboratory environment rewards bodies that conform to selective pressure. In the laboratory, therefore, individuality is bred out of bodies. *Pithos* became a physical reaction to connotations associated with the word chassis and to the idea of bodies conforming to the requirements of the lab. I knew that I wanted to present a work that suggested less reliable forms of containment.

The installation, *Pithos*, presents two elements in a blacked out space: a simple clay vessel and an 8-channel audio. The vessel, which lies upturned in the center of the space, has synthetic DNA (*Bioassemblage #1*) worked into the body of the clay. The 3-min audio plays what initially appears to be the same phrase repeatedly and intermittently from eight different sources that are difficult to locate in the darkroom. With each repetition, the phrase mutates until its form has changed entirely. The phrase begins as “What will happen if I store this thought safe within you?” This is what I encoded in the synthetic DNA, which I then stored within *E. coli* bacteria in the laboratory. The phrase mutates in the audio according to a simple evolution algorithm which distorts the words until they are no longer recognizable.

I imagined the sound of the phrase spilling out from a central vessel into the room as a disembodied chorus of voices, mutating and changing from its original form. This again was an intuitive decision that I felt would engender a sense of both chaos and liveliness. I knew that I wanted to embed my thought-as-DNA within a

[5] For example Edinburgh University’s *Genome Foundry*, within the Centre for Synthetic and Systems Biology houses a factory-style genetic production line, with robot arms that assemble genetic material, providing ‘genetic constructs for academic and industrial customers’ https://www.ed.ac.uk/biology/research/facilities/edinburgh-genome-foundry/what-we-offer.

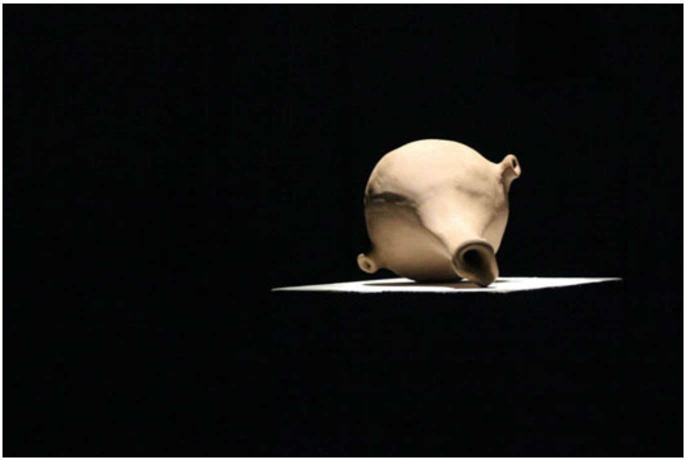

Fig. 17.3 Pithos. Installation Detail, BALTIC39. Eight-channel audio, clay vessel, DNA plasmid bioassemblage (Photography by Louise Mackenzie, 2016)

simple terracotta vessel, but significantly, I did not enter into the task of making it with a clear design of the object in my mind. The form that the vessel ultimately took: a womb-like shape with three openings, arose through my body as I worked, thus it became an act of thinking through the body, an assemblage of the clay, the DNA, my body and mind, intra-acting.

Reflecting on this work now, there were clearly two strong guiding influences in the making of this work and in the shaping of the vessel in particular: my experiences in the laboratory and the reading that I undertook in reaction to these experiences. I understood the laboratory *E. coli* from my position as an outsider to the lab. Like the *E. coli*, I, too, was a body out of place. Learning that a living entity could be considered a chassis, made to conform to the requirements of the laboratory, brought about a visceral—almost empathic—reaction in me. This reaction, in turn, led me to consider other potential metaphors for this body out of place. What might happen if the body was reframed as something other than a chassis? My reading of Donna Haraway led me to Ursula le Guin's *Carrier Bag Theory of Fiction* [11], in which pots and bags become the original human tools rather than sticks and clubs. Also, and I cannot pinpoint why here–perhaps the foreshadowing of the genetic production line–my mind kept turning to the Pandora myth. On researching the chequered history of this myth, I had found that the original container was not a box but a vessel formed of clay and water [12].[6] After further reading, I found that, prior to being fashioned from clay and water, Pandora was a

[6] A *pithos* was a vessel that contained goods of economic value: wine, oil or grain. The word *pithos* appears in the classical translation of Hesiod's poem *Work and Days,* where Pandora is described as a *pithos,* fashioned by Hephaestus from earth and water. Other translations depict Pandora as the first woman on earth, or an evil to blight all mankind.

revered earth goddess from pagan fertility festivals [13]. This information was in my mind while I sat to work on the form that would hold my synthetic DNA, but I could not predict how it would turn out. I allowed the form to flow from my mind and body directly into the clay.

I use the above example to discuss a specific material experience with synthetic biology, which may be very different from the experience of another type of biology with a broader focus – environmental biology, for example. When you speak of hegemon biology, I am instantly reminded of our more recent conversation about the many cultures of biology, and in this, I wonder whether, as with some projects of art and philosophy that consider biological materials, there are similar projects within biology that consider more spiritual or conceptual questions?

This returns me to the topic of materiality per se. When you suggest that philosophical concepts are not a translation of materiality or a description of sensory forms, therefore, I would agree (and yes, the particulate nature of biology feels close to metaphysics). Rather I feel an overwhelming urge to ground philosophy in the reality of experience, where the combination of materiality and expression becomes a repository for ideas. I use the word repository, over translation for example, because ideas are always multiple and contingent.

This leads me to reflect on your suggestion that there is no 'neutral life,' which in one way has parallels to the idea of 'molecules with intent.' You are, of course, referring to the situated circumstances in which one encounters life. I add to that the situated circumstances of a given life (human or non-human). To address your comments on the context of the laboratory, I have become aware, since working in the laboratory, that for many forms of life, this is their only habitat. I would not say, therefore, that they lack an environment but that their environment has certain constraints or criteria. Take laboratory-bred *E. coli*, for example, which I discuss in my thesis. The first known strain was derived from the faeces of a child by German bacteriologist, Theodor Escherich in 1885 [14] and today, so many strains have been developed and mutated that there is an independent wiki site dedicated to them.[7] Over almost 140 years, these bacteria have transitioned from living body to scientific resource to genetically assembled product. The strain of *E. coli* that I chose to work with in the laboratory (one of the most common strains in use today) is trademarked and can be delivered straight from the factory to the fridge to the lab bench, having never seen the inside of a living gut.[8] These *E. coli* are single-celled organisms, and to this effect, I can describe them as molecules with intent, in that they intend to live. I can attest to this through my attempts to care for them through their continual cycles of growth, feeding, and death. Thus, I have often wondered about the term 'wild' in relation to organisms that quite literally have no place outside of the laboratory. Their relationship with humanity is entangled, beginning in the body, and yet their life (in my case, the life of laboratory *E. coli*, in sterile

[7] https://ecoliwiki.org/colipedia/index.php/Welcome_to_EcoliWiki.

[8] These organisms are referred to as the product, 'One Shot® TOP10 Competent Cells'. *Thermofisher Scientific*.

plastic tubes filled with standard liquid nutrients) is as far removed from the life of a body in the wild as it is possible to be. What does this mean for the situated production of scientific knowledge in the context of the laboratory?

Mexico City, June 26, 2020

Dear Louise,

You made me think about distance with your last letter and the way in which knowledge has been produced in collaboration with others through the history of humankind. There is no such thing as single knowledge but a constant flow of ideas, whether traveling or mail. That is why in part, I proposed this exchange of letters to honor and recognize how communities of knowledge were built through centuries and to have a meaningful and deep dialogue between us that normally does not happen with the rapid communications in social media.

In *Pithos,* you were working with *E. coli* as a form of life, as a representant of life. *E. coli* as a model organism allegedly speaks for the others. But, what does it mean to speak on behalf of the others, to be the representant of other life forms? It is impossible to study each living entity in its singularity. The very question of singularity is challenging. Therefore, I ask what place and effect *E. coli* has as an exponent of life?

Here, the double meaning of the category of "life" becomes obvious, a doubling that we have to notice. Let us pretend that with life we are referring to human life, could we say that there are model lives that serve as a representant of human life? Or would we argue that each human life is unique, in its narrative, in its feature, and that, therefore, it deserves to be treated according to its singularity? Would we say that? *Any* plant, *any* bacterium, but human existence. Literature has taught us how to exploit the singularities of human lives creatively, but beyond literature, where human existence becomes universal through the power of symbols, the question of human life tends to be addressed in a "model organism" way. No need to insist that, for example, medicine has used the white occidental male as the standard of human life or that philosophy has used European bourgeoise existential conditions as the standard of life. Who speaks for the other? Who can represent the other? Who is accountable for that representation?

Thinking about *E. coli* and the history that you recount regarding the healthy child and his faeces (who was the child? Was he also German?), let us consider Henrietta Lacks' case regarding the Hela cells. The cells were taken from her without her consent or even knowledge, then used and sold at a global scale for research [15]. The cell line that was cultured from Lacks' cancer cells is referred to as "immortal" due to its durability. The Lacks' case has been discussed very much in terms of ownership. To whom does the cell line belong? Who deserves the economic benefit since it is produced in labs and sold worldwide? But a cell is not a single cell organism. *E. coli* is an organism by itself. It lives in our guts, but it is itself. Sure, the question about identity is brought forward with the microbiota. If we are inhabited by so many critters [16], is our body ours? What would be the story of our *own* existence if we take the perspective of other narrators instead of "us," like the microbiota that inhabits us or the amino acids as agents of our metabolism? What an impossible tension… the cell is our cell, the bacterium is not our bacterium, but in a way, it is …

Still, the question concerning representation appears in our disquisition, since a Hela cell line or *E. coli* as a model organism are representatives of certain approaches to life within the biological epistemes. Let us say that the artwork is a representation of something different than itself. At least, that is the classical understanding of the artwork as mimesis. A lot has been debated in this respect, arguing for the independence of the artwork that has a meaning by itself, not because it has a referent that exists outside the artwork. This argument regarding the ontology of the artwork sometimes is misunderstood in terms of the ability of the artwork to depict something in the "real" world [17]. Beyond that interpretation–which I find very limited–I will argue that the artwork establishes a particularly meaningful and ontological relationship with the world [18]. In a way, it represents the other, not by substituting it but by making it appear under different light and meaning. What emerges in the artwork is, then, not a replication, but another possibility of/for being. The artwork is a representation of what there is. And what there is cannot be reduced to the sum of sensible entities and their attributes. The artwork is then not speaking on behalf of the others but producing meaningful alterity of otherness. Its singularity depends on being able to produce something that was not there before, and this has nothing to do with originality but with the aperture of a certain idea of the world. To shape the world through the power of art…

And the vessel in *Pithos* is absolutely unique and singular. You were working with the vessel and with the bacterium with your own hands; you involved your own body in it. What are your considerations with a living matter that is any matter and with a non-living material that comes to be something singular and unique? What is it to touch the terracotta and to touch the *E. coli*? In what way is the bacterium representing the other as a model organism? Does it matter which bacterium? Not really; they are exchangeable and completely substitutable. If some are damaged during the experiment, they can be replaced with others. It is their feature of replaceability that makes them so convenient for the lab. As many as needed (sometimes human lives are also like that). How then is the bacterium able to speak on behalf of the others? When alterity is reduced to sameness, then it is possible to speak on behalf of the others. What is exchangeable is not every organism but information. Knowledge is information. And information is translatable.

When molecular biology was acquiring its lure, it started working with model organisms, such as Thomas Hunt Morgan's famous *Drosophila melanogaster*.[9] At that time, what was valid for the fly was also valid for the elephant. The assumption

[9] A new epistemic space was constituted with studies on heredity, of which Morgan's experiments on flies were part. This new epistemic space is linked to the modern synthesis paradigm and the "hard heredity" that is implied in genetics. See Meloni, M. (2016). Political Biology: Science and social values in human heredity from eugenics to epigenetics. London: Palgrave Macmillan.

was that the way in which matter, in this case, living matter, is organized should be the same for every entity and that the code, therefore, should be universal. We know now that this is not the case.[10] The genetic code, which allegedly explained any living entity, was an abstraction, a codification, a transmutation of life into information that can be mathematized. But what is a living entity with respect to biological episteme? Model organisms have been transformed into epistemic artifacts that can be arranged and manipulated according to needs and concerns. Beyond the ethical level of this discourse, which I do not want to address here, there is an ontological-epistemological level involved. What kind of entities are these ones produced for the lab? And what kind of knowledge is obtained from an epistemic artifact?

To produce organisms for the sake of knowledge is not the same as bringing them into the social world. Genetically modified organisms that are used and consumed have different ontological and epistemological statuses. They become commodities mass-produced. However, epistemic artifacts are also mass-produced. Experiments are even outsourced as more and more robots perform steps in experiments. Industrialized knowledge, so to speak. Standardized also, as with bio-bricks and kits to perform genetic editing. I have this nostalgic image in my head about the conditions of production of empirical knowledge in the nineteenth century: the cabinets of curiosities and expeditions. Things were not a model, but a token, an example of the extraordinary. This, of course, is just a nostalgic fantasy because, on many occasions, this happened under the umbrella of colonialism, as in the case of the French expedition to Mexico and the axolotls that were sent to Paris[11] or the research performed with indigenous communities by North Americans and Europeans in the rain forest in Mexico in the 1940s [19]. I insist on considering the conditions of production of empirical knowledge. How is a living entity treated when it (her/him/they) appears in the frame of research? How do we treat the other when investigating it?

Quaestio mihi factus sum (Augustine, *Confessions,* X. 33).

But when I investigate myself, do I have to dissect myself?

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[10] Just as an example, I quote the studies of Mexican scientist Elena Álvarez Buylla about the plant *Lacandonia schismatica*, whose functions regarding floral organ identity are different from the model organism *Arabidopsis thaliana.* Álvarez-Buylla, Elena R., et al. (2010) B-Function Expression in the Flower Center Underlies the Homeotic Phenotype of Lacandonia Schismatica (Triuridaceae). The Plant Cell, vol. 22, no. 11, pp. 3543–3559. doi:10.1105/tpc.109.069153.

[11] During the French intervention in Mexico (1862–1867), the "Comission Scientifique du Mexique (CSM)" sent axolotls to Paris. The CSM was formed by appointment of Napoleon III in February 1864. This is a case of colonialism and imperialism. The axolotl has belonged to the history of colonialism and imperialism from the moment it was taken by the commission and sent alive to Paris, where it was reproduced under experimental conditions. From then on, the axolotl would belong to the history of biology as a laboratory animal. Its territory would shift, from Mexican canals and lakes to laboratories, aquariums and, finally, to genetic stock centers. The commission gathered French scientists and sent them to Mexico to conduct research in the fields of anthropology, zoology, botany, mineralogy, paleontology, geology and medicine. Ramírez R. y I. Ledesma, 'La Commission Scientifique du Mexique: una aventura colonialista trunca', Relaciones 134, primavera 2013, pp. 303–347.

A life that is not long and seriously meditated is not a fully lived life…

Why *E. coli*?

To work with a vessel, to work with a bacterium. Both are entities. Sensible. Material. In a very ancient ontology, one would be considered an artifact and the other a natural entity. That is how Aristotle, in his *Physics* and *Metaphysics,* divided the entities.[12] But now, with the emergence of molecular and synthetic biology, a change in definitions is probably needed. The bacteria that you produced in the lab are a different kind of entity, a biofact [20], something in between nature and artifice. Art is indeed a manipulation of matter. The personal relationship that the artist can establish with matter goes from absolute instrumentality to intimate care—the matter as other: an instrument, a medium, or even a subjectivity.

What is the intimate care that you applied while working with the vessel? Did you talk to it? Did you caress it? What is matter for an artist like you? And then, working with a living entity, is it different? What kind of respect does *E. coli* engender in you? Is it subjectivity? Is it something that you interact with? Or is it just matter in a Petri dish? Life appears in a totally different context in the lab. Life is not an attribute that belongs to matter and is just there. What is life? I wonder about the context of the very question. Because nature has always been there, as a category, as a mode of being of what there is, as something that art interacts with, works with. Nature, for example, appears in land art as a subjectivity, I would say. But it is a risky assumption. What is subjectivity after all? And what is the difference between nature and life as categories? While walking in the open field, feeling and sensing what there is, without making any distinctions, air, water, rocks, sky, plants, animals (invisible bacteria, unimaginable microbiota), does life appear as something separate there? Or is life an epistemic category formed by life sciences and biology since the nineteenth century?

When art decided to work with living entities and to traverse and pierce the question about life, it was acting and experiencing life as something separated from what there is; therefore, it needed the biological theoretical framework in order to configure this "new" way of being [21]. Art also needed to adopt the space where that episteme could grow and present the new way of being: the laboratory. One thing emerged with the other because everything in a certain space, and the space in which something is, is not something void and undetermined, but with characteristics and specific determinations. Life as an epistemic category framed within the margins of molecular biology requires the space of the laboratory as its specific environment. And there, life can be separated: analyzed, fragmented, chopped into micro pieces, sequenced, and transformed in quanta of information. Life only exists within certain limits and is determined by the limits in which it appears. The lab is a limit. A limit is that from which something comes to be what it is [22]. A limit does not exist on its own. It is always the limit *of* something. *E. coli* is bound to the

[12] In *Physics* II and *Metaphysics* V, the sensible entity is presented as something caused. The distinction between natural and artefactual entities is established according to the different causes.

laboratory as the limit to which it can exist. The limit configures the entity. Even if it exists outside the lab, for example, in our own gut, even then, it is configured by the lab. Therefore, what is *E. coli*? Can it be experienced as a subjectivity?

Conclusion

Through an experiment in writing together, the authors have explored the use of life in the context of contemporary biological knowledge practices. Their relative contributions lead to a position in which life cannot be considered as a universal or neutral category but depends on the context, on the circumstances where it appears, and where it can subsist. Life has to be interpreted according to specificities that include space, time, and certain historical possibilities for appearance, including material and intelligible possibilities. Art practices incorporating living media also work with knowledge practices that have brought forward molecular biology and biotechnology. It is important, therefore, to comprehend that what is at stake is not only certain living entities or tissues or fragments of organisms being manipulated in the lab but also a worldview that is still interrogating the concept of "life" as a product of epistemologies and technologies. Both art and philosophy, through situated and contextual engagement with biological epistemes, can begin to address Augustine's investigation of the self through first acknowledging the inseparability of life from subjectivity.

Core Messages

- Life is not a universal or neutral category but depends on the context and circumstances where it appears and subsists.
- The collaboration of contemporary art and philosophy allows consideration of biological knowledge practices as situated and contextual.
- Through correspondence that works with the body's materiality as a space for thinking, art can interrogate what we mean by biology and how we understand our own existence as biological entities.

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18

Mechanism Versus Organism: A Loosely Kantian Perspective and Its Implications for Bioengineering

Reto Gubelmann and Marco Toscano

"Organisierte Wesen sind also die einzigen in der Natur, welche, wenn man sie auch für sich und ohne ein Verhältnis auf andere Dinge betrachtet, doch nur als Zwecke derselben möglich gedacht werden müssen, und die also zuerst dem Begriffe eines Zwecks, der nicht ein praktischer sondern Zweck der Natur ist, objektive Realität, und dadurch für die Naturwissenschaft den Grund zu einer Teleologie, d. i. einer Beurteilungsart ihrer Objekte nach einem besonderen Prinzip, verschaffen, dergleichen man in sie einzuführen (weil man die Möglichkeit einer solchen Art Kausalität gar nicht a priori einsehen kann) sonst schlechterdings nicht berechtigt sein würde."

Immanuel Kant

Summary

Building on the work of Immanuel Kant and researchers working in his tradition (but without getting lost in exegetical details that are immaterial for this volume), we discuss a notion of the living organism based on its formal teleological structure, contrast it with mechanistic objects, and draw some consequences for the notion of bioengineering. Bioengineering, in our

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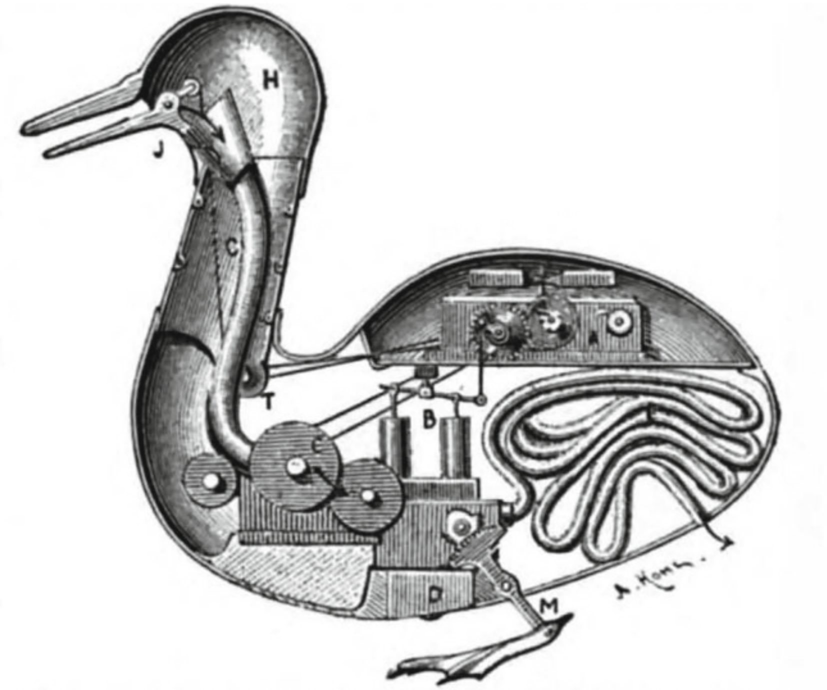
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_18

understanding, is close to a *contradictio in adiecto*: either something is alive, which implies substantial autonomy in its inner functional organization, or it is engineered, which means that the engineer continuously determines the thing's functional organization.



INTERIOR OF VAUCANSON'S AUTOMATIC DUCK.

A, clockwork; *B*, pump; *C*, mill for grinding grain; *F*, intestinal tube; *J*, bill; *H*, head; *M*, feet.

Vaucanson's digesting duck (1899)
(Adapted from Wikimedia Commons, the free media repository https://en.wikipedia.org/wiki/Digesting_Duck#/media/File:Digesting_Duck.jpg).

Keywords

Bioengineering · Cyborg · Kant · Leibniz · Neural networks · Organism · Transformer

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in chapter 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

What kind of thing is a living being, and what could it mean to engineer one? In this article, we suggest that in order to appreciate the particular nature of living things as opposed to non-living things, it will be beneficial to remind ourselves how deeply our idea of the sciences as essentially investigating non-living physical matter (that is purely mechanistically structured) is rooted in the tradition of the European Enlightenment. To the concept of a mechanism, we owe our intuitions of causal explanation and technical construction of machines and other scientific knowledge applications. The idea of an organism, which we suggest is characterized by the remarkable features of teleologically structured units such as systematic growth, healing, and reproduction, is hard to square with this mechanistic conception of science and its objects. Here, we begin by detailing Kant's distinction between non-living and living beings (Sect. The Development of Kant's Conception of Living Beings). Then, we put this distinction in the context of the quest for bio-engineering (Sect. Taking Stock: What It Takes to Be Alive According to Kant). Finally, we discuss the implications of Kant's distinction for two different forms that the quest of bioengineering may take (Sect. Kant and Bioengineering: The Cases of Artificial Intelligence and the Cyborg).

The Development of Kant's Conception of Living Beings

Kant's Epistemology is the *locus classicus* for discussing the modern idea of mechanisms. Taking up loose ends from Leibniz's ontology, Kant tries to establish neat boundaries between mechanisms, organisms, and the objects of traditional theological and philosophical reason, such as God. His Critique of Pure Reason ("Kritik der Reinen Vernunft," KrV) furnishes a revolutionary metaphysical and conceptual grounding for physics, a discipline that, as a consequence of Newton's brilliant work, was taken to be the ideal of natural science. At the same time, the KrV delivers a biting critique of traditional metaphysics, undercutting many traditional aspirations of metaphysical theorizings, such as providing arguments for the existence of God or the quest to gain knowledge about the world through concepts alone.

Kant's concept of a mechanism (Sect. 2.2) fits neatly within this overall architecture. Unfortunately, the same cannot be said for the concept of living beings or organisms. It seems fair to say that Kant got caught up in a double-bind here. On the one hand, he wanted to clear the grounds from all obscure metaphysics to make room for the science of physics. On the other hand, he was aware that living beings do not fit into the metaphysics of the KrV. In this vein, the Third Critique, the Critique of the Power of Judgment ("Kritik der Urteilskraft," KdU), can be seen as partly dedicated to providing an adequate conception of organisms. In Sect. 2.3, we introduce this conception. It seems clear to us that there are tensions between this conception and the metaphysics of the KrV, but we do not elaborate on them for the purposes of this contribution.

Before beginning our discussion of the KrV, we give some background by sketching Leibniz's conception of organisms. This is important because Leibniz's thinking on this topic has been pivotal for Kant's theorizing on the matter.

Sui Generis, But Not Anti-mechanistic: Affinities Between Kant's and Leibniz' Intuitions Regarding Living Beings

In this section, we shed light on some points of contact between Kant and Leibniz regarding the status of living beings. We thereby follow the lead of Philippe Huneman [1]. He reaches the following verdict regarding the status of living beings in the KrV: he writes, "an account of the specific status of organized beings […] is not to be found in the first Critique" (p. 183). This diagnosis is closely analogous to our suggestion in the introduction to this chapter. Huneman bases this diagnosis on a fundamental disagreement between Kant and Leibniz on the notion of an organism. This disagreement, however, is framed by an underlying agreement between Leibniz and Kant on how organisms are not to be explained: by positing some organizing soul which is in principle beyond the mechanistic explanations provided by physics—which both Kant and Leibniz admire (see [1, p. 164] for Leibniz' debate with Stahl on that matter).

Leibniz tried to avoid positing something supra-mechanical by distinguishing living beings from machines only quantitatively, not qualitatively: living beings are, in contrast to machines, infinitely organized (ibid.). Ontologically speaking, living beings are machines, just very subtly organized ones, while epistemologically speaking, we will never be able to conceive a living being as a machine since our mind is finite and cannot cognize infinite structures. This, however, Huneman (p. 178) argues, is precisely where Kant correctly senses a contradiction: "according to Leibniz, one should thus consider the division [of a given organic body, RG & MT] as already achieved, albeit infinite, since it is represented in a concept (this point defines precisely what is articulation, Gliederung), and at the same time, one must conceive of it as a never-fulfilled series, since one applies here the rule of regress—which means producing an infinite division through the regress itself, the form of this division being undetermined prior to the regress" [1].

Huneman shows in this passage that there is a problem with Leibniz's notion of organisms as infinitely subtle machines. Since we have a concept of the organism, the organism's division into its parts must be achieved; otherwise, our concept would be empty. However, being finite minds, we can never achieve this division. Huneman (pp. 178–179) then shows convincingly that for Kant, Leibniz confuses divisibility of a body as being in space (which is infinitely divisible) with divisibility of a body as an organism, which cannot be infinitely divisible if we are to have a concept of it [1].

Refuting the Leibnizian distinction between organisms and machines leaves the Kant of the KrV without any means to distinguish them. However, Huneman (p. 184) then cites a passage from *Dreams of a Spirit Seer*, where Kant confesses that Stahl's strict distinction of organisms from machines has immediately convinced him [1], a conviction that Kant was unable to cash out in metaphysical terms by the time of the KrV. In addition to this conviction of Kant, Huneman (p. 85) shows that there was a general trend in Kant's days to advocate "[…] a more "immanentistic" view of organisms—a view defining the intelligibility of organisms both within the intrinsic specific forces that characterize them and through the laws of their manifestations, instead of considering them from the viewpoint of a general mechanistic scheme for understanding nature" [1].

In short, Huneman finds Kant cross-pressured already at this early point:

i. first, he rejects any kind of vitalism, the reification of what is distinctive about living beings (such as a living soul);
ii. second, he is convinced that there is a categorical distinction between living and non-living beings; and
iii. third, he finds Leibniz's attempt to draw such a distinction without falling into the reification trap unconvincing.

In the following, we delineate the traces of this tension in two of Kant's major works. After introducing how the KrV conceives mechanistic objects, we turn to the KdU to discuss Kant's conception of a living being.

Mechanistic Objects in the First Critique

In the KrV, the only causal relationships that are in nature are efficient, not final. According to the second analogy of experience, "[a]ll alterations occur after the law of cause and effect" [2].[1] If Kant's argument in the *Analytic of Principles* is conclusive, this second analogy is a requirement of our mode of cognition ("Erkenntnis"): whatever is possibly experienced by us is structured according to the *Second Analogy*. The same does not hold for final causes. No analogy of empirical thinking states that we could experience nothing unless it stands under a means-end relationship.

What does this mean for mechanistically constituted objects? What is a mechanistically constituted object? Take the example of a watch. A watchmaker designed it in Le Locle in Switzerland. She is a senior professional and has designed and assembled all of its many parts to show the correct time, date, and moon phase for centuries ahead. It is powered by a mechanism that draws energy from its bearer's wrist movement. This energy is transmitted through many wheels and sub-mechanisms to move the heads at exactly the right speed.

The goings-on within the watch can all be explained completely mechanistically: this wheel causes that wheel to turn, which in turn causes another gear to be set in motion, etc. Over and above this mechanistic explanation, one can sensibly ask certain why-questions: why is this wheel taking precisely this position in the entire mechanism? An answer could be: this is necessary to ensure that the watch is functioning properly; it shows the correct time. The watchmaker designed everything within the watch to this end.

You do not, however, need to resort to such teleological explanations. The mechanistic explanation suffices to know everything that is going on in the watch. This changes only if you try to identify the watch as a watch. What belongs to the watch? Everything that is indispensable for it to perform its function. In this sense, you need to know what it means for the watch to function properly to decide whether, say, some really fancy packaging that glimmers in the dark, powered by the mechanism of the watch itself, actually belongs to the watch or not.

Organisms as Natural Purposes

The *Third Critique* analyzes the notion of a living being by developing a determinate concept of an organism. Consider the following passage: "Organisierte Wesen sind also die einzigen in der Natur, welche, wenn man sie auch für sich und ohne ein Verhältnis auf andere Dinge betrachtet, doch nur als Zwecke derselben möglich gedacht werden müssen, und die also zuerst dem Begriffe eines Zwecks, der nicht ein praktischer sondern Zweck der Natur ist, objektive Realität, und dadurch für die Naturwissenschaft den Grund zu einer Teleologie, d. i. einer Beurteilungsart ihrer Objekte nach einem besonderen Prinzip, verschaffen,

[1] "Alle Veränderungen geschehen nach dem Gesetze der Verknüpfung von Ursache und Wirkung" (KrV A189/B232) [3].

dergleichen man in sie einzuführen (weil man die Möglichkeit einer solchen Art Kausalität gar nicht a priori einsehen kann) sonst schlechterdings nicht berechtigt sein würde" (KdU B295/A291) [4].[2]

According to this passage, organized beings are the only beings in nature which, conceived in isolation, must be thought of as purposes ("Zwecke"). The referent of the anaphoric term "derselben" is not entirely clear: it could refer back to "Dinge," "Wesen," or "Natur." The most probable reading is to take it to refer back to "Natur," since, in the further course of the sentence, natural purpose ("Zweck der Natur") appears explicitly and prominently. Thus, Kant here claims that organized beings are unique insofar as they always have to be thought of as natural purposes. By this, they furnish ("verschaffen") objective reality to the concept of a natural purpose. This, in turn, justifies the introduction of teleology into natural science, an introduction not legitimate otherwise because we cannot establish the possibility of such a causality a priori via a transcendental deduction.

Why does Kant think that the study of animals requires teleological concepts? The main reason is that in an animal, the matter's organization occurs in a way conducive to its purposes as a living being in a way that is beyond the scope of mechanistic explanations [4] (KdU B292f./A289). More precisely, what is characteristic for a natural purpose, a self-organizing being [5] (*"sich selbst organisierendes Wesen,"* KdU B292/A288), is the reciprocally productive activity of its constituents, which Kant calls organs. By comparison, artifacts like watches cannot repair themselves, let alone reproduce themselves. Living beings, however, can do precisely that because they possess a formative power [5] ("*bildende Kraft*," KdU B293/A289) to bring their matter into the form conducive to their purposes.

Thus, it is inconceivable that we find mechanistic explanations of organisms as teleological phenomena. Rather, Kant argues for the objective reality of natural purposes in a surprisingly positive way by giving a clear-cut structural model of teleological objects. Teleological objects are organized things, which means that their parts are mutually constitutive. Mutual constitutivity yields an object's special functional unity, as every part is at the same time an end and a cause for the others. Teleological objects are causally closed.

To grasp the metaphysical consequences of Kant's conception of organisms, it is helpful to contrast them with machines. The identity criteria of a concrete machine take into account objective and subjective parts. The objective part identifies the causal mechanism within the empirical world and bears existential import. The functional purpose of the specific machine can be taken to be an intention that is subjectively bestowed on it by the human mind, say, to track time correctly. No objective reality has to be accorded to the concept of purpose. In contrast, a

[2] "*Organized beings are thus the only ones in nature which, even if considered in themselves and without a relation to other things, must nevertheless be thought of as possible only as its ends, and which thus first provide objective reality for the concept of an end that is not a practical end but an end of nature, and thereby provide natural science with the basis for a teleology, i.e., a way of judging its objects in accordance with a particular principle the likes of which one would otherwise be absolutely unjustified in introducing at all (since one cannot at all understand the possibility of such a kind of causality* a priori" (KdU B295/A291) [5].

concrete organism's identity criteria exactly seem to yield such a case of objective reality, according to Kant. First of all, we are confronted with an appearance attributed to properties irreducible to mechanistic reconstruction: reproductivity, growth, and healing. That is what separates organisms from machines. Kant's crucial step is this: the specific organic properties are directly linked to the idea of purposeful articulation (Zweck, telos).

However, this last step also undercuts the KrV's doing away with any non-mechanistic structures in nature, an act that Kant thought necessary to clear the ground for physics and to eliminate all unfounded and obscurantist metaphysics. Indeed, as the KrV closely associates the reality of final causes with a creating deity, it is unclear whether the KrV's refutation of the teleological argument for God's existence still stands at this point. We will not dwell on this fascinating tension any further.

Taking Stock: What It Takes to Be Alive According to Kant

Let us again begin with Huneman's research. Huneman argues that Kat tries to improve on Leibniz by distinguishing the parts of an articulated being *conceived as a mere mereological sum (that is, as a whole that is not more than its parts) of spatial parts, a sum which is infinitely divisible,* on the one hand, and the same parts *conceived as functionally identified parts (whose division into further functional parts comes to an end)* on the other hand. For instance, the liver, conceived as an organ, can be divided almost infinitely, down to nuclear fission. The functional unity, in contrast, is lost much earlier. At some point of dividing it up, the liver will not perform its function anymore and hence cease to exist as an organ. The ten-dollar question is now how to bring these two ways of conceiving the same chunk of matter together.

Huneman (p. 182) suggests the notion of an articulated being. An articulated being is conceived as constituted by functionally identified parts. Hence, living beings, constituted by organs, would be prime examples of such articulated beings. These parts are said to be "superimposed" on the same parts conceived as mere mereological sums of spatial parts [1]. Something similar should hold for the relations between each part of the articulated being: the mereological aspect of their spatiotemporal distribution is qualitatively distinct from their functional interaction that determines each part's role in the articulated whole.

How are these two 'aspects' and their interrelations distinguished (and related) so that they reflect our experience? What is the relationship between the functional aspect and the mereological aspect of the same junk of matter? In agreement with the KrV, we experience the parts of an articulated being in the same way in which we experience unarticulated beings such as stones or houses. However, the watch or the beaver differ from the stone or the house insofar as their parts are identified and delineated not simply in mereological terms; experiencing their spatiotemporal structure corresponds to a functional one that is not entirely fixed by the relation they bear to our cognitive faculty, but also by the relation they have *to each other*. Their parts are not only parts for us, but also for each other (as it were, for themselves). This means that the functional interrelations of spatiotemporal parts in articulated beings are not dissolvable in the mathematical and dynamical *Synthetic Principles of Pure Understanding*.

In sum, this leaves us with the following picture, one that, as we have suggested, is not without tensions in the Kantian system itself. Kant wants to draw a strong, principled distinction between living and non-living beings without falling into the trap of reification. Non-living beings such as Rudy the canindroid – a machine designed and built by human beings—are mechanistically structured; their goings-on can be fully explained by solely referencing efficient causes. Only in order to identify artifacts such as watches or canindroids one has to consider these objects' functions. Living beings, in contrast, are organisms. They are characterized by the fact that each of their parts has self-organized to function to the benefit of the other, the organism can autonomously heal itself and hence continue to function, and it can reproduce itself.

Regarding bioengineering and the artificial production of living beings, we can make use of the philosophical concepts of *organism* and *mechanism* to establish a clear-cut distinction between living things and machines. From this, it will be possible to set criteria for the goal of producing artificial life:

i. first, living beings are more than the sum of mechanistic descriptions that we can give of their going-on. They are functional units; and
ii. second, this functional unity of living beings is, in a certain sense, autonomous; that is, their ends are set within themselves. By this feature, we capture the astonishing capacities of living substances to systematically and autonomously grow, heal, and reproduce themselves.

These are abilities that human-made machines like Rudy the canindroid are not currently possessing. Our technical capacities are limited to manipulating existing living substances according to our current scientific or practical understanding of at least some of the causal mechanisms within their bodily constitution.

However, a further step seems to come within reach. Evidence suggests that advanced artificial intelligence (AI) systems have autonomously evolved functional structures that strikingly resemble organisms in Kant's understanding of the concept. In the remainder of this paper, we will flesh out teleological structures within advanced software systems, consider the notion and ethical implications of the cyborg, and discuss some implications for the task of bioengineering.

Kant and Bioengineering: The Cases of Artificial Intelligence and the Cyborg

After giving a sketch of Kant's conception of living beings as functionally structured organisms, we now draw some consequences with respect to bioengineering. Bioengineering can be understood in two senses:

i. first, in the sense of creating living organisms out of non-living objects; and
ii. second, in the sense of substantially modifying already existing organisms.

Accordingly, we first analyze the constitution of contemporary AI systems to see to what extent one could conceive them as successful instances of bioengineering in the first sense, that is, of creating living beings out of non-living objects. Second, one can speculate on the consequences of bioengineering in the sense of enhancing the cognitive and physical abilities of a traditional human being. Such speculation leads us to contemporary debates about cyborgs.

Neural Networks as Organisms?

According to Kant, a being counts as living if it is functionally constituted, can grow, repair, and reproduce itself. In this section, we will tentatively suggest that there are now AI systems that show the functional constitution emphasized by Kant's conception of an organism; furthermore, this organization has not been designed by a human engineer, as in the case of the watch; rather, it is a consequence of self-organization. In contrast, we will suggest that these systems show no signs of being able to repair or reproduce themselves autonomously.

The kind of system to be introduced is the so-called transformer, introduced initially in the field of neural machine translation (NMT) [6]. The encoder-decoder structure gives a simplified layout of an NMT system: the encoder takes in the sentence in the source language and produces a high-dimensional representation of it (as it were, a "grid of numbers," usually called the 'context'). The decoder then uses this representation to generate a sentence in the target language. This dual structure maps nicely on the tasks of so-called natural language understanding (NLU, assigned to the encoder) and so-called natural language generation (NLG, assigned to the decoder). This also means that the context, in traditional NMT architectures, has to carry all the information about the semantics of the source language sentence needed to produce a translation. The same context is used to produce all of the translated words, which has later proved to be a bottleneck in the entire system's information flow (Fig. 18.1).

True to NMT-orthodoxy, the transformer model proposed by [6] consists of an encoding part and a decoding part. Self-attention layers are central to this architecture that fundamentally distinguishes it from traditional NMT systems. This brings computational advantages. It is possible to parallelize the system massively,

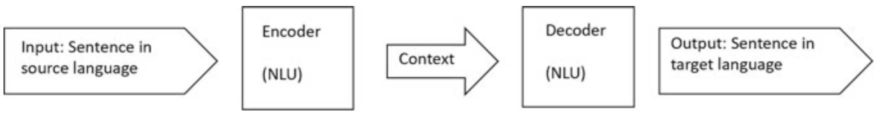


Fig. 18.1 An abstract view on the general encoder-decoder structure of neural machine translation systems

that is, the processing of all words in a sentence simultaneously, while traditional architectures such as recurrent neural networks impose sequential restrictions. It also helps with long-term dependencies; as it were, the parallelized structure allows the encoder to attend to all words in the sentence simultaneously.

More importantly, scientists generally agree that the self-attention mechanism is a significant driver for the transformer's demonstrably superior performance in a wide variety of NLP tasks. In contrast to the pioneering attention mechanism from [7], the modeled self-attention mechanism connects an input sentence to itself, emphasizing these parts of the sentence that are particularly relevant for the word currently in focus. In this way, these self-attention sub-layers contextualize the words very neatly to the respective sentential context, making explicit semantic and syntactic relationships between them.

In an extended version of their paper, to be found on arXiv, the authors provide visualizations of the work done by the self-attention layers. Based on such qualitative analysis, the study [6] examines the function of self-attention layer number five and concludes that it is "apparently involved in anaphora resolution." What is exciting about this is not only that this specific attention layer does seem to be involved in anaphora resolution and pretty successful at it (NLP engineers have wrestled with this problem for decades; the transformer seems to have solved it in a matter of 3.5 days' training); what is more, this sub-layer autonomously started to assume this function during training. There was never an explicit decision on the human engineer's side that this specific part of the mechanism should be dedicated to this task.

It might be worth dwelling a little on this aspect. What the human engineer contributes is just the bare structure with large numbers of parameters, numbers whose values change during training. These values are then seeded (initialized with random values), and then a training routine starts in which the system autonomously produces output, compares this output with the correct solutions, measures its error, and tries to adapt its parameters such that this error decreases. It was epistemically (and perhaps metaphysically) impossible for the AI engineer to predict the function that self-attention layer 5 came to assume due to training.

What follows from this for the question of whether such neural network systems are alive, conceived from a Kantian perspective? Is the transformer more like a watch or more like a beaver? Is its organization merely mechanistic, or does it show the kind of purpose for itself that is characteristic for organisms according to Kant? Let us take stock. On the one hand, we submit that the spontaneous organizational capacities and the functional organization of the transformer speak in favor of considering it as an organism. Attention layer number 5 has spontaneously assumed the function of resolving anaphora. This is not a purpose that was simply set by its human designer, like in the case of the function of a specific sub-mechanism of the watch. Rather, as it were, the system autonomously evolved this functional organization. Furthermore, even if no human being ever hit upon the idea to study the functional organization of the transformer, this organization would still be real in the sense that it is an essential part of the functioning of the transformer and hence, in the end, of its demonstrably superior performance. In this sense, the functional organization is not merely a result of our conceiving the system but rather part of the very being and functioning of the transformer – independently of our cognitive relation to it.

This functional independence raises exciting questions on the proper conception of the humans' role in charge of these systems. To the extent to which the autonomy of their functional organization increases, it becomes less convincing to conceive of humans as classical engineers and more convincing to liken them to farmers cultivating the crop. Cultivating involves a substantial responsibility in ensuring the proper circumstances for the crop to flourish, but it does not include building and maintaining the plant the way like one is building and maintaining a bridge. Plants grow by themselves; they autonomously develop their inner functional organization. Contemporary AI systems are similar to plants in this regard, which injects an aspect of cultivation to the humans' role in charge of the systems.

On the other hand, when it comes to the criteria of being able to repair itself and reproduce, we submit that one can only emphasize the true extent of the challenge that faces anyone that intends to engineer rather than cultivate organisms. While there is a research area called *neural architecture search*–essentially based on the idea that AI is best at discovering the best new neural architectures–this does not amount to reproduction in any sense close to the reproduction of living beings. As it were, their offspring is entirely disembodied: the systems conceive software, not hardware. Humans conceive both.

Even more, while there are attempts to cope with individual network cells that malfunction (which consists in adding a so-called residual connection around each cell to ensure that one cell's malfunctioning will not destroy the performance of the entire system), there is nothing close to an AI system's autonomously fabricating, say, new GPUs in case some of its hardware is destroyed. Concerning these two aspects, reproduction and healing, it is clear that the human takes the role of a classical engineer: she has to develop factories to mass-produce the hardware, and she has to get up late at night to fix a broken server.

In sum, we suggest that cutting-edge AI systems indeed have organismic structures, but they fail to self-repair and reproduce; they remain typical non-living objects. This conclusion leaves us with an interesting conceptual puzzle: these AI systems fall between the cracks of the European Enlightenment's conceptual grid to categorize beings. It takes an act of creativity, specifying our inherited vocabulary, to come to terms with this incongruence.

Programming, Autonomy, and the Ethics of Cyborg

In the last section, we have seen that the advances in AI concerning the reproduction of life are real, but also that they are very much limited in scope. This is due to structural reasons. Relative and systematic autonomy in the shape of a teleological structure appears to be within reach as software systems start to cross over from being programmed to programming themselves. At the same time, this capacity of setting one's own limits is itself limited by the fact that these capacities are not embodied. There seems no way for the teleological features of the software to reach over onto the hardware in which they are set up. Thus, systematic growth, healing, and reproduction are inconceivable.

Still, a combination of machine bodies and autonomous programming in the future is conceivable. This would make up for the lack of embodiment and even introduce new scope to the idea of life: machine life. However, again, it would be too much to say that this new form of life would be bioengineered–not even if we were prepared to accept the breathtaking widening of the scope of the term “bios” in such a case. The more decisive point is: It would be more appropriate to say that the form of life in question is engineering itself, autonomously as it were, by supplying its hardware with ever new inorganic material according to its needs.

Even here, in this scenario of science-fiction, a familiar demarcation affirms itself. The formula–inherited by Western Enlightenment and reconstructed above–is this: If you can engineer it, it does not live, and if it is alive, you have not engineered it. The more ambitious sense of bioengineering does, therefore, seem to be beyond our grasp. We see no way of leaving behind what is being captured by the basic conceptual distinction between mechanism and organism.

We have seen that neither Kant and Leibniz nor technical progress have been able to do away with the disturbingly simple fact that living substance cannot be created out of non-living substance, as it were, *ex nihilo*. That is not true for watches and canindroids who owe their existence to an engineer, providing it with purpose and goal. No matter how deceivingly detailed, Rudy the canindroid is a heteronomous being, a being whose purpose and functional organization have been bestowed to it *from the outside*. What keeps its matter together is not Rudy itself, but an engineer and the mechanistic design she imposed. In comparison, we can call organisms relatively autonomous because what is keeping their matter together are the very organisms themselves. Being alive is to be transforming inorganic matter into a body. Thus, bioengineering will be bound to mere manipulation and enhancement, cultivating what is always already alive.

Living beings cannot come from nothing. They develop in a time-consuming and complex process. This process does not invent, in a strict sense, living matter but merely transforms it. Complex living beings are produced by reproducing already living substances. Life presupposes life, albeit in simpler forms. This is why the inception of complex life forms *ex nihilo* is a mad idea. All existing forms of life come from that long process of building and trying and failing.

The traditionally established distinction between mechanism and organism was about capturing a distinction within the concept of creation. Life was created in a way inaccessible to the craft of human beings. Within the context of the European Enlightenment, this had both epistemological and ethical implications. The limits of human technology were taken to be the limits of human understanding and its rule. The exploitation of life was bound to a supposedly natural taxonomy of beings and legitimized by its normative-hierarchical implications. Now there are questions:

- Which living being is a product of nature? And which is a product of culture?
- Which technical manipulation is, as we might say, naturally stable? And which is an aberration?

- At which point does an engineered enhancement turn its bearer into a cyborg?

Essentialism–still very active within the heritage of Western Enlightenment—is the idea that there are clear-cut demarcations between what is produced by God (or nature, however, conceived) and what is produced by man. No matter how frightening the thought: we cannot refer to essentialism to decide what form of life is performing naturally and what form of life is not. Progress in bioengineering and its technical capacities continue to blur the very basic distinctions essentialist taxonomies are built on. And, supposedly, advances in the field of AI are going to blur distinctions on an even larger scale.

The inaccessibility of life has ethical implications. By working around the irreconcilable tension between mechanism and organism, rather than suppressing it, both Leibniz and Kant allowed for an ethical element, a theological rest, within their mechanistic foundations of man's mastery over nature. This element of the ethics of the inaccessible life should be taken seriously. It can be taken up and put to use in the world of bioengineering, the world of the cyborg. Following authors like Donna Haraway, we can appreciate the forced disintegration of essentialist taxonomies and their morals pressed by the growing importance of bioengineering. In her Cyborg Manifesto, Haraway (1985) not only shows how essentialism reproduces patriarchal and colonialist forms of dominating the other, i.e., women, people of color, workers, animals, by dividing and conquering matter by norming it according to antagonistic dualisms [8]. Haraway also puts forward an image of positive and inclusive practices of difference and affinity. This makes sense of Kant's and Leibniz's points. After all, every living being reproduces its standard of normality according to its own relative autonomy, the realm of material and functional variations its specific teleological constitution continuously allows for—and remains inaccessible to us.

Such ethical speculation can seem to go too far astray for the concerns of bioengineering and the people and institutions involved with it. In reality, scientific research and its industrial implementation are supposed to be very down to earth. However, that does not do away with social responsibility. For, standing at the threshold of manipulating the genetic and micro-genetic make-up of existing forms of life, two pressing images suggest themselves (compare [9]):

i. in one image, the amount in which technological capacities of manipulation of life and living substance advance is directly matched by advanced normalization and exploitation of forms of life according to the needs of profit and domination. This is the scenario where the patriarchal and colonist heritage of Western Enlightenment goes off, dispossessed of its own essentialist morals; and
ii. in the other image, the formative power [4] (*"bildende Kraft,"* KdU B293/A289) of living matter is freed and multiplied by the growing technological possibilities and its hardly foreseeable mutations. In this scenario, the amount of rising technological capacities is only matched by that of rising responsibility to care and deal with the complicity of every action and its consequences.

Conclusion

According to Kant, a non-living object is mechanistically constituted: all of its going-ons can be fully explained with recourse to efficient causes. In contrast, living beings are organisms. They are autonomously constituted by final causes, their parts being defined by the various functions they perform for the entire organism. In this way, Kant tries to improve upon Leibniz's proposal and develop a conception of living beings that avoids the trap of reification while still providing a categorical difference between living and non-living beings.

From the background of this Kantian distinction between living and non-living beings, we suggested that bioengineering can either be understood as the quest to engineer life out of non-living matter or as the quest of engineering already existing living beings. Applying the Kantian distinction to cutting-edge AI systems reveals that these systems clearly show organismic features while still lacking essential aspects of living beings. It highlights the peculiar nature of these systems, and it creates a fruitful situation for future research: how should we conceive these beings? Are we in the process of creating a third category of beings over and above non-living objects and living beings?

Also, the growing importance and capacities of bioengineering, in general, invigorate the ethical dimensions of Kant's and Leibniz's attempts to conceptualize life. Their endeavor is historically situated within a mechanistic framework of man's mastery over nature. At the same time, in ultimately respecting the inaccessibility of living matter, the two philosophers have provided us with a hint for the dystopian dangers as well as the utopian hopes for bioengineering and the powers it beholds.

Core Messages

- We have discussed a notion of the living organism based on its formal teleological structure, according to Kant.
- Organisms are contrasted with mechanistic objects, and some consequences are drawn for the notion of bioengineering.
- Bioengineering is close to a *contradictio in adiecto*: either something is alive, or it is engineered.
- We argue that the growing capacities of bioengineering invigorate the ethical dimensions of Kant's and Leibniz's attempts to conceptualize life.
- In respecting the inaccessibility of living matter, the two philosophers offer a map for bioengineering's dystopian dangers and utopian hopes alike.

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19 New Media Art: The Liminal Space Between Thinking and Perceiving

Paola Lopreiato

> "*We think in images. We thought in images before we used words.*"
>
> Harriet Wadeson

Summary

In today's era, we can say that art is often reliant on or intersects with technology. This close relationship has led to the development of new interactive systems that transcend the purely artistic purpose. This chapter describes how new media art, assisted by new technologies (and often in collaboration with science), implements and enhances our knowledge of thinking processes, emotions, and perception.

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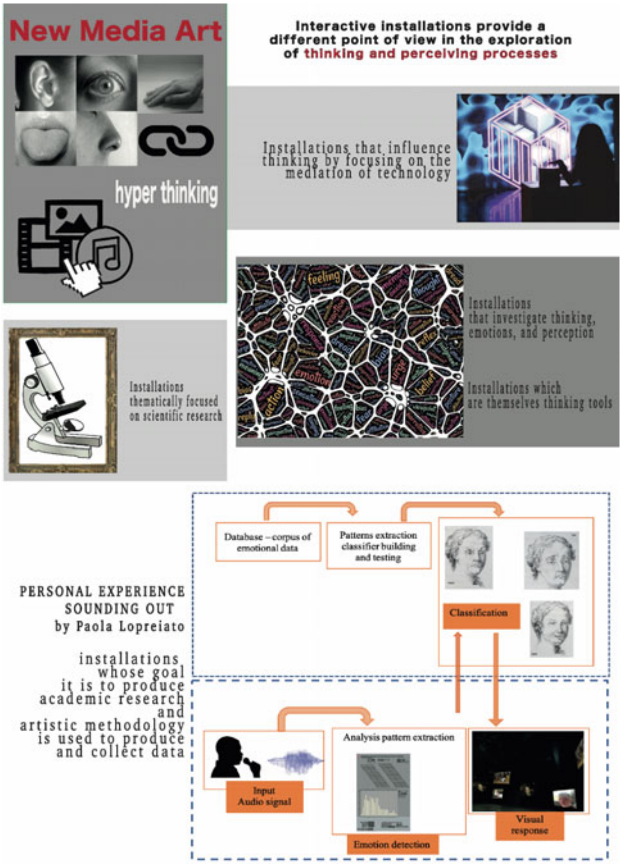
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_19



Different examples in new media art. It provides a different approach and point of view in the exploration of thinking and perceiving processes. The examples provided here are cases in which art can implement and enhance our knowledge of thinking processes, emotions, and perception.

Keywords

Emotions · Immersion · Interaction · New media art · Perception · Technology · Thinking

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

New media art, with the use of various kinds of media and state-of-the-art technology, is characterized by its ability to incorporate both video, images and text, as well as touch and smell. Furthermore, this form of art can use a non-linear narrative and hence a non-linear way of thinking. In anthropologist Frank Rose's words, "every new medium has given rise to a new form of narrative" [1]. Mediated by technology, new media art is a form of multisensorial hyper thinking through which "a new type of narrative is emerging, one that is told through many immediate ones in a non-linear way, that is participatory, and often game-like and that is designed above all to be immersive" [1]. In this new way of making art, stories are not only immersive and content participatory, but the thinking process is also transformed. The technological revolution, internet, algorithms, artificial intelligence, and software that can communicate and interact give the audience a first-person perspective. From this perspective, not only does the audience participate in the artwork as receivers of a message and spectators but also participates in the creation of the art piece. In fact, the work is not describing someone else's experience; on the contrary, the artistic experience is about the audience who is creating and taking part in it simultaneously. In recent years, artists have become increasingly interested in process-oriented art, which means that the act of creating takes precedence over the finished product in their artworks. This foregrounding of the process may or may not be discernible in the final work. This development is also because people seek immersive experiences since, in no small part, because of the use of social media, they have grown accustomed to real-time interactive communication.

History teaches us that the *work of art is the child of its time* [2] and how often artists indulged or followed the taste of the period they lived in. Contemporary artists cannot escape from reality around them, consequently including real-time and interactive communication in their art pieces. Besides being *the child of its time,* art is *often the mother of our emotions* [2], and this is why when the new media artist sets up a certain *environment for the audience to participate in*, the interaction between the audience and the artwork leads to unexpected results as it is in human nature to look for meanings and connections. The unexpected outcome of the art piece is emotionally involving but at the same time disorienting both for the audience and the artist: "we know this much: people want to be immersed. They want to get involved in a story, to carve out a role for themselves come, to make it their own. But how is the author supposed to accommodate them? What if the audience runs away with the story? And how do we handle the blur—not just between fiction and fact, but between author and audience, entertainment and advertising story and game? A lot of smart people -in film, in television, in video games, in advertising, in technology, even in neuroscience are trying to sort this question out" [1].

Contemporary art allows the audience to connect with the artwork and exchange ideas with the artist, something which was not possible or limited to the private sphere of the person in the past. In contemporary art, people share their thoughts in real-time while experiencing the installation, and at the same time, the individual, her/his experience, and reaction to the installation are used to implement the art process. The artists create situations and present content to trigger people's emotions, perception, reasoning, and decision-making. However, there is no control over what will occur in people's bodies and minds when interacting with the artwork. As opposed to non-interactive art, the audience in interactive art is not only changed by the artwork and influenced by the artist's insights but also shapes the artwork. New media artists are more often searching for reactions from the audience, using art as a thinking tool or content producer while also focusing on the mechanisms of generating insights.

New Media Art: Artistic Case Studies on Thinking and Perceiving

Current artistic experimentation investigates topics such as thoughts, perception, and feelings, sharing aims and technology with scientific research. Art, as well as social disciplines (philosophy, psychology, and anthropology), have always shared a curiosity towards life sciences and many examples in art prove that art can be a way to improve academic research. It should be, in fact, underlined that art is not purely speculative in nature and that many case studies illustrate how art can be reliable equally in terms of research methods and results. Since this essay addresses issues related to thinking, emotion, interaction, and perception, the examples I detail below deal with one or more of these aspects, all mediated by new media.

I will draw here on several examples of installations constructed by artists (often in collaboration with scientists), including Julian Olivier et al., Jane Grant et al., Youssef Kashef, Abdelrahman N. Mahmoud, Rana el Kaliouby, Henrik Lörstad, Mark d'Inverno, John Eacott, and Bill Viola. For this purpose, I have divided the installations into five key types:

i. Installations that influence thinking by focusing on the mediation of technology;
ii. Installations that investigate thinking, emotions, and perception;
iii. Installations which are themselves thinking tools;
iv. Installations thematically focused on scientific research (where artistic knowledge is generated regarding science); and
v. Personal experience installations focused on academic research (where artistic knowledge and methodology are used to produce and collect data).

Installations that Influence Thinking by Focusing on the Mediation of Technology

In this type of installation, a person activates something, e.g., a sound, image. A sensor or software captures and manipulates data that can then be explored by that person, who can move around and provoke different situations and thereby understand how the sensor/software works in a set situation (i.e., a performance or an installation). The artwork aims to create a device to influence people's choices. An example of this is "The Advertiser," by Julian Oliver and Damian Stewart: "The Artvertiser" (2008) is a software platform for replacing billboard advertisements with art in real-time. This project, by Julian Oliver and Damian Stewart, works by teaching computers to "recognize" individual advertisements so they can be easily replaced with alternative content, like images and video" [3].

In this artwork, people use a unique device to look at their surroundings and detect advertisement billboards, which they can then substitute with other images through software used by the device. The result is not as engaging and primary as the concept of mediation itself. In fact, the way we perceive things and understand them (i.e., mediation) in this improved reality situation (as the artists call it) and the device and its interventions are the aims and principal concerns. During the live presentation of the project (in Berlin as part of Transmediale 2010, Brussels for the Europe-wide Media Facades Festival and Rotterdam's Image Festival), the artists and scientists exhibited how and what the software was doing through the device. Even though for the artists, people's choices and actions were the uncontrolled part of the work and less important, these actions and choices were important as they were useful to explain the role of the software and how it shaped people's interaction with reality: "any system that relies on a programmer to input rules of behavior will eventually run into a situation that programmer hasn't thought of" [1].

Staying in the realm of uncontrolled outcomes, *Intelligent Street* by Henrik Lörstad, Mark d'Inverno, and John Eacott is another work that seeks to blur the traditional distinction between the creative process and artistic tools and between the artist and the audience. This installation is a way to compose music by participants triggering sensors: people can use the installation to make music, rendering them both musicians and listeners (Herber: 2007) [4]: "Intelligent Street was a telematic sound installation where users could compose their sound environment through SMS messages sent via mobile phone. The piece was developed in 2003 by Henrik Lörstad, Mark d'Inverno, and John Eacott, with help from the Ambigence Group. Intelligent Street was situated simultaneously at the University of Westminster, London and the Interactive Institute, Piteå, Sweden via live video connection. Users at either end of the connection were able to see and hear the results of their interactions. Using freely associated, non-musical terms such as ``air' or ``mellow,' participants sent an SMS message to Intelligent Street, and were able to hear how their contribution impacted the overall composition" [4].

The focus of the installation, in this case, is therefore on the product rather than on the process. However, each of these types of installations (including the examples described above) differ in terms of their approach; in each case, the medium, the reaction, and personal judgment influence the participants' awareness. In all these situations, there is also an additional step, which occurs when the participant not only feels and perceives these effects but when the effects, which influence the environment, change the person's thinking and decision-making process. There is thus a continuous progression of change and reaction in participants' awareness as they follow new paths and create new layers of experience. Nevertheless, this final step sometimes remains implicit. For example, Eacott et al.'s intentions are concentrated on showing how music can change the mood of physical space [4], while for Julian Oliver and Damian Stewart, the device and its mediation are the principal concern.

Installations that Investigate Thinking, Emotions, and Perception

In this kind of installation, the aim is to explore emotions created by the effect of people's actions and reactions; the reactions from the participant trigger the system in the installation, which, in turn, stimulates people to reflect on their emotional world. An example of this is "The Chameleon Project" (2008–2010) by Youssef Kashef, Abdelrahman N. Mahmoud, and Rana el Kaliouby. Their article The Chameleon Project: An Art Installation Exploring Emotional Contagion explains how they tried to explore emotional contagion and emergence through art practice. They outline the installation as follows:

The participants will enter a defined space. Three screens are connected to three computers. Each screen will be displaying a digital portrait of an everyday person showing expressions that can be classified within six emotional states (happy, neutral, sad, angry, disgusted, surprised). The digital portraits are programmed to wait in the background until the emotional face reading system senses a participant's face. After sensing the emotional expression of a participant's face, the video portrait will walk forward to address the participant, attempting to begin an emotional dialogue with the participant that would be perceived as emotionally congruent to the participant's emotional expression. The video portrait will attempt to stimulate the participants in such a way as to elicit an emotional facial expression from them that is recognized by the emotion face reading system. The system constantly monitors the facial expression of the participant, selecting video portrait segments that aim to respond to the audience in an "emotionally intelligent" way, in order to build an emotional bond with the audience. The work can interact with three people at a time. If the system finds that one participant has a particularly strong emotional expression, the emotion is propagated to all three monitors. People can leave and enter as they wish [5].

Here, the primary concerns are emotions and how to trigger them; people are part of this exploration because they are the element that sets off the process and through which the result is observed. The artists and scientists who created the work wanted to, above all, explore the emergence of emotions. What the artists needed for this artistic case study was a reaction, not people thinking of or lingering in their new mental and physical states. Even if the authors state that the audience's thoughts were not the main subject of analysis and that their work does not aspire to make people dwell on what they experience, reports on the installation from participants were used as tools and reported in the Chameleon research project. Those reports were interesting as they showed the connections between people's mental processes and physical states in relation to the system (video and cameras). As reported by participants, what they took away from the installation was an augmented awareness and a new way of thinking about the consequences and interaction between man and machines: "in an attempt to recreate the emotion, the feeling flooded back. I felt quite moved, this intimate relationship with a camera lens was a new experience for me, and I found its scrutiny a great challenge" [5].

Installations as Thinking Tools

There are examples of artworks that we could say go deeper in the study of thinking and decision-making. The artist group Knowbotic developed models for digital representation of understanding in the art project "Dialogue with the Knowbotic south (DWTKS):"

> Their virtual installation dialogue with the Knowbotic South reach has been exhibited at several exhibitions; it processes scientific data from research stations' networked databases to create a changing abstract representation of Antarctica. It visualizes and maps Antarctica in a totally non-mimetic way. In DWTKS, the data from the networks is visualized as changing starbursts pixels on large projection screens in a dark room. The data is collected and activated by softer agents, the knowledge robots or KnowbotS (Grau O. 2003) [6].

This installation, more than being an example of the analysis of thought, is an example of a thinking tool; the data collected from scientists are presented to the public through virtual software, an interactive tool that uses a virtual environment to represent data with pixels. People moving in the virtual reality (VR) environment can change it by activating related sounds. The authors (scientists and artists) aimed to create a world where people can understand data but at the same time can interact with them, creating and generating events and, consequently, poetic moments. This is, therefore, an example of cooperation between art and science and of how artists not only show and explain information and scientific findings but can encourage reasoning. As the historian Oliver Grau states, if software or computers communicate and translate content, they can be considered thinking tools; consequently, as *DWTKS is an installation based on such a system, it becomes a thinking form of art*: "theoretically, if the computer metamorphoses into a universal translating machine for sensory impression than it should be considered a thinking tool. To put it briefly, the structure of a program's data organizes symbols for a specific purpose. For many years, the only mode of operation was the question and answer dialogue and abstraction that effectively created a considerable distance between artists and work. Thus, attention and creative thought are bound, to a large extent, to the interactive features of the program" [6].

Another example of art that boosts thinking and stimulates choice is ``Ultima ratio" by the German media artists Daniela Alina Plewe. In this installation, the visitor participates by co-operating with the setting. The automatic system suggests the visitor should resolve a conflict, for example, whether Hamlet should kill or not kill Claudius. The public can also provide the system with new inquiries and conflicts to resolve. As such, the interactive and simulated decision-making is not just unidirectional, going from the software to the person, but also allows new insights from the visitor to be offered to the system to develop it. New media art that involves technology and advanced algorithms and can interact and change through the interaction with people experiencing the installation is the way how contemporary artists make people reflect on reality while creating new thinking pathways. As Grau states, Plewes's work *Transcends the traditional concept of rationality* [6], and she overtakes the usual thinking process. History of art teaches us that this has always been the aim of artists or at least has been so consequently. The difference between traditional art and new media art is that now people not only receive information from and are stimulated by the art experience, but they can also contribute to the realization of the artwork itself and are part of the process of creation in a mutual exchange.

Installations About Science or Adapting Scientific Findings and Theories

A significant example of this category is the work of Jane Grant, specifically her works “Ghost,” “Fragmented orchestra,[1]” and “Threshold,[2]” which were “developed through the desire to sonify thinking to make audible the firing patterns in the cortex” [7]. In these works, it is possible to see how neuroscientific discoveries and theories can be explored and explained through art practice: “we hope that the project will illustrate the complexity of consciousness and create an artwork that is beautiful both in itself and in the parallels it has with the process of the brain” [8].

Throughout her artistic career, Prof. Grant has tried to give voice to neuroscientific topics involving perception, memories, and thinking. As expressed in her papers, she seeks to give an artistic form to the brain and its patterns:

> The Fragmented Orchestra is a vast distributed sonic structure created by Jane Grant, John Matthias and Nick Ryan. It was installed in the United Kingdom between December 2008 and February 2009. It consisted of 24 fixed geographical locations, including FACT, Liverpool, University of Plymouth, Landscove Primary School, Devon, The National Portrait Gallery, London, Millennium Stadium, Cardiff and Kielder Observatory, Northumberland. At each of the locations, a 'soundbox' was installed, which consisted of a microphone, a small computer connected to the internet and a Feonic' drive', a device that transmits audio through resonating architectural surfaces. Sound made in the spaces was transmitted across the internet to a server computer in the FACT gallery. In this computer, we ran an artificial neuronal network, an adaptation of the Izhikevich's recently developed non-linear integrate and fire model that incorporates spatial 'axonal delays' between synapses and a spike-timing-dependent plasticity algorithm, which causes the synaptic strengths between neurons to become updated as a function of the differences in signal arrival times [8].

Another important example of art researching perception, memory, and mental processes is the work of Bill Viola:

> “Viola's primary subject is the physical and mental, the connections and interplay between the outer world and the inner realm. He is concerned with exploring the interaction of his images with the viewer's memory, as well as with the subconscious and its dreams and imagination. He is particularly interested in that moment of exchange between the viewer and the artwork when energy is, released and the viewer achieves a new awareness. “In a way my work is very literal, but it has more to do with the after-experience than the actual experience in itself,` he told an interviewer.” As if memory were a sort of filter, another editing process. In fact, the editing is going on all the time. Images are always being created and transformed… I think memory is as much about the future as it is about the past … I'm interested in how thought is a function of time, there is a moment when the act of perception becomes conception, and that is thought. For Viola, the image is merely a schematic representation of a much larger system, and the process of seeing is a complex process that involves far more than surface recognition” [9].

[1] By Jane Grant, John Matthias and Nick Ryan.

[2] Composed using the Neurogranular Sampler, a digital instrument created by John Matthias at Plymouth University

In Viola's work, as in the work of Jane Grant (John Matthias and Nick Ryan), the central aim is to make the audience explore the concept that is proposed.

Personal Experience: Installations and Artistic Methodology Used to Produce and Collect Data (Within Academic Research on Emotions and Sound)

Each discipline studies a topic from its perspective and uses instruments that are inherent and functional to its approach. Usually, when science (more specifically biology and medicine) studies emotions, thinking, and perceiving, the variables are related to biofeedback analysis such as galvanic skin response (GSR), heart rate (electrocardiography or ECG), and brain activity (neuroimaging). They are measured using instruments, for example, functional magnetic resonance imaging (fMRI), skin conductance recorder, and heart rate monitor (HRM). Regardless of the tools used to produce and collect data, data analysis and usage are essential, especially for contemporary art. In fact, in the past, artists changed their focus from the portrait of nature to the industrial object, or their means from canvas and brushes to their own body; in our technologically mediated era, the artists have focused on data and computation. Furthermore, this is also an era in which art and science often collaborate, especially in disclosing the secrets of the unseen world. As the writer, L. Manovich, states, “the desire to take what is normally outside the scale of human senses and to make it visible and manageable” aligns new media art and data visualization art with modern science.

> The desire to take what normally falls outside of the scale of human senses and to make it visible and manageable aligns data visualization art with modern science. Its subject matter, i.e. data, puts it within the paradigm of modern art. In the beginning of the twentieth century art largely abandoned one of its key—if not the key—function—portraying the human being. Instead, most artists turned to other subjects, such as abstraction, industrial objects and materials (Duchamp, minimalists), media images (pop art), the figure of artist herself or himself (performance and video art)—and now data. Of course, it can be argued that data art represents the human being indirectly by visualizing her or his activities (typically the movements through the Net) [10].

My artwork and research projects reflect the shared curiosity of disclosing the secrets of the unseen with science and show the influence of the technologically mediated era through the use of digital art and VR. My installations “Sounding out” and “Seams” are examples of the collaboration between art and science in research and how art can be a potent tool to implement and fill gaps in research in perception and emotion.

Emotion categorization is, in fact, one of the most interesting undertakings in speech signal processing both in science and art, as sound is an essential vehicle for interaction that can be used to recognize the speaker, speech, and even emotions. Current academic research and knowledge in this field are based on the conviction that our comprehension and consequent response to others’ emotions are due to our ability to judge the content of a speech, its volume and frequency or time rate of speech, hypernasal resonance, and breath emission [11].

However, my artistic research led me to conclude that emotions also change the overall energy of the sound we emit, which is an invisible mechanism compared to more accessible physical information such as pitch and amplitude. To outline the emotional states in sound during my installations, I needed a tool capable of detecting emotions in voices in real-time. Nevertheless, reviewing current studies in this field and the tools and methods they applied, I realized that they were not suitable for my artistic research process. Analysis of content, breath emission, and detection of peaks was time-consuming. It could only be done after recording; so, the existing methods did not allow me to carry out the analysis in real-time. Furthermore, these research methods did not consider the detection and analysis of emotion in a natural setting, the issue I was interested in as an interactive audio-visual artist. Hence, I thought of a parameter and a tool that did not depend on the person's ability to express emotions (in a definite way like actors), the situation, or the equipment I was using. The parameter I used was the energy distribution in sound, specifically in human voice emission. I[3] designed a program in Max/MSP software, the so-called "energy band analyzer," that examines the different energy distributions in speech signals in an emotional situation. The tool (Max Msp) was initially designed for music composition (and is used mainly for live composition). It includes several algorithms for the analysis, recording, and manipulation of sound. The "energy band analyzer" divides the spectrum of the audio coming from the microphone in 25 filters to decompose the sound flow into a continuous stream of 25 values that represent the distribution of the acoustic energy of the sound event. This is possible as the patch calculates the average energy per critical band while integration/accumulation of the energy acquired for each critical band is collected; the algorithm also evaluates the percentage of energy acquired until the time t_x for each band in relation to the total energy output of the sound until the time t_x (Fig. 19.1).

There is an absence of research on sound energy distribution, and it has never really been considered a key factor in detecting emotions in sound. Extracting the information on energy distribution in speech, the "energy band analyzer," however, has proved to be a reliable tool to deduce the emotional state of the speaker without relying on the contents or the environment of the footage; moreover, the signal's quality does not influence the results. I first worked in my studio using the "energy band analyzer" in Max/MSP to examine recorded sound samples, producing a series of graphs. The data confirmed a correlation between the energy distribution in the voice and the emotional state of the person. Based on these findings, I then included the patch in my installation to detect emotions in real-time. The installation can be figuratively understood as a way to see the unseen. In the installations, the "energy band analyzer" detects the participants' emotions analyzing their voice

[3] The "Sounding out" project and installation is a solo project, but the patch used in the project was made in collaboration with prof. Alfonso Belfiore. So, when I talk about the max/Msp patch and I mention myself I mean "me and prof. Belfiore" as this patch was created rearranging the patch of the project Quanta of Sound.

Fig. 19.1 Energy band analyzer. This figure shows the functioning of the patch during the analysis of a live audio sample. The screen is divided into six parts. This image shows part n.1, where the audio is selected; n.2, where the artist can see the live processing of energy; n.6 that is the on and off button; n.3 that shows the live energy progression in each of the 25 bands (which are approximate of 100 Hz each)

in real-time, and provides the participant with a coherent visual response to show that the system recognizes the inner states (mind) in the shape of energy (body and environment).

"Sounding out" was an artistic experiment to prove how art can contribute to knowledge on this new relationship between emotional states and sound (analyzing energy distribution instead of using the usual parameters). It led to the offer of a new track/display system for outlining these relationships and opened up new scenarios in the production of dynamic interactive art that reacts to the perceived emotions (Fig. 19.2). However, my interest was not only to create an artistic tool to produce and collect data for academic purposes but also to find a way to represent these data through art and disseminate results (Fig. 19.3).. From this starting point, I implemented my work on emotions by using immersive video to visualize the collected sound analysis data, and I developed a second installation called "Seams." These two installations allowed me to examine the physical features of emotions through data analysis (Sounding out) and data visualization (Seams). The computer could recognize the speaker's emotional state or at least the speaker's intended emotions by using specific sound analysis. At the same time, the immersive installation Seams made the study's data more accessible and intuitive, not only for researchers but also for a broader audience.

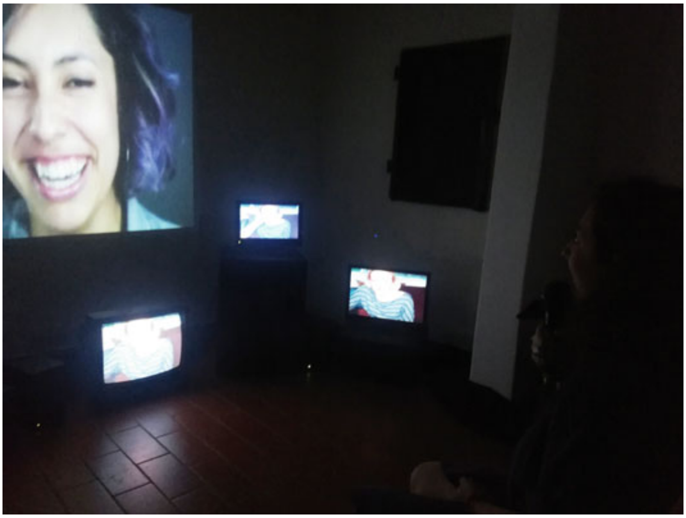


Fig. 19.2 Energy distribution of sound in the 25 bands. The heat map shows how sound energy is distributed in every 25 bands and outlines the difference between anger, happiness, and sadness

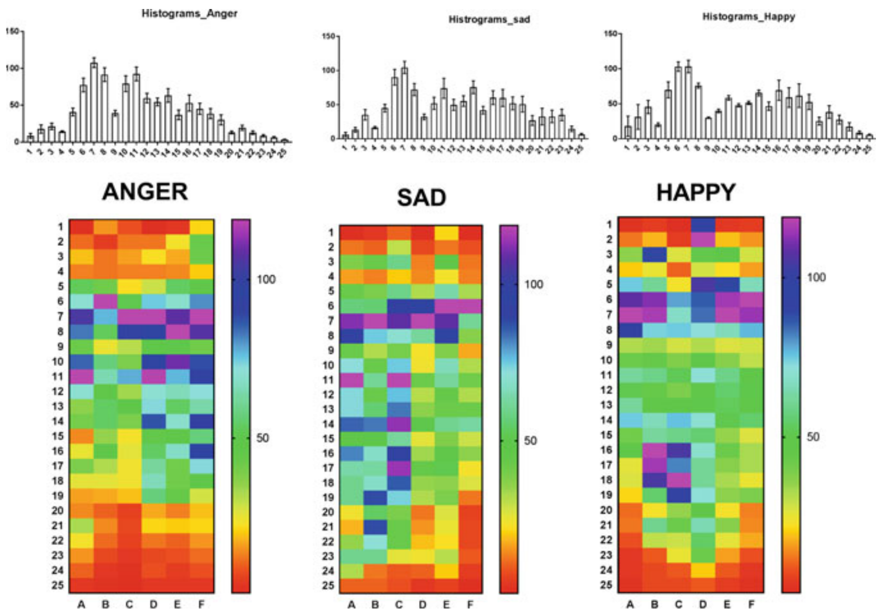


Fig. 19.3 "Sounding out" exhibited in Florence June 2018 at the "il corpo la luce il suono" festival

In “Seams,” by using non-verbal interaction (VR videos and music composition), I could convey to the public the results of the analysis done in the installation “Sounding out.” Instead of the statistical graphs and maps employed by scientists to explain and show results, I used 360° video and music to convey my results. The VR videos of “Seams” are a visual and audio narrative representation of the discoveries made during the “Sounding out” project. The advantage of using visual tools to convey my results to a broader audience (other than just academics) is that art (the VR installation) “creates knowledge that connects the head to heart” [12].

The term visual narratives representations expand on Lieblich who stated that investigation of any research questions "can use narratives"; and that "the narrative (itself) can be investigated by researchers as their research object" […] I refer to Denzin and Lincoln who say: "The visual narrative tells many different stories at the same time as it mixes and combines multiple images" […] A visual image narrative allows us to "listen beyond the words". The therapeutic advantage of storytelling in art-therapy-based research is the way it creates knowledge that connects “head to heart” [12].

As data and graphs are challenging to interpret and less straightforward means of communication, I found that my installation (Seams) was a complementary and more direct way to speak to people and show the connection between sound energy and emotions, which emerged from my analysis of sound.

Representing one data set into another is quite common practice, particularly in the computer era. From the sculpture of Jeremijenko, which is wired to traffic data and reacts in real-time to the changes in traffic dynamics, to the neurogranular sampler designed by Jane Grant (et al.), which “was developed through the desire to sonify thinking (Grant et al. 2009),” in many contemporary installations the aim is to give an artistic form to patterns of human behavior and thinking. As Manovich says, “data visualization moves from the concrete to the abstract, and then again to the concrete” [10]; as such, in “Seams,” I outlined patterns and structures from the analysis of voice recordings (concrete) and then converted them into many vibrant visual images and sound elements (abstract) so to translate what I discovered into art (concrete).

Conclusion

Art is the experience of expression, communication, and sharing and is crucial in investigating mechanisms that constitute the inner emotional world in terms of thinking, logical, and rational expression. It is an expression of lived reality. On the one hand, the knowledge of the brain and body, their structures, and their functioning can be a way to understand certain aspects of art. On the other hand, this chapter shows art as a tool for investigating the functioning of our mind, central nervous system (CNS), body, and perception. Our mind formulates our feelings, from which our own thoughts, perceived objects, concepts, and interpretations of the world and reality arise. In this vision and immersed in this stream of consciousness, our journey towards art begins. The work of art embodies the creative act of directing inner and outer energies and impulses, whose deeper meaning is perhaps irremediably unreachable. The characteristic of art to organize and canalize inputs from and to the world makes the artwork a ritualistic process, extraordinarily capable of offering a projection of the inner world of one's mind to others and vice versa. From this perspective, art can be considered an incarnation of a soul in an empty body. For the observer, art can also become the medium that enables communication with the concrete and the phenomenological. New media art is further an occasion to reflect, recognize, and perhaps understand nature concretely and unexpectedly. Hence, when we research, why is it so important to choose a different approach and not only a purely scientific one? It is essential because if we investigate reality, we are not only talking about the matter, the flesh, or the neuronal connexions. Reality is about the relationships between the inner and outer world, the body and mind, between people, between past and future, between the singularity and the context, etc. With all these things happening together, it is hard to believe that the purely scientific approach can be the only way to carry out research, giving us a complete picture of the overall phenomenon. Life is about singularity, uniqueness, and specificity; therefore, when a scientist takes away the peculiarity of a person or situation to verify something, he indeed verifies something, but at the same time, he revises a lot of what is happening. In academic research, the subjectivity of both the situation and the observer needs to be eliminated from any scientific experiment. However, nowadays, more and more often, other disciplines (among which art) are becoming relevant in research to close the circuit between the rational mind and the unconscious mind and enable communication between them. From this perspective, I hope that the collaboration between art and science will increase in the future.

Core Messages

- In investigating the functioning of our mind, it is important to recognize how contemporary art is a valid research tool.
- Interactive installations provide a different approach and point of view in the exploration of thinking and perceiving processes.
- New media art, with its use of multiple tools and its capacity, can stimulate several senses.
- New media art is considered a form of multisensorial hyper thinking that provides non-linear and alternative approaches.

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Towards a New Science of Interfaces: Bridging Art and Engineering

20

Luca Iandoli, Alejandro Salado, and Giuseppe Zollo

> *"I like the rule that corrects the emotion. I like the emotion that corrects the rule."*
>
> Georges Braque

Summary

The practice of systems engineering has been said to be both an art and a science. While the scientific part is necessary to produce actual designs, the artistic one seems to drive the value of the underlying system structure. Should certain aspects of art be integrated with engineering? Interestingly, systems engineers and master painters seem to use a similar set of rules to effectively manage complexity, balancing rules that reduce noise with rules that add meaning. Furthermore, there is a strong resemblance between the problem context and the solution processes of large artistic endeavors, such as original film scores and theatre productions and large engineering projects. In this chapter, we explore how the arts can be leveraged to design effective interfaces. There are many cases that the complexity of the interaction between a user and a system mostly occurs at the interface level. We suggest that any interface

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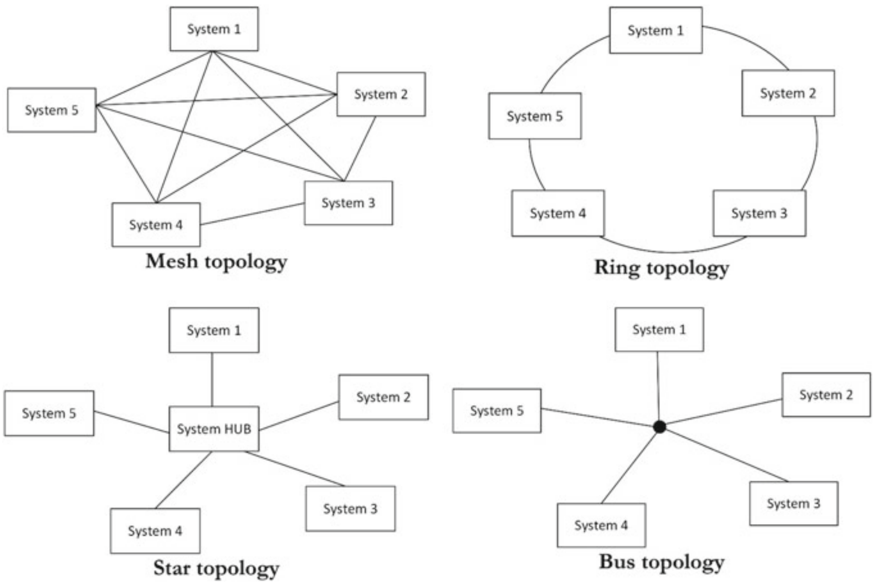
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_20

contains a set of messages for the users as encoded by the designer and that the proper encoding of this information is critical in enabling a satisfying level of interaction. In this sense, an interface design, as creating an art piece, is a communicative act, where both artists and engineers package information to deliver meaning. In this chapter, we show, supported by examples, that such meaning delivery can be more efficient and effective if the aesthetic value is incorporated in the interface's design.



Fundamental network topologies

Keywords

Art · Engineering design · Interface design · Product design · Systems architecture · Systems engineering

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of THINKING: Bioengineering of Science and Art.

Introduction

Commonly known as "*a transdisciplinary approach and means to enable the realization of successful systems*" [1], systems engineering can be conceived as "*the engineering discipline that deals with the study and application of strategies to ideate, realize, and operate engineered systems*" [2]. Interface design and control is a core activity of systems engineering [3] and is central to this chapter.

The practice of systems engineering has been said to be both an art and a science [4, 5]. While the scientific part is necessary to produce actual designs, the artistic one seems to drive the value of the underlying system structure [6]. Many believe that effective systems engineers must exhibit a good balance of technical and cognitive skills [4, 5, 7]. The need for this balance has inspired some colleagues and us to actively explore how the arts occur in and may enhance the practice of engineering [8].

While in art and humanities, the pursuit of aesthetic values is ubiquitous, the aesthetic discourse has been systematically overlooked in modern and contemporary engineering and science, a tendency that has contributed, we believe, to widen a deep disciplinary gap between humanistic and scientific knowledge. We deem this gap to be not only merely academic but also a missed opportunity for the broader development of engineering and technology design. Fortunately, there are some signals that this attitude is starting to change. For instance, some NASA leaders have claimed, since at least 1969, problems with the development and delivery of engineered systems lie at least partially in not pursuing elegance in engineering [9, 10]. A possible reason for this is that elegance is "*immediately apparent when it exists, yet it is difficult to define*" [9]. On the contrary, following a set of codes or established procedures provides a more objective framework for conducting and or driving engineering assessment.

We suggest that the subjectivity of aesthetic appreciation should not be a limiting factor for its pursuit in engineering contexts. Moreover, in this chapter, we show that certain aesthetic properties, such as elegance, have an objective component as well, as highlighted in recent studies in neuroaesthetics [11], which shows that master painters, for example, tackle complexity by resorting to a set of rules that the human brain interprets as elegant or beautiful [11]. We have shown in prior work [12] that the elegance of system architecture (that is, the underlying structure of an engineered system), as scored by engineers, and an objective metric as its effective complexity are strongly correlated [12]. Interestingly, we also found patterns based on rules of design heuristics guiding *"the structural form and the dynamic behavior of architecture to reduce its complexity"* [13]. These heuristics are similar to those employed by master painters in the arts and fall into two main classes: meaning-adding (MA) and noise-killing (NK) strategies [14]. Surprisingly, it turns out that both systems engineers and master painters balance these two classes of heuristics to manage complexity effectively. In the arts, *"if one relies on NK strategies alone the experience is oversimplified and its interpretation becomes dull and trivial; conversely, too intense use of MA strategies makes a representation overwhelming and unnecessary complex"* [14]. In systems architecture, NK strategies address the simplification of a complex concept or system to its essential core constructs. In contrast, MA strategies capture the complexity of the system by highlighting the interaction of those constructs [15]. Furthermore, these NK and MA techniques are effective in systems engineering practice to manage complexity [12], communicate system models [16], and capture and convey tacit knowledge through aesthetic judgments [17].

Similarities between the arts and engineering are not only limited to techniques employed to engineer a system but also in the problem context in which large artistic endeavors occur and the processes used to undertake them. Specific examples have been established for the creation and production of the original score of a film [18] and the production of a theatre show [19]. The former study mapped composition and recording tasks to systems engineering activities (e.g., dramatic structure analysis, cue sheet creation, the description of main leads and their composition in the arts, versus identification of design objectives, system architecture, and detail design in an engineered system), as well as the organizational structures of the two (e.g., arranger, composer, and orchestra in the arts versus prime contractor, subcontractor, and system integrator in an engineered system), and the different stakeholders that they need to (e.g., film director, scriptwriter, the audience in the arts versus customers, owners, users in an engineered system). The latter study identified specific methods that were common to both the theatre production and the development of an engineered system, which included, among others, preference elicitation, leadership, teamwork, integrating different viewpoints, and design reviews.

In this chapter, we explore how the arts can be leveraged to design effective interfaces. In many cases, the interface is the only part of a system that is visible to the user. At the interface level, most of the complexity of the interaction between a user and a system occurs. We suggest that any interface contains a set of messages for the users as encoded by the designer and that the proper encoding of this information is critical in enabling a satisfying level of interaction. In this sense, interface design is a communicative act, and the parallel with artistic intent is tantalizing: both artists and system designers package information to deliver meaning. We suggest that the same dynamics are also in play when designing internal system interfaces (that is, interfaces that facilitate machine-to-machine interaction). This chapter shows that such meaning delivery can be more efficient and effective if the aesthetic value is incorporated in the interface design.

In the next section, we show that interface design is primarily about facilitating users in processing abundant information, even more so in the presence of increasing digitalization. We then present a theoretical framework based on neuro-aesthetic research, evolutionary psychology, and art critique showing that aesthetic judgment is a tool our mind has at its disposal to resolve complexity. Finally, we provide some evidence that the aesthetic approach to interface design can be successful through three case studies referring to well-known products and systems.

Interface Design in the Age of Overabundant Information

Digital technologies provide tools and means that could enable us to apply information and intelligence more efficiently and incorporate them into products and services. Electronics and software are now accounting for the value of a car by 50%,[1] while this was unimportant previously, with about 1% in the 50 s and 10% in the 80 s. Electric and self-driving cars are probably the best when thinking about increasing the current value.

An executive working for Domino's, who was a guest speaker in one of our classes, told us during the break that "people think [Domino's is] a pizza company, [when] in reality [it is] an information technology company." He was alluding to the sophisticated technology that Domino's has to digitalize the experience of ordering and delivering food and capitalizing on the vast amount of analytics that pizza ordering makes available.

These are just two examples from quite traditional industries showing how digitalization changes the production and fruition of goods and services in all sectors of the economy. While digital technologies empower our experience in many ways, this empowerment comes with a price: *information overload*.

Proper delivery and organization of digital information become so of the utmost importance, not only for data scientists and app developers but virtually for anybody that has to handle big data and needs to communicate digitally (and who does not?). Anytime we deliver or collect information through some digital medium, the relationship between what we want to communicate (content) and how to visually

[1] https://www.statista.com/statistics/277931/automotive-electronics-cost-as-a-share-of-total-car-cost-worldwide/

arrange this content (format) becomes even more crucial than in non-digital media. Think, for instance, about the level of editorial curation that Instagram users adopt when posting a picture.

Digital designers and companies are at work to help us deal with this increasing flow of information, and several approaches to create solutions have been proposed. We classify these approaches into four broad categories, which can, of course, be combined: information filters, persuasive technologies, aesthetics, and natural language.

Information filters include algorithmic data-driven solutions that screen information based on our preferences and choice behaviors. Filters trace individual and collective behavior and can learn what we like from the digital traces we leave when we use our digital devices in a connected mode. Collaborative filtering is a technique that exploits high-precision profiling techniques to infer what we like from what "people like us" favor. Filters have the huge pro of making this information screening layer completely frictionless for the users. However, filters also come with critical cons:

i. first, they may create information bubbles [20] and reduce exposure to diverse information;
ii. second, they lack transparency: users are generally not aware nor of the amount of personal information they share, neither that the information they are fed with is highly personalized (for instance, not everybody knows that two users using the same search keywords will see quite different results if they google the same query); and
iii. third, more important for this chapter, filters favor passive and shallow consumption of information that can impair critical thinking, reflection, and proper understanding of content.

Another way humans cope with abundant information is through habits. Habits are routine behavior that enacts standardized and almost unconscious responses to recurring or similar stimuli. Habits can be extremely efficient, but they suffer from the same limitations of filters (suppression of diversity, passivity) plus another big shortcoming: habits can induce addiction. Addictive behavior has been openly pursued by digital designers following the paradigm of persuasive technologies [21] when a clear understanding of the phenomenon is absent because of the regulators' laziness on the matter. Resistance to changes can be explained by the huge economic interests behind hooking up users to a certain app or platform. As we know it, the digital economy is an economy of attention; the more users' attention is maintained, the more it can be monetized through ads or data selling. While the persuasive design was born from making our devices and technologies more user-friendly, it is only a few steps away from a manipulative and unethical design that tricks users into habits patterns companies can easily monetize [22].

The third approach to help users to cope with information overload is aesthetics. This trend is visible in the pursuit of simplicity in product design [23], leading to a revival of minimalism and Bauhaus-inspired rational and clean design [24]. Surely, aesthetics has always been a differentiation factor in consumer products, but there is more than that. In this chapter, we argue that we like a beautiful design not only because it is aesthetically pleasing but because a rewarding aesthetic experience is an effective way to deal with the increasing complexity of our lives in the digital age.

The design of aesthetically pleasant products makes even more sense when most of the information we process is originated from visual stimuli. We live in a visual digital age. Digital technology makes the production and consumption of visual content more affordable and widespread than ever, but it also generates the need to digest torrents of data. For this reason, companies are increasing their efforts in developing more effective interfaces, which are themselves visual. Relying on visual information has its inconveniences as well. Unlike text, images are hard to compress and search. While more capable and faster hardware and networks can overcome the problem of transmitting visuals over the internet, the possibility to compress an image is also a proxy for its complexity: the more complex a visual is, the less it can be compressed. The difficulty of compressing an image is thus a symptom that we lack effective technologies to understand images.

Companies are trying to overcome the limitation of visual interfaces with voice-activated control based on natural language processing enabled by artificial intelligence (AI). While these technologies have achieved maturity and reliability levels that can be embedded in consumer technologies, we are only scratching the surface of the complexity of language-based human–machine interaction. As Kuang and Fabricant [22] notice, the level of interaction users can have with a voice-activated assistant is rather shallow. We argue that this lies in that current language processing can still not support the level of generative conversations through which humans learn from each other. For instance, when we are looking for something in a department store, the store clerks can proactively help us not only with standard questions but also with a more sophisticated understanding of what we really need or trying to say.

While we wait for AI’s substantial progress in this field, we can still try to develop a novel and better approach to the design of visual interfaces by leveraging our brain's natural capability, the ability in this chapter we refer to with the expression aesthetic reasoning. As we argue in the next section, most of our reasoning is, in fact, based on aesthetic judgment, and in particular, we focus on how the production of aesthetic judgment relies on a fantastic capability to compress meaning into highly communicative representations. In the next section, studies in neuro-aesthetics show how this ability to convey sophisticated meaning with highly communicative effectiveness is particularly present in artwork creation and fruition.

We argue that aesthetically optimized visual communication is an effective solution to handle information overload and counteract two opposite and negative trends that can be abundantly observed in the bad design of many interfaces: overdesign and underdesign. Overdesign overshoots complexity by stuffing our devices and lives with more features, layers, functionalities, structure, and gears, while underdesign consists of trivializing the user experience by making it as frictionless as possible but also meaningless and passive. The obvious solution is that a design should be “*as simple as possible, but not simpler,*” as Einstein thought. Following ideas developed in the science of complexity [25], we call this ideal level of complexity effective complexity, and in the following section, we show how aesthetic reasoning in design can help us achieve it.

The Proposed Framework

The design of effective interfaces requires a deep and thorough understanding of personal user experience during the interaction with a device. Personal experience is an essential source of learning for both individuals and designers, but it is problematic, as experience contains abundant and ambiguous information. Besides, while some aspects of experience can be assumed and even predicted, the interaction with a new device is likely to entail surprise elements.

Abundance

In 1983, the Italian writer Italo Calvino published a book [26] whose main character is Mr. Palomar, a very acute observer who spends his time trying to describe every detail, even the most microscopic, of his visual experiences. Here is an example of how Mr. Palomar describes a lawn: “*between a small plant and another there is always a leafy sprout which barely emerges from the soil and has a white hair as its root that is almost invisible; a minute ago we could have neglected it but soon we'll have to count it too. Meanwhile, two other threads that a little while ago seemed just a little yellow here are now definitively withered and should be canceled from the account. Then there are the fractions of blades of grass, cut in half, or levelled to the ground, or torn, the leaves that have lost a lobe…*” [26] [our translation]. Palomar feels the frustration that he cannot exhaust the description of the lawn in any possible detail. At every moment, he must decide what to overlook, what to highlight, how to group different elements into a broader category, but above all, he must decide when to stop. In Palomar's obsession, we see the signs of pathology: the impossibility of defining what is important and what is not. It turns out that it is not information that helps us discriminate relevant events from irrelevant ones but emotion.

The neuroscientist Antonio Damasio found Palomar's obsession in a patient (fictitiously named Eliot), who had suffered brain damage from a previous surgery [27]. Eliot had lost the ability to extract salient information from his experience: he could not perform ordinary tasks such as deciding with which pen to write or which restaurant to go to because an excess of analysis paralyzed him. The world for Eliot was *too informative*. Damasio diagnosed that brain surgery had compromised Eliot's emotional brain circuitry, allowing humans to label events and weigh their importance based on their emotional salience. Since Eliot was impaired in his ability to feel emotions, the world seemed flat to him: every detail counted.

Eliot's case reminds us of two common mistakes designers make when designing an interface:

i. making information available to users in excess; and
ii. neglecting the emotional salience of the stimuli an interface provides.

Surprise

Consider a person groping around in a dark, unknown room. If the room layout and the objects that it contains exhibit regularity, this *blind* person could make assumptions and build, by trial and error, a mental model of the room from the data of her/his experience. This example is suggested by Gombrich [28] to exemplify how we look for regularities in our experience. He affirms: *"Without some initial system, without a first guess to which we can stick unless it is disproved, we could indeed make no 'sense' of the milliards of ambiguous stimuli that reach us from our environment. In order to learn, we must make mistakes, and the most fruitful mistake which nature could have implanted in us would be the assumption of even greater simplicities even greater than we are likely to meet with in this bewildering world*." Evolution has wired this rule in our biology. We formulate hypotheses in the form of simple, actionable rules (for example, move in a straight line) that can be tested through experience and revised when needed.

This fruitful mistake is only a part of the story. The search for an effective scheme requires another essential skill. The person in the darkroom, bumping into an unexpected obstacle, is required to reconfigure her/his mental model. To do this, she/he must accept an unexpected obstacle as inevitable. The person must be able to deal with the confusion that the unexpected obstacle introduces in the expected order: she/he must learn to recognize surprises and appreciate the potential impact of surprises in learning. The information that an unexpected outcome brings to us to see a new, more effective mental model [29]. Hekkert [30] models the trade-off between finding regularities and managing surprises through two types of information processing strategies. The first type aims to search for novelty by collecting the highest possible amount of diverse information that can be integrated into an existing mental model. The second type aims to search for unity through an attempt to integrate novel information into a coherent structure of relationships. For instance, by continuously moving from one strategy to the opposite, a person moving in the darkroom builds an effective mental image of the room itself.

This model can help us describe and understand how users interact with a novel interface by an alternating search for novelty and unity. The model predicts that a good interface provides a good balance between these two basic information needs.

The Usefulness of Art

Some insights for designing effective interfaces based on the information processing model we have described in the previous section come from an apparently quite unrelated field: studies on perception and appreciation of art.

Art critically contributes to the development of basic human cognitive skills, and it is the appearance of artistic imagery that seems to be associated with a deep discontinuity in our biological and cognitive evolution. Our sapiens ancestors created the paintings in the Lascaux cave between 15,000–7,000 BCE. Probably, hunters and gatherers alike could find that this figurative art offers nothing immediately practical that continues today. On the other side, we can see the technical futility of art. Our ancestors used visual representation to create a visible and sharable outlet to their emerging ability to imagine reality [31], the ability to:

- invent a reality before living it, to anticipate a possible alternative reality;
- simulate a behavior, a situation, a reaction before experiencing it; and
- predict the consequences of their actions.

The usefulness of art is then primarily cognitive. Art helps us gain mastery of our senses, through which we get the abundance of information and surprising moments that come to exist when creative or insightful thoughts are translated into effective forms that others could easily understand. According to Arnheim [32], art "*manages to organize a wealth of meanings and forms within a global structure that clearly defines the place and function of every detail within the whole.*"

Artworks have been analyzed from a variety of points of view. In addition to art historians, philosophers, anthropologists, sociologists, and psychologists, cognitive scientists, biologists, and neuroscientists have offered in recent years their contribution as well. These scholars investigated works of art through new research questions and new quantitative and experimental methods. The growth in this *cognitive* interest toward art and art appreciation can be explained as follows:

i. first, the art object is an artifact. It is created by someone with the precise purpose of making accessible to others the artist's inner psychological world. The Symphony n. 3, also known as the Eroica, was created by Beethoven with the desire to express in musical form the ideal of social justice and freedom that Napoleon, before becoming himself a tyrant, was inspiring to all Europe while diffusing the ideals of the French Revolution through his military liberation campaigns. We could analyze the Eroica in detail to understand how the author translated his message into a form that is still a source of pleasure and meaning for contemporary listeners; and
ii. second, the artistic artifact is open to both emotional and intellectual understanding. The shape of an artistic artifact is not that of a scientific dissertation or that of an equation, which must be understood through logical inference and specialized knowledge. The art object requires, above all, an emotional understanding. It pushes users' cognitive systems to evaluate their experiences by

activating both their emotional and intellectual resources. To enjoy Symphony n.3, it is enough for listeners to abandon themselves to the musical flow. However, if they want to amplify their pleasure, they need to understand the how and why of the creation and making of Eroica and possess some basic understanding of music to appreciate that their feelings of joy are triggered by an *Allegro con Brio* within E major. Today, neuroscientists, through neuroimaging technology, can get analytical and biological insights on how this appreciation process unfolds.

The Aesthetic Processing of a Visual Interface

Understanding the emotional and intellectual skills activated in art appreciation provides extremely important lessons for designers, particularly for designing interfaces. Interfaces have to be capable of prompting users towards the activation of their emotional markers to assign the right importance to the objects falling into their perceptual domain such as symbols, knobs, buttons, viewers, indicators, and messages, among others, and to combine their emotional reactions with an intellectual understanding of the interface, in order to decide appropriate and effective courses of action quickly. Similarly, a systems engineer or a systems architect can resort to those emotional reactions and intellectual understanding to assess appropriate and effective courses of action related to the internal interfaces of a system.

Neuroscientists and psychologists have studied how observers explore an image by searching patterns to reconcile their visual experience with their expectations [33–35]. Leder, Belke [36] proposed an interesting model to capture the relationship between aesthetic perception and reasoning. The model illustrates how tacit and explicit understanding of an artistic experience is wowed to generate, after several iterations, a rational judgment and an emotional reaction.

The tacit processing is automatic. It includes both a primary perceptual analysis (based on the brain's abilities to distinguish sensorial properties such as contrast, symmetry, groups, etc., [33, 37–39]) and a primitive classification of current experience (based on previous experience). Evidence showed that repetition could be used as a means to enhance familiarity and, therefore, as a source of affective priming or preference [40–42].

Explicit processing involves high-level cultural skills acquired with experience. It is strongly influenced by culture and context. For example, the classification of a painting and its appreciation are influenced by the knowledge of the school and the period to which the artist belongs. According to Leder, Belke [36], *"once a concept of an artistic style is learned, the perceiver is then, based on a generalization of style* [43], *able successfully to recognize new examples he has never seen before. […] Declarative art knowledge and experience improve these processes."*

The explicit recognition of perceived elements, the ability to assign linguistic labels to them and to process sentences, is decisive for aesthetic understanding: *"for example, a rather naive perceiver might be satisfied with the recognition of the* *train station in Monet's La Gare St Lazare, because 'he likes trains because they remind him of a journey.' More generally, Martindale* [44] *has explained those processes which elicit pleasure and understanding by the number and diversity of associations activated by a stimulus. In his terms, semantic associations and their episodic memory associations reflect the understanding of an artwork"* [36]. Through explicit understanding, observers develop a conscious strategy of reducing variety and ambiguity, as they take into account only some elements enacted by the flow of experience.

It is important to emphasize that aesthetic processing is far from linear. The brain develops many tacit parallel processes, makes many tacit hypotheses that it discards before moving on to conscious processing, which must necessarily go on sequentially, one pattern at a time, as two verbal argumentations cannot be made in parallel.

There is a further decisive point. Intermediate aesthetic processing products are constantly evaluated by an emotional state, which tells the observer whether he is going in the right or wrong direction. Emotional evaluation is decisive in choosing which direction to choose among many possible. Emotional understanding impregnates the body and activates a network of cultural references, which define an internal guide that indicates the right way, a focal point on the horizon towards which to head, a tacit criterion to judge whether the path taken goes in the right direction.

Emotional understanding works like the buoy in a regatta field. The buoy is on the horizon. Your boat is going upwind. There is no straight path towards the buoy because the direction depends on the winds and the sea conditions. A skipper, however, can evaluate the gain, and he establishes whether she/he is approaching or moving away from the buoy. Accordingly, our emotions provide us with a compass that helps us discern whether the tacit and the explicit processing of experience are gaining or losing in understanding the stimulus.

The boat sailing upwind's zig-zag path to reach the buoy also provides us with a good metaphor of how our cognitive system tries to accomplish an effective interpretation of experience. Our cognitive system is continually engaged in two contrasting actions: on the one hand, it tries to test expectations with the information that the sensory apparatus makes available (Searching for Novelty); on the other hand, it develops new hypotheses to accommodate unexpected events (Searching for Unity). This oscillating behavior aims to avoid both excessive amounts of novelty, which would overwhelm and make it confusing and an excess of unity, which would make us blind to novel and surprising information. Berlyne [37] described this tendency *"to prefer stimuli characterized by a moderate level of complexity"* for the first time. He pointed out the presence of an association between moderate complexity and a higher level of hedonic pleasure. The American designer used this idea in design studies in the Most Advanced, Yet Acceptable (MAYA) model [45] and proved its efficacy in explaining products' aesthetic appreciation.

Thoughts

Psychologists and neuroscientists could create links between aesthetic appreciation and interface design. Below are some of these insights as derived from the proposed theoretical framework described in this chapter:

- *Complexity,* it is relative to the task that the interface helps to solve. Complexity cannot be hidden or neglected. Aesthetic reasoning, both in design and in fruition, is a useful tool to resolve the complexity;
- *Information overload*, users need more performance but do not want more information. They are already overwhelmed by abundant information coming from various sources, and providing them with even more information will not solve the complexity issue. Instead, users need effective compression of information into constructs they can easily understand and operate. Artists can teach us ways to achieve such effective compression through the creation of elegant and meaningful forms;
- *Emotional salience and surprise,* they are critical filters that help users navigate abundant information. Novel interfaces, as works of art, are appreciated emotionally as much as cognitively. The emotional reaction is typically faster and can bias our logical understanding in negative or positive ways; and
- When dealing with novel information, such as a new interface, users simultaneously look for *novelty and unity*. A good interface must support this dual process and facilitate both types of information processing.

In the following section, we report three case studies of effective uses of these principles in product and system design.

Combining Art and Engineering in Interface Design: Some Examples

We showcase in this section the bridging of art and engineering in engineering with three application examples that broadly cover different types of interfaces in engineering systems. In the first one, we present effective user interfaces for which aesthetics played a major role in driving design decisions. In the second one, we show how aesthetically pleasant visualizations can yield high effectiveness in handling and interpreting vast amounts of data. In the third one, we assess the aesthetic properties of effective network topologies that define different ways to connect machines and facilitate communication between them.

User Interface

Minimalist design is today very popular. From Apple’s best-selling products to Marie Kondo’s suggestions on how to make our life simpler and more rewarding through the Japanese art of decluttering and organizing, it is easy to observe a trend among consumers toward the pursuit of clean, simple, and yet easy to use, high performing products. This trend, however, has deeper roots than the designs created by Steve Jobs and Jonathan Ive. It dates back to the Bauhaus, an influential design school and community founded in Germany in 1919 by Walter Gropius.

The Bauhaus had the ambitious program of combining craft and art with mass production to create extremely functional yet accessible and simple products for a large consumer base, which could be easily manufactured on a large scale. This search for simplicity and affordability was certainly induced by the dire economic crisis that hit Europe and the US between World War 1 and the 1929 financial crisis. However, it was also a reaction to the excess of ornate pre-war design based on Art Nouveau as well as of the influence of new philosophical movements such as Russian constructivism. Bauhaus’ students and artists privileged functionality by pursuing at the same time aesthetic value based on subtraction and restrain. For this reason, the Bauhaus faculty included masters of abstract art such as Paul Klee and Wassily Kandinsky, who taught courses on the theory of colors and shape.

Principles of abstraction and subtraction of details through minimalist design found one of their more exemplary application in the work of Dieter Rams, a German designer who served for 40 years, from 1955 to 1995, as Chief Design Officer at Braun, the most important German appliance company of the time. His design philosophy is summarized in his book *The Ten Principles of Good Design*. Rams’ most representative design works include the SK4 radio-disc player, the T3 portable radio, the ET66 pocket calculator, and the Viltsoe 606 shelving system (Figs. 20.1, 20.2, 20.3 and 20.4).

All these products share Rams’ effort of achieving immediacy and transparency in the relationship between the object and the users. Similarly to abstract artists who stripped down from their paintings all visual details that would distract the viewers from the understanding of the subject, Rams focuses on plain, clean, and colorless design, in which a few key elements stand out to engage the users’ attention to facilitate the execution of simple movements to operate the device. This element is manifested in the browsing wheels in the pocket radio, an element that probably influenced Apple's I-pod design. In the ET66 pocket calculator, buttons are grouped by subtle different colors and locations to indicate the variety of functions (input, operation, or status). In the SK4, the innovative use of a plexiglass cover provides users with a 360- degree view of all the device controls, organized in functional clusters to facilitate navigation.

It is evident from Figs. 20.1, 20.2, 20.3 and 20.4 that these solutions have passed the test of time, which is a sign of elegance [9, 46, 47]. Rams’ minimalist interfaces and aesthetics end up facilitating users’ information processing by alleviating the fatigue of navigating complex visual arrangements and guiding the users towards the intuitive use of a device. They represent an effective example of how aesthetic

Fig. 20.1 Portable calculator. Adapted from Wikimedia Commons, the free media repository, https://commons.wikimedia.org/w/index.php?curid=17904398

Fig. 20.2 SK400 radio and disc player. Adapted from Wikimedia Commons, the free media repository, https://commons.wikimedia.org/w/index.php?curid=4777254

principles invented in visual arts can be adapted to favor functional aesthetics that can help users of a product navigate complexity and interact effectively with new technology.

Information Visualization: Google's Interface

Every day 3.5 billion web searches are done with the Google search engine. It means that around 40,000 people look at the Google search page every second. Google's logo has been the most viewed image in the world of all time.

Fig. 20.3 Viltsoe furniture. Adapted from Wikimedia Commons, the free media repository, https://commons.wikimedia.org/w/index.php?curid=11075707

Fig. 20.4 Braun T3 transistor radio designed by Dieter Rams and Ulm School of Design (object 2012/30/1)

The puzzling aspect of this image (i.e., Google's logo) is that it looks under-designed at a first inspection. The webpage does everything to avoid imposing its presence: it only shows the company logo at the center of the screen and an empty bar where the user can write the object of desire or curiosity. It is a two-way conversation: Google asks the user, *Tell me what you want*, the user answers, *Here is my request*, and then the search engine, after responding to the request effectively and efficiently, seeks your feedback directly (by inquiry *Are you satisfied?*) and indirectly (by counting the links the user clicks and likes). Nothing in the webpage interferes with this user experience.

The interface is the triumph of the *Power of the center*, a visual composition strategy wisely used by the artists [48]. Visual centers are sources of forces driving the eyes' movements during the exploration of the whole image. Since visual centers are the starting and arrival points of visual exploration, they act as structural elements that give order and coherence to the visual experience (e.g., like pillars and vault ribs of a Gothic church). For the visual centers to act effectively, it is essential that they stand out from the image background and become the focus of our attention, very much like the spotlight in a theater focuses on an actor in a scene. Hence, the strength of a visual center must not be diminished by the other composition elements.

In the case of Google's interface, we see all these principles at work. The visual centers are two: the Google logo and the search bar. Two poles, the first one is offering a search service (the logo), and the second one is asking for it (the search bar). The rest is just a white surface, a void *canvas* that has much in common with the void used by Zen artists [49]. That is a free space that the imagination can fill at will and that the user's gaze can use as background while concentrating on the object of her/his research. It is this void that supports concentration and dialogue between the user and the service through the interface. The history of Google's interface is interesting and has been well documented. Google.com was registered on September 15, 1997. The first logo of 1998 showcased primary color (still in use today; another example of the test of time) and exhibited an exclamation point, perhaps inspired by its competitor, Yahoo!

In 1999, Google transitioned to a simplified search box with a choice that was the opposite of the one adopted by the major portals at that time, full of content (e.g., online magazines and white pages directories). The designer, Ruth Kedar, remembered that it was important to design something user-friendly both on the homepage and in the logo to overcome psychological barriers in using an internet interface [50]. The choice of primary colors (blue, yellow, and red) was inspired by the same desire for simplicity and friendliness, keeping the letter *l* in green and isolated, as a witness of relationships that other colors and forms created between them. According to Kedar, only the letter *G* appears in capital letters to instill a feeling that the company is solid and serious while communicating playfulness using vivid different colors [50].

There have been many attempts to review the image of the site to emphasize the introduction of new services (TABS, 2001; FROOGLE, 2002; IGOOGLE 2005; GOOGLE SUGGEST 2008; Sidebar and GOOGLE INSTANT, 2010). However, they were all short-lived. In 2015, a new, simpler logo was created with a geometric font and a white and neat homepage. The original inspiration remained unchanged, however.

The history of Google's interface exemplifies the importance of simultaneously addressing the functionality, usability, and psychological relationships between the user and the system in interface design. Furthermore, it shows the great difficulty of achieving effective simplicity, a key tenet of elegance in engineering [12]: the result of eliminating all that can be annoying noise and focusing only on what is essential.

Connecting Machines

Consider an arbitrary number of systems or components that need to communicate between them; that is, they need to exchange information to provide certain functionality. In systems architecture, the terms functional and/or physical architectures are often used to refer to the communication structure. In the field of networks, the connection of different components is called topology.

There are several ways in which these systems or components could be connected to facilitate such communication. Yet, there are a few fundamental structures or topologies that have been particularly effective in coping with different connectivity challenges. These are the Mesh, Ring, Star, and Bus topologies, which are shown diagrammatically in Graphical Abstract (where boxes represent systems or components and lines represent connections between them; the solid circle in the Bus topology represents the bus). In the Mesh topology, components are connected pairwise to communicate directly and individually with all the other components. In the Ring topology, components are only connected to two other components. Communication with the rest of the components is achieved by relaying the messages in a daisy chain approach. In the Star topology, another component is added as a hub, to which all components are connected and control the communication between them. In the Bus topology, all components share a single communication channel and either collectively control the communication through it, or one or more of the components are tasked with control.

It has been hypothesized that elegant engineering solutions seem to be particularly effective [9]. Empirical research indicates that, at least, there seems to be a correlation between the effective complexity of system architectures and how elegant engineers perceive them [12]. We know that these four topologies have become widely employed because they are particularly effective in dealing with different networks' challenges. Can we also say that they are elegant or, at least, exhibit aesthetic features of beauty? Furthermore, could those aesthetic properties indicate such effectiveness? We use the architecting strategies from master painters presented in [14] to answer these questions.

First, one can observe that all four topologies exhibit symmetry. Furthermore, the symmetry is recursive, as the topologies can be repeatedly *folded*. In fact, symmetry is maintained regardless of the number of systems or components that are connected in the network at a given time. Second, the Star and Bus topologies make use of the Power of the Center. They use a central element (the hub and the bus, respectively) to reduce the complexity of the point-to-point connectivity in the Mesh topology. Visually, the Star and Bus topologies look much cleaner, as fewer lines are used to represent the network. The Bus topology goes, in fact, a step farther than the Star topology since the hub disappears and is substituted by just a *point*. The Ring topology takes simplicity a step further and makes that *point* (the bus) disappear. Third, as with most architectural representations, the four topologies make use of Subtract Details to focus on the structure of the connectivity, abstracting out specific details about the implementation of the communication. Therefore, we conclude that the four topologies indeed exhibit (visual) features that are considered to convey beauty (i.e., are aesthetically pleasant) in paintings as well as in engineering solutions.

We move now to answering the second question and use the aesthetic features to infer some performance aspects of the different topologies:

- Symmetry enables the scalability of the solution. Note that, in the four topologies, scalability is achieved by fulfilling simple rules. In Mesh topology, add one component and connect them to existing ones. In Star and Bus topologies, add one component and connect it to the hub or bus, respectively. In the Ring topology, add one component in between two existing ones. Hence, we can state that the four topologies are scalable to handle problems of different sizes (albeit with varying levels of scalability, as discussed later);
- Of the four topologies, the increase in *visual messiness* as the network's size grows highest when using the Mesh topology. We can infer that probably, scaling up the Mesh topology requires the biggest effort; hence, scalability of the Mesh topology is limited by the complexity of the cross-connections;
- Of the four topologies, scaling the Ring topology is the only one that requires breaking the structure to arrive at the new one; a connection between two components needs to be split to put the new component in between. Artistically, the Ring topology is the only one that requires *erasing* a part of the drawing, whereas the other topologies only need the addition of new *straws*. We infer from this that there may be disruptions associated with scaling, substituting, upgrading, etc. the Ring topology, which will not be present in the other topologies;
- The power of the center emphasizes the prominence of an element in the solution. In engineering terms, there is a centralization of certain functionalities. Therefore, we can predict in this case potential issues of capacity when scaling up the solution, as well as disruptions being caused by vulnerabilities, upgrades, failure, or maintenance tasks of the central element, for example, which will not occur in the Mesh topology due to, precisely, its decentralization in communication. Between the Star and the Bus topologies, these problems may be more critical in the Star topology due to the *larger* prominence of the hub (higher complexity, since it includes active functionality) with respect to the bus (just a passive conveyor);
- The extreme simplicity of the Ring topology informs as well about potential vulnerabilities due to the extreme dependencies created between the different components to maintain that simplicity, as well as scalability issues due to the *distance* between the components.

- The subtraction of details allows for the topologies to be instantiated with a large variety of communication protocols, which make the solutions generic and appealing to solve a large class of problems;

Indeed, (accurate) prediction of the different topologies' performance requires mathematical analyses that consider in-depth characterizations of the elements that form the network. However, as shown above, we contend that several of the main tenets and features of the topologies can already be inferred by simply assessing the nature of its aesthetic aspects.

Conclusion: Towards a New Humanism for the Science of Interfaces

In this chapter, we have shown how aesthetic considerations in the interface design are not only a way to create technology that is more pleasing or less intimidating but can help in crafting tools that facilitate users to process complex information and use technology in an effective and efficient way.

Insights and findings from diverse disciplines, including neuroscience, evolutionary psychology, and design science, converge towards the idea that reasoning in aesthetic terms or reasoning aesthetically is a key cognitive tool that evolution has forged to augment our ability to elaborate complex information. Studies on the perception of beauty show that artists have exploited this ability for centuries to communicate complex meaning by packaging information into effective visual forms. Research in Neuro-aesthetics helps us open the black box of artistic perception and learn key lessons on how we process visual inputs and the impact of this processing on higher-level cognitive processes such as learning and decision-making.

The chapter also illustrates how aesthetic reasoning has a strong emotional component. While research in psychology has largely investigated the role of emotions in reasoning and decision-making, the emotional discourse has often been neglected in the debate on interface design, until recently and with few exceptions.

The perspective to interface design presented in this chapter calls for a humanistic approach to design that brings together humanities and engineering, very much like studies on linear perspective in the Renaissance flourished through the integration of art with mathematics. Such integration must be based on a deep and accurate understanding of how the visual organization of information on an interface impacts our perception as well as our ability to understand and design knowledge representations that can drive our behavior towards meaningful as well as efficient courses of action. Interesting insights and suggestions are offered by studies on visual complexity and information compression. One tool our brain leverages to deal with complex and abundant information is effective compression techniques. The analogy with the studies on Renaissance artists' perspectives is once again enlightening: Perspective is, in fact, a geometric technique to compress space into a 2-dimensional representation that is also remarkably friendly to the optical illusions and distortions that the human eye exploits to process complex visual information.

We argue that our brain activates similar aesthetic heuristics to process complexity also in other forms and information formats that are not visual but that we can visualize to understand them better, as we showed in the case of visual engineering models. The identification and analysis of these heuristics could be not only a fertile research field but also one that will necessarily require collaboration among various disciplines from opposite sides of the humanities-STEM (science, technology, engineering, and mathematics) continuum.

Core Messages

- Aesthetic features can be used to design interfaces that exhibit an ideal level of complexity.
- Aesthetic features can be used to infer the core characteristics of system architectures.
- Studies on art can offer valuable insights to understand how information can be effectively packaged.
- The pursue of the elegance provides a promising direction for coping with the increasing complexity of systems.

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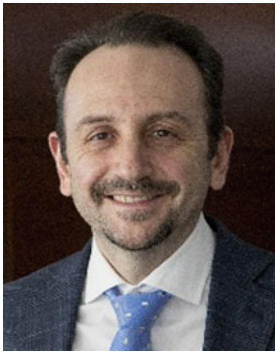

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Art as Metacognitive Tool for Critical Thinking in Engineering

21

Patricia Caratozzolo

> *"My business experience revealed life to me in many aspects.*
> *that I might otherwise have missed. In it one sees tragedy, nobility,*
> *meanness, high aims, low aims, great ideals, no ideals…*
> *The fabric of existence weaves itself whole.*
> *You cannot set an art off in the corner and hope for it to have vitality, reality and substance.*
> *A substantial art comes directly out of the heart of experience of life and thinking about life and living life. My work in music helped my business and work in business helped my music."*
>
> Charles Ives

Summary

The study hypothesis developed in this chapter is that the exercise of art criticism and aesthetic judgment encourages the emergence of such specific temperament dispositions necessary for a substantial increase in critical thinking skills in engineering students. The metacognitive tools designed in this work considered that criticality requires sensitivity to problems and skills to redefine approaches beyond subjection to functional fixation, a frequent cognitive bias of engineering students. Some of the competencies analyzed belong to the category of soft skills: such as critical and creative thinking or the ability to embrace contradictions and take risks; while others belong to the category of digital

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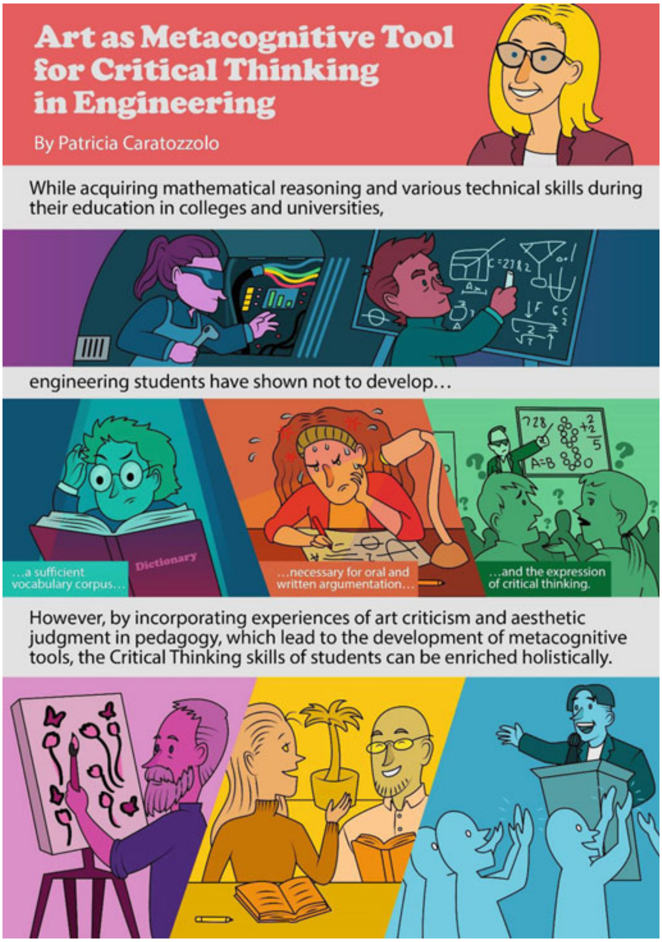
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_21

literacy skills: the ability to understand, interpret or evaluate information that is presented in fragmented, branched or visual-graphic formats. This chapter shows that the moments of aesthetic reflection and artistic experience in the engineering classroom, including theater, literature, fine arts, modern dance, and classical music, are highly effective because the reflection on an artistic artifact goes beyond the concept of utilitarianism and functionality. The advantage of inserting flexible artistic spots within the rigid scientific space is that the artistic artifact, when intervened by the students, awakens in them a state of metacognitive self-awareness that favors criticality.



Graphical Abstract

Keywords

Creativity · Critical thinking · Educational innovation · Higher education · Metacognitive · Self-awareness · Soft skills in engineering · STEAM

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in chapter 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

My artistic work contributes to my engineering and engineering work enriches my art. This could be a personal interpretation of the quote from the famous American musician and composer Charles Ives. And it has also been the leitmotif in the life of the author as a teacher and researcher in educational innovation: How to get young engineering students to nurture their critical thinking with tools derived from creative thinking? Or in a nutshell: How to develop "creativity in criticality"?

It has been shown that critical thinking skills can predict important educational outcomes but that a high level of motivation is related to academic achievement at a comparable level. In fact, many studies found that motivation contributes to the prediction of achievement even above ability [1, 2].

After a series of experimental studies conducted with engineering students over the past five years, the author has found that interventions aimed at jointly improving critical thinking and creative thinking are the most successful in increasing student academic performance. These assumptions could show that a creativity-criticality tandem precipitates emotional, social, and technological changes that in turn drive the development of new ideas, inventions, and technologies. The proposal of this project was to introduce a "creativity in criticality" approach in the fields of study of engineering programs, to catalyze innovations that advance those fields holistically: the practice of artistic experiences and aesthetic judgment produces high levels of intrinsic motivation that enable looking at the old ideas in new ways, allows individuals to take risks necessary to advance disruptive thoughts, introduce completely new concepts into their proposals, and finally, integrate diverse concepts in new, unsuspected ways. A glimpse of what will be presented in this chapter can be seen in Graphical Abstract.

Currently, the majority of students in engineering programs belong mainly to Generation Z. Therefore, it is of paramount importance to explore innovative approaches that strengthen the competencies, skills, and attitudes necessary for their successful insertion into the workforce, especially those related to criticality, decision-making, originality, initiative, leadership and emotional intelligence [3].

In their latest reports on the future of education and work, the Organization for Economic Cooperation and Development, OECD, and the World Economic Forum, WEF, coincide in emphasizing the importance of introducing the concepts of upskilling and reskilling in undergraduate curricular programs in colleges and universities. The origin of these recommendations emerged a few years ago when the notorious gap began to be observed between, on the one hand, the required level of skills and abilities necessary in the new jobs of the Fourth Industrial Revolution and, on the other hand, the low performance of students in exit evaluations reported by international accreditation agencies [4, 5]. In the five years prior to the COVID-19 pandemic (2014–2019), a dichotomy can be seen in the way of facing the development of these competencies: some researchers did it from a strategic pedagogical approach in the classroom, with the incorporation of educational innovation techniques; while others opted for the incorporation of cutting-edge technological tools [6–9]. During the years 2020 and 2021, the drastic -and inevitable- change to digital platforms unleashed an avalanche effect that flooded the teaching–learning space with too many technological tools, causing the opposite effect to the one sought: they hindered the metacognitive self-awareness of the students and neglected the importance of the evaluation of the process of acquisition of skills and competences [10, 11]. At the end of 2021, the researchers concluded that the academic use of cutting-edge technologies (webinars, applications, prerecorded videos) was not enough to ensure intellectual engagement. In fact, the most recent studies confirm that students are not motivated to work as a team, nor can they reach states of deep reflection when collaborating on digital platforms [12, 13]. The present chapter considers several questions on the way to engage engineering students by cultivating certain temperament *dispositions* instead of technical *abilities*:

- How to include strategies and experiences for developing creativity in engineering subjects with a high level of specificity?
- What is the best design of a transversal approach that considers those specific critical thinking dispositions (the ability to think open-mindedly with intellectual empathy) that effectively improve students' motivation?

- How to incorporate experiences that develop critical and creative thinking skills in the classroom regardless of the technological tools that serve as educational platforms?

Generation Z and Higher Education

Generation Z students (date of birth between 1995 and 2010) differ in some respects from Millennials, both in terms of learning styles and the way they communicate in writing and orally [14, 15]. Despite this, a review of the literature seems to indicate that the taxonomies that describe cognitive processes can reliably model the behavior of both cohorts. However, there does not appear to be a consensus on how to effectively develop the creativity and criticality skills of Generation Z students, based solely on the uneven performance they may have had during their high school years [16].

To characterize and evaluate the oral and written communication skills manifested by Generation Z students in engineering courses, it is possible to consider the results of two studies carried out by the author, during 2020 and 2021 [17, 18]:

- Regarding critical reading, both studies determined that the individuals in the sample presented high levels of difficulty in understanding argumentative texts with high-ranking vocabulary;
- Regarding academic writing, almost all students in both studies admitted difficulties in maintaining discursive coherence when writing long essays, as well as making a large number of spelling and grammatical errors; and
- Regarding the ability to express ideas in oral presentations, a high percentage of individuals in both studies recognized difficulties in maintaining concentration and expressing ideas fluently.

The results presented in both studies highlighted the enormous challenge of strengthening critical thinking when higher levels of critical reading and writing skills have not been solidly developed.

This chapter aims to rethink the problem that arises from a false belief ingrained in recent years: using cutting-edge technology is equivalent to a successful teaching–learning process. On the contrary, the young people of Generation Z begin to manifest difficulties in communicating effectively and show, despite their skill in the use of information technologies, increasingly poor performance in tasks that require: active listening, interpretation of messages presented from perspectives outside their environment, construction of knowledge from segmented or incomplete information, and demonstration of empathy in digital media. The international reports related to the jobs of the future show a clear trend towards very profound changes related to the competencies, skills, and attitudes required of the next engineers [4, 5]. Due to this, the Fourth Industrial Revolution is driving, in turn, numerous changes in higher education, which are translated into the new framework of Education 4.0. The following model is a possible way to develop the creativity and criticality skills required in this framework so that future engineers can face challenging situations without being seduced by the fallacy of technology immediacy to replace cognitive effort.

Creativity in Criticality Approach

The development and design of a new theoretical framework for a joint approach on creative thinking and critical thinking was a consequence of the strong trend of the last decade, on the successful incorporation of art in the curriculum of science, technology, engineering, and mathematics (STEM) programs, especially in engineering [19]. The creativity and criticality models will be described separately in the following subsections. Then an explicit, balanced, and superimposed incorporation of both types of thinking will be carried out in a joint approach.

Creativity Model

For people to fully develop their capacity for creative thinking, their mind must be attentive not only to the synergy between multiple intrinsic stimuli but also to be aware that their reasoning is shaped and influenced by what happens in the environment and also by what other close individuals think. In the case of students, in the environment of their learning process in a classroom together with other peers and led by an instructor, it is very convenient to define a creative model such as the one proposed by Csikszentmihalyi [20, 21]. Csikszentmihalyi's model considers the interaction of three elements:

(i) A *person* is who wants to show their ideas;
(ii) The *field* is the symbolic knowledge shared by each society; and
(iii) *A domain* is a group of individuals who decide which ideas can be included in the field.

According to this model (Fig. 21.1), it is evident that the cognitive process of individuals is no longer limited only to their internal mental processes but to multiple and intricate external relationships.

Criticality Model

Before adhering to some form of knowledge, a critical thinker reflectively analyzes the foundations that underpin ideas and carefully observe the conclusions that emerge from each decision-making [22]. It is possible to use this definition by John Dewey to develop a theoretical framework that relates the skills that characterize the

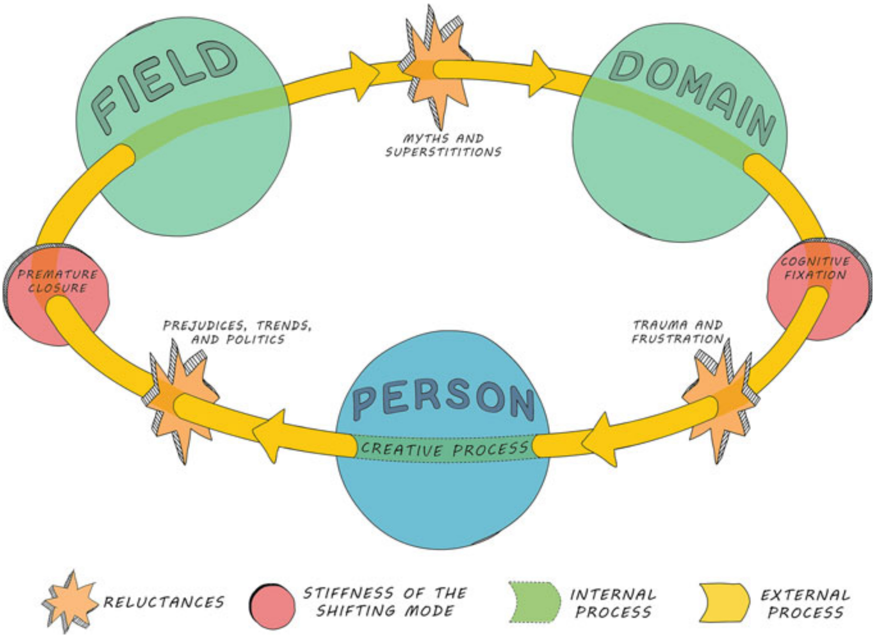


Fig. 21.1 Creativity in criticality, the FLOW model

cognitive process of a critical thinker and the conditions that must be established in the classroom to ensure that students will reason reflectively and be able to face their tendency to engage in biased thoughts (the false idols of Francis Bacon), which lead them to draw invalid conclusions. The idols that make up the framework of the criticality model are:

- the tribe (superstitions and myths of human nature);
- the market (prejudices and misunderstandings due to the language);
- the cavern (traumas and frustrations of each individual); and
- the theater (trends and general opinion of the society) [23].

For each cohort of individuals, the particular idols of the criticality model (market, theater, tribe, and cavern) are manifested in an intimately interconnected way with the elements of the creativity model (person, domain, field). This interconnection between models, exclusive to Generation Z individuals, is described in Table 21.1.

Table 21.1 Comparison between criticality and creativity models

Criticality model	Who is who?	Creativity model
Cavern	The student	Person
Tribe	The professor and classmates	Domain
Market	Cutting-edge knowledge and technologies	Field
Theater	Current educational trends	

Thinking Modalities and Metacognition

In order to integrate the separate models of creativity and criticality into a single "creativity in criticality" framework and to understand this approach from the perspective of cognitive thinking modalities (according to Jerome Bruner), the definitions of each modality were revisited [24, 25].

The critical thinking model responds to the characteristics of the *logical-scientific modality* (style of thought in a formal mathematical system of conceptualization and categorization of ideas). The creative thinking model responds to the artistic-narrative modality (style of thinking in a formal system of verbal and non-verbal language of perception, imagination, and inventiveness).

An interesting aspect of the concept of thinking modalities is the possibility that shifting can occur in any direction, that is, from creative to critical thinking and vice versa. However, many studies suggest that shifting from critical to creative thinking has been systematically undervalued in academia. There is a false perception that students in STEM programs should only use the principles of criticality rather than creativity [26, 27]. It was, therefore, necessary for the new framework to explicitly include the *shifting mode* (the ability to switch between thinking modalities) in a bidirectional way in order to empower both modes of thought. The study also considered the stiffness of the *shifting mode* according to the magnitude of two cognitive biases:

i. *Premature closure*: cognitive bias that causes the student to not consider reasonable alternatives after an initial diagnosis of a problem is made; and
ii. *Cognitive fixation*: cognitive bias that causes the student to evaluate the functionality of an object only in the way it is traditionally used.

A representation of the cognitive process from the point of view of the "creativity in criticality" approach is illustrated in Fig. 21.2 and elsewhere (see Fig. 2 in [18]). It can be seen that this approach goes beyond the internal mental process of the individual (cavern), also showing the external path of the FLOW (the presence of the domain and the field), the reluctances that hinder the thinking fluency, and the biases that decrease the flexibility and devalue the ideas and products of the process.

As part of the study, it was determined which were the key elements of the new approach to "creativity in criticality" that:

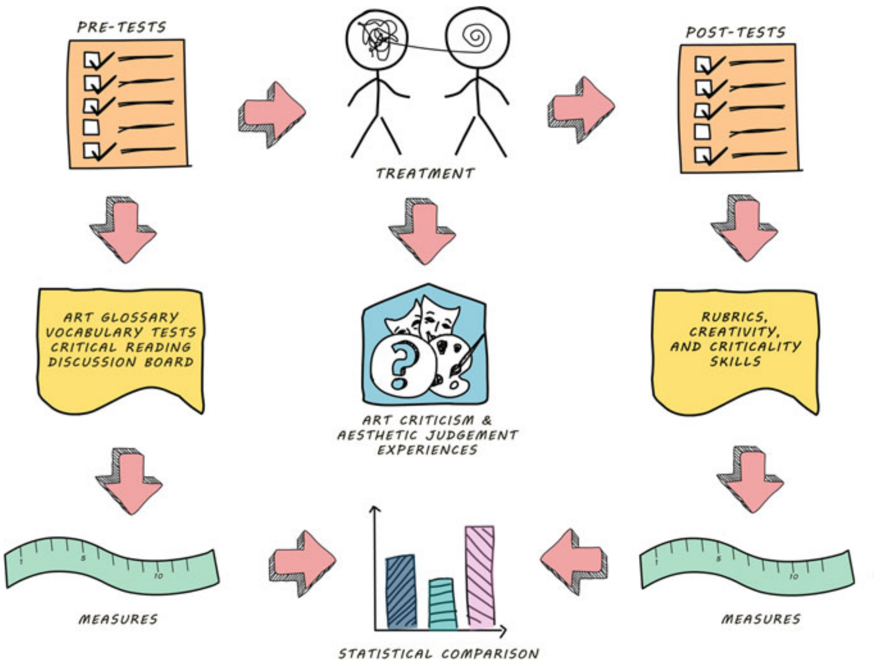


Fig. 21.2 Methodology design

i. first, soften the stiffness caused by the two biases mentioned above (cognitive fixation and premature closure);
ii. second, weaken the typical reluctances of the model (myths, superstitions, prejudices, frustrations, traumas, and tendencies); and
iii. finally, improve the learning experience of the young people of Generation Z

Three concepts were identified, which were very useful to design content and didactic experiences within the approach:

i. The *Metacognitive Dimension of Knowledge* allows students to become aware of their own knowledge acquisition process, ensures their intellectual commitment, and rewards their cognitive effort;
ii. The *Scaffolding System* allows students to advance confidently through the different stages of the cognitive process; and
iii. The *Zone of Proximate Development (ZPD)* allows students to reach the level of potential intellectual development, not only through the internal (individual) process but accelerated through the activity of the external (social) FLOW [28, 29].

As mentioned earlier, Fig. 2 in another author's publication [18] provides a graphic representation of the combination between two taxonomies: that of the dimension of cognition by Bloom; and that of the dimension of knowledge by Anderson and Krathwohl. The notions of cognitive efforts and metacognitive efforts are represented by the heights of the steps and the respective "vector" directions of movement in each taxonomy. The objective of learning corresponding to each subject can be "translated" into the number of steps involved in that representation. This will allow the students to explain the levels of effort and involvement that they will have to develop throughout the course. The correct interpretation of this representation can allow the course instructor to know at what level of development (cognitive and metacognitive) each student is and provide timely individual feedback on the weaknesses and strengths evidenced in each instance of the teaching–learning experiences [30].

Introducing Art Experiences in Engineering Programs

The exercise of art criticism and aesthetic judgment -through memorable experiences in the classroom- can promote the appearance of those specific dispositions of temperament necessary for the development of creativity and criticality of the young people of Generation Z. For the experiences in a classroom to be memorable -taking into account the creativity in criticality model- it is necessary for all students to feel actively involved and committed to activities designed so that their creative processes FLOW in the group [31].

The chosen methodological design can be represented as in Fig. 21.2, which shows a possible selection of instruments used as pre-tests and post-tests, the creative experiences (treatment) that allow the FLOW of ideas among the participants, and the moments of evaluation, through performance measurement and statistical comparison. The most successful and creative experiences often include fine art analysis sessions and the appreciation and critique of artistic masterpieces, including selected works of architecture, artistic designs, and sculpture. These types of experiences expose engineering students to concepts that they would hardly know in a class on STEM topics: appropriation, deconstruction, decontextualization, redefinition, and dislocation of artifacts, allowing them to leave the position of spectators and become involved as creators [32]. By encouraging them not to wait passively for an explanation about the art object, they are trained in their ability to understand, translate and encode symbolic information and to elaborate their own concepts and constructions through abstract reasoning [33]. The following are some of the characteristics that a designer should consider for an experience to be memorable:

- The experiences must be carried out with total concentration with the conscious objective of provoking creativity in criticality (it is not entertainment);

- Students must be aware that they are part of a creative group and that the results of the experience will be collective (individual effort and motivation are required);
- The process should include continuous evaluation and feedback to ensure gradual progress of students at their own pace (scaffolding and ZPD concepts); and
- The instructor should serve as a close guide and provide accurate and timely feedback on performance through assertive evaluation of individual and group achievements.

The memorable experiences that students share with their instructor and classmates can be considered real training for their future attitude towards lifelong learning. Holistic learning experiences allow to strengthen criticality competence on specific topics and at the same time enrich resilience skills to solve ill-defined problems creatively.

How Metacognitive Tools Foster Creativity in Criticality

For metacognitive tools -included in the design of the experiences of art criticism and aesthetic judgment- to function holistically in a model of creativity in criticality, they must consider two concepts: “specificity of the domain,” by Robert Ennis; and “Torrance framework,” by Paul Torrance.

The “specificity of the domain” concept ensures the validity of the creativity model in any engineering program [34]. The adaptation of Ennis's original theory to the model requires that the design of the experiences must include: the enhancement of previous knowledge so that students can confidently advance on the designed scaffolding; the assurance of the transfer between domains; and finally, the commitment to a moderate or strong degree of specificity.

The Torrance Test of Creativity Thinking, TTCT, was designed by Torrance in the 60 s and is still an instrument with high predictive validity; however, it needs to be implemented by a certified instructor and requires interpretation by experts, which makes it unsuitable to be implemented by any teacher in a classroom. Instead of using the TTCT, a valid option is to take advantage of the basic concept of the Torrance framework for evaluating the impact of artistic experiences in the classroom [35, 36]. In this way, TTCT tools can apply to the design of both the experiences and the assessment.

Due to the complex nature of creativity (and the strong influence of perceptions, emotions, and beliefs on the cognitive process), it is not possible to measure creativity in a single step but, only indirectly, through the assessment of four creative thinking indicators, which are:

i. *fluency*: How many and how significant are the ideas generated?;
ii. *originality*: How many of those ideas were uncommon or unusual?;

iii. *flexibility*: From how many points of view and perspectives did these ideas emerge?; and
iv. *elaboration*: How many additional details went with each idea?

The following paragraphs describe five examples of experiences using the criticality creativity model: treatments, instrumentation, metacognitive tools, justifications, learning objectives, and a brief description of the procedures.

Artistic Experience #1: Paintings

Resource Example (Painting): "Never morning wore to evening, but some heart did break" [37]

Critical Thinking Skill addressed: Attentiveness towards different situations.

Intervention Procedure: Students critically interpret the image and write their own versions using the style of art critics. Students complete a questionnaire based on the TTCT test: Can you guess what happens in the picture? Can you imagine the immediate or long-term consequences of what happens? What's the most unlikely hypothesis you can think of? What is the most extraordinary *denouement* you can imagine?

Metacognitive tools: asking and answering questions about artworks using Art Crit Cards is making meaningful connections between what we see and what we experience. When we tell or write (through debates, dialogue seminars, opinion blogs) what we experienced and felt when we observed an artifact, we understand the object and articulate in language what otherwise remains only muddled, fragmented, and disconnected.

Cognitive tools: engineering reasoning requires settling questions to solve complex problems. It is imperative that engineering students reflect on the importance of:

i. firstly, a good elaboration of the questions, using the appropriate language, glossary, and terminology; and
ii. secondly, of the need for reformulation, reinterpretation, and reworking, if the interlocutor so requires.

They can divide a question into sub-questions to understand and encompass all possible answers, including those untested and potentially risky, embracing divergent perspectives.

Artistic Experience #2: Censorships

Resource Example (Essay): "A Modest Proposal" [38]

Critical Thinking Skill addressed: Broad Perspective View.

Intervention Procedure: Students carry out a brief investigation on the historical context of the work and on the type of publications in the written press that were used to express political ideas. A classroom discussion can also be held to reflect on the pre-television, radio, and internet media to influence public opinion and how techniques such as sarcasm and satire were used to circumvent the censorship of authoritarian governments.

Metacognitive tools: Each literary text works by presenting the reader with different points of view. On many occasions, for example, the writer resorts to the use of metaphors, double meaning, parables, and even sarcasm and fantasy to deceive the censoring apparatus. The ability to read between the lines will allow the reader to detect fallacies and inconsistencies.

Cognitive tools: engineering students are able to take specific positions with a broad vision and evaluate the possible consequences and implications of situations.

Artistic Experience #3: Surrealisms

Resource Example (Artwork): “Fluxkit” [39]

Critical Thinking Skill addressed: Taking risks.

Intervention Procedure: Students take a virtual tour to learn about the artistic concerns of the society of the time; they work individually completing worksheets following the method of art criticism and aesthetic judgment; then the group divide into teams, carry out a brief role-play activity, and record interviews for a documentary with their cell phones; finally, they can build a “Fluxkit” and present it to the group as a model to be featured in an art gallery.

Metacognitive tools: complexity derives from the presence of contradictions, and artistic manifestations such as Surrealism embraced irreconcilable elements exploring the absurd and the extravagant. The artistic interpretation of techniques such as collage and grattage challenges the natural impulse to eliminate contradictions and allow to deal with ambiguity and uncertainty.

Cognitive tools: engineering students must develop their ability to face uncertainty in order to solve a complex problem without rendering false conditions and incomplete descriptions. The complexity of the problems sometimes unleashes a very frequent cognitive bias in engineering students, Premature Closure, which prevents them from persevering when facing obstacles.

Artistic Experience #4: Music

Resource Example (Short Story) (Music): “Concrete Music” [40] and “*Musique Concrète* movement” [41, 42]

Critical Thinking Skill addressed: Embracing Contradictions

Intervention Procedure: Students do a critical reading of the short story and then analyze the responses to a questionnaire. Students can also participate in a song-writing contest with their own short songs that they created using software for electronic music composition.

Metacognitive tools: the human brain is hardwired for pattern recognition, which makes it more difficult to render the world new or unfamiliar. Musique Concrete movement used lines, geometric and tessellated patterns to baffle viewers and convey feelings of instability.

Cognitive tools: engineering students must be able to bypass the brain's pattern recognition tendency to reevaluate the meaning of certain data and recognize the possible implications and consequences (technical, social, ethical) in multi-layered (grey) contexts.

Artistic Experience #5: Photographs

*Resource Example (Graphic Report)(Novel): "*An American Exodus: A Record of Human Erosion" [43] and "The Grapes of Wrath" [44].

Critical Thinking Skill addressed: Connecting, Synthesizing, Transforming.

Intervention Procedure: Students read excerpts from the novel and carried out an investigation on the social concerns of that time; then, they divide into teams and carry out a role-playing activity in which they record testimonial scenes for a documentary video with their cell phones; finally, students practice creative writing and compare the stories that emerged from the exercise.

Metacognitive tools: perception is a reciprocal action. An artist can control the image but not the reaction to it. "*The image burns, blaze in flames and consumes us*" (Georges Didi-Huberman). Photographs can be used as a testimony of political, social, and cultural events or a means to lie or manipulate. The interpretive analysis of Photographic Art is a powerful tool against ˵image illiteracy" and prevents us from the risks of a bad or incomplete interpretation.

Cognitive tools: on many occasions, engineering students must conclude the interpretation of graphics, images, and simulation results. Although they are supposed to infer only what the data support and check the internal and external consistencies of those inferences, they risk making hasty interpretations by not clearly identifying the assumptions that allowed them to reach those conclusions.

Conclusion

The Fourth Industrial Revolution requires current engineers to perform highly not only in the technological field but also in the skills of the twenty-first century, especially with regard to critical thinking and creativity. The models and tools developed in this research considered that criticality requires sensitivity to problems and skills to redefine approaches beyond submission to functional fixation by including metacognitive awareness in learning processes. The proposal to use concepts and models from the artistic and cultural world allows the design of memorable experiences and spaces for reflection with activities borrowed from theater, literature, fine arts, modern dance, and classical music. In this way, even in the rigid scientific space of the engineering classroom, students develop their creative potential through genuine metacognitive self-awareness. Finally, the creativity in criticality model is a valid approach to enrich the specific temperament dispositions currently required by Generation Z engineering students.

Core Messages

- The use of cognitive and metacognitive tools allows spaces for reflection to develop creativity skills.
- Metacognition, or thinking about thinking, is a multidimensional set of general rather than domain-specific skills.
- Living memorable experiences promotes lifelong metacognitive self-awareness in Generation Z students.
- Training students in creativity will allow them to face problems they have not learned successfully.

Acknowledgements The author would like to acknowledge the technical support of the Institute for the Future of Education, Tecnologico de Monterrey, Mexico, in producing this work. The author appreciates the work of art designers Diana Mariani (Figures 21.1 and 21.2) and Patricia Rodríguez (Graphical Abstract). Parts of this submission were presented at two international conferences: Frontiers in Education International Conference, FIE, in October 2020, Uppsala, Sweden (https://doi.org/10.1109/FIE44824.2020.9273994); and IEEE Global Engineering Education Conference, EDUCON, in April 2021, Berlin, Germany (https://doi.org/10.1109/EDUCON46332.2021.9454110). Part of this work was carried out within the financial support of Novus Grant with PEP no. PHHT085-21ZZNV016, Institute for the Future of Education, Tecnologico de Monterrey, Mexico.

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Dimensions of Thinking, Reflecting and Knowing Through Design

22

Harah Chon

"Applied to the matter before us: we can learn thinking only if we radically unlearn what thinking has been traditionally. To do that, we must at the same time come to know it."

Martin Heidegger (Heidegger (1968) What is Called Thinking? Harper & Row Publishers, New York)

Summary

Design is defined by complexity, in both its practical and theoretical applications, and positioned to address the developmental, situational, technological, and societal challenges of the external world. The study and practice of design require ways to select, frame, understand, address, and tackle the increasingly complex systems and contexts of design. This emphasizes the intangible attributes of design residing in thinking, reflecting, and knowing. Design capabilities have evolved with the development and engagement of various tools and frameworks to produce deeper reflections, meaningful contributions, and discourses of design. This chapter reviews the parameters of thinking-in-design, the reflective activities leading towards the design-of-practice, and the actions and applications resulting from knowledge-through-design. The shift of design, from traditional practice to systems-based thinking approaches, is further discussed against the dimensions of thinking, reflecting, and knowing in design.

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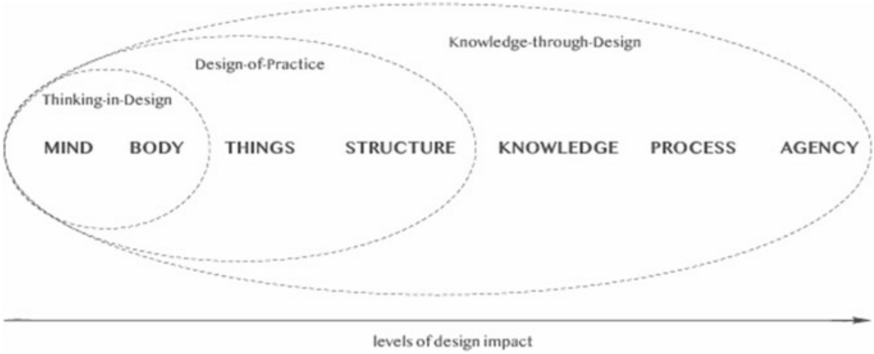
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_22



The dimensions of design.

Keywords

Design discourse · Design knowledge · Design theory · Design thinking · Reflexive design

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

Design has extended beyond the boundaries of traditional practice, influencing new ways of thinking and interacting to inform social change, support collaborative experience, and engage in human knowing. As global challenges present more complexities within selected contexts of study, the discipline of design has evolved to produce a more powerful and meaningful impact. Design is no longer defined as a series of methods or means for problem-solving but articulated through the processes reasoning, producing its own ways of thinking and reflecting to generate the transferrable knowledge appropriate for adapting to the forces of change in a complex world. Each phase of design's progression has redefined the values produced, reevaluated the meaning of experience, and recontextualized the frameworks through which we position design perspectives. This calls for a new way of utilizing, examining, and defining the impact of design through discussions of thinking-in-design, the production of design-of-practice through design reflexivity, and ways in which knowledge-through-design inform future cultures of design.

The discipline of design often deals with continually changing ambiguity and ill-defined parameters of issues, where the cognitive practice of thinking becomes a means for clarifying and shaping its systems and contexts of study. Through thinking, as a way of framing and contextualizing design, a reflective practice emerges to reify and critically evaluate emerging ideas, tools, processes, and outcomes. These modes of design contribute to design knowing, where knowledge establishes a basis to adapt, inform, alter, and shift perspectives for future actions.

Design is exploratory in its ability to produce multiple frames and perspectives of a given situation, relying on iterative developments to question, probe, and assess its impact. As the tools, methods, and processes of design become more accessible and relevant beyond the scope of the design profession, there is growing importance in further defining the tacit and intangible skills of design. The formal applications of design, in theory and practice, require a deeper understanding and articulation of the broad skills and knowledge needed to address the increasing complexity of design issues.

The Study of Design Against a Growing Complexity

Design has evolved across its neighboring disciplines to establish its applications and shift its studies from craft to interaction, experience-based, service-oriented, human-centered, and design thinking. No longer an insular discipline and practice, designers now have to work across multiple levels and adapt to the roles of the analyst to synthesist, generalist, and critic [1], developing the ability to dissect problem spaces through systematic processes and frameworks [2]. Figure 22.1 illustrates the positioning of the designer against complex design environments. The designer, as an individual actor or working within a team of actors, must learn to

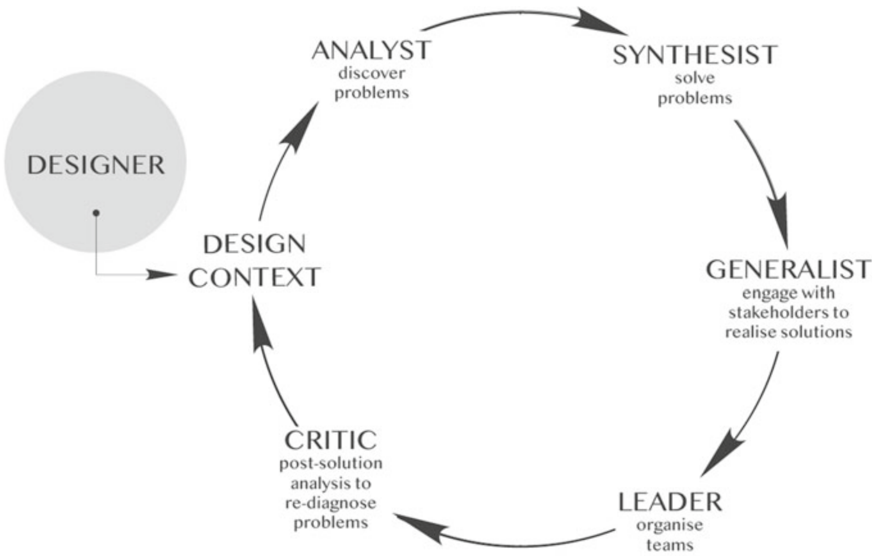


Fig. 22.1 The roles of design [1]

identify and understand problems within a given context of design to move through the various roles and stages of design.

Team effort is central to design, where designers assume the roles of generalist and leader to engage multiple perspectives and disciplines to realize a solution. Within such working groups, processes are required to solve the complex problems that are often layered within co-design approaches to synthesize initial ideas and solutions across a problem space. The criticality of a design lies in the ability to change frames when viewing a particular phenomenon, easing the cognitive load of design through divergent and convergent phases [2]. In the role of the critic, the designer is able to reflect on the entire design process and reassess the original problem space to evaluate the effectiveness of the proposed outcome or solution. Design is, therefore, a practice of thinking that produces actions through reflective practices leading to the formulation of knowledge.

The challenging new contexts of design demand improved developments and tools to deal with changing situations and technologies, often relying on collaboration to build upon knowledge and methods for positive change. Simon's definition [3] of design emphasizes the function of devising a process, through courses of actions, to effect change from existing to preferred situations. This requires designers to establish clear frames and perspectives of action, particularly when dealing with the growing complexities of design problems where design relies on interdisciplinary knowledge to serve multiple needs against the widening scope of design impact [4]. Norman [5] supports the interdisciplinary conditions of design by arguing for the integration of a deep appreciation of people and the social sciences and a deep understanding of science, mathematics, and engineering. Knowledge of peripheral areas, fields, and disciplines will add value to modern design, equipping designers with the ability to tackle root causes rather than the symptoms [6]. This reflects the call to move design from a focus on problem-solving activities towards a systems-oriented approach in thinking.

As technologies continue to undergo rapid change, design plays an increasingly important role in responding through collaborative approaches, processes, and frameworks. Methods and systems need to evolve to develop deeper understandings through observation and contextual framing, supporting the iterative cycles of design. Design cannot be limited to the scope of problem-solving but should be discussed as a practice beginning with the posing of strategic questions to establish propositions within a problem space that can be clarified through intentional and systematic exploration, experimentation, and experience. The experiential nature of design supports the processes of thinking, reflecting, and knowing to transfer thought into action, establishing and developing a deeper understanding of design phenomena.

Thinking-in-Design

Design is a discipline of realizing solutions and impacting change by exploring problem and solution spaces through facilitation of communication across the problem-relevant environment [7]. The role of thinking, as a form of design practice explicated as *design thinking*, can be described as a cognitive style of problem-solving, a general theory of design, or an organizational resource to drive innovation [8]. This section discusses perspectives of thinking-in-design, beginning with the implication that design is a significant factor in shaping human experience, with the plurality of design as being applicable to different problems and subject matters in the reconsideration of problems and solutions [9]. Thinking-in-design is presented through a review of shared philosophies, changing perspectives, modalities, and implications.

The perspectives of thinking-in-design provide an overview of thinking as framing and understanding, synthesizing, rationalizing, communicating and articulating, and reasoning and processing (Table 22.1). According to Buchanan [9], designers conceive subject matters in two ways on two levels as part of a process of discovery. Kolko [10] formalizes the synthesis process of design through an abductive sensemaking process, which often results in the emergence of themes and paradigms that shape future design activities. Lindberg et al. [7] outline a normative approach to design that extends mono-disciplinary rationales into more flexible meta-rationales to build strategies upon a common ground. Sevaldson [11] argues that design thinking is inseparable from design practice within processes of synthesis, where complex information is organized through tentative, iterative, and heuristic development. Design produces different ways of thinking that are fundamentally different from other disciplines, producing its own methods of reasoning

Table 22.1 Perspectives of thinking in design

Wicked and indeterminate design problems [9]	
General level	The designer holds a broad view of design and the scope of application
Particular level	The designer begins with a quasi-subject matter, as an indeterminate subject
Philosophies of synthesis [10]	
Sensemaking	An action-oriented process to integrate experiences into understanding
Abduction	An inference or intuition that is directly aided and assisted by personal experience
Descriptive-analytic design [7]	
Paraphrasing	Formulate and re-formulate the design question or task
Restriction-free thinking	Avoid personal judgments and develop shared judgments
Meta-rationale	Diversity should be encouraged to move in maximized domains of competence
Conceptual frameworks of systems oriented design [11]	
Design thinking and design practice	Design thinking is inseparable from design practice Synthesis is the central aspect of design thinking
Visual thinking and visual practice	Heuristic process of visualization, descriptive and generative diagramming Communicates information through participation and collective production
Systems thinking and systems practice	A general framework to deal with complexity Ability to address multiple aspects and generate holistic and synergistic responses
4 ways of design reasoning [12]	
Deduction	Shifting knowledge, patterns of relationships and observations from cause to effect
Induction	Discovering patterns in relationships through observation to infer and propose predictions
Normal abduction	Conventional problem-solving to clarify the problem scope
Design abduction	Defining key concepts and clarifying the problem space by employing a design process
Systems view of creative design thinking [13]	
Creativity in design	Process of developing individual perception through human capabilities
Creativity in a systems view	Produces a network of interactions to form new functions and innovations
Modes of thought [14]	
Construction	Process of interacting with the surrounding environment
Discrimination	Process of thinking about the world to formulate interpretations
Resolution	Process of making sense of the experience of phenomena to resolve problems
Assimilation	Process of devising action through an approximation of truths

and logic to identify patterns for action [12]. The cognitive orientation of design allows for descriptions, interpretations, and shifts in perspectives to be communicated [13]. Buchanan's [14] modes of thought build on the logic of pattern definition to suggest that systems fall into ways of interacting, thinking about the world, engaging phenomena to make sense of experience, and guiding research and practical action.

Modes of thought shape human experience through creative inquiry by conceptualizing and clarifying the systems framing design complexity [14]. It is through the function of thinking that the study and practice of design are pushed beyond problem-solving to radically shift thinking-in-design as an important precondition to addressing the complexities of problem spaces [12]. Designers are tasked with intuitively and deliberately shaping design situations, positioning, and repositioning problems by identifying the views of participants and the issues concerning them to develop relevance for further exploration and development [9]. This involves a high degree of thinking, producing a form of creativity that is innately and fundamentally human to present and provide experience [13]. The sensemaking process of synthesis activities allows for levels of thinking to manipulate, organize, and filter problem contexts [10], where visualization techniques provide the function of building networks through mapping and defining boundaries of systems [11], presenting pragmatic ways for the strategies of thinking-in-design to be made transferrable beyond the design discipline for an over-arching meta-disciplinary application [7]. The perspectives of thinking-in-design present the necessary and conscious act of making sense of complex design issues and problem spaces through varying modes of seeing, understanding, analyzing, describing, cataloging, organizing, and planning courses of actions, shifting across intangible to tangible and implicit to explicit dimensions of design. Design thinking, therefore, can be thought of as a set of contingent and embodied routines that constitute different ways of interacting with and within the sociocultural world [15].

Reflective Practice

Design concerns human pathways that provide insights into the obstacles, problems, and possibilities of change [14], relying on processes of thinking that are embedded within the shifting from problem to solution spaces. The design experience embodies different levels of activity that extend thinking beyond abstract and theoretical dimensions to develop and formulate concrete ideas and practices. Designers have the ability to process information through sensory and tangible methods, using the conversational activity of seeing and drawing as a means to make sense of, understand, appreciate, and communicate [16] and, in this form of thinking through drawing and sketching, embodied representations of thought and knowledge are produced [17]. The reflective practice of design, as leading towards the design-of-practice, will be further discussed through an examination of reflection as a form of concrete thinking and design inquiry.

Reflection is a temporally suspended activity that occurs after an experience takes place when its outcomes can be separated as part of the experience to be extracted, examined, and described. This posits that the act of reflection, of undergoing a continual evaluation through reasoning, reveals insights to establish an overall comprehension and understanding of the experience. Reflexivity, against the context of design, can be seen as the contemplation and negotiation of thought and understanding. This stage of design presents a form of internal dialogue where the conceptualization of a tangible design begins to materialize and take shape through reassessing, redefining, and recontextualizing all preconceptions of a design problem. The fast-changing nature of design contexts and issues demands periods of systematic reflection to fully contemplate the shifts from old to current situations and make informed decisions to alter future courses and plans, as illustrated in Fig. 22.2. This diagram depicts design reflexivity as residing in the present, relying on the past experience to form future intentions along the dimensions of understanding. The recursive nature of reflexivity allows for all levels of thinking to be transferred through internal mechanisms of feedback and feedforward.

Reflection is a necessary condition of design thinking that affirms and modifies initial conceptions of a design problem in order to validate future intentions and implications. The reflective process of design can be seen as a temporal experience that mediates the space of design inquiry, allowing the continual occurrence of systematic reflection to reinforce the positioning of design against external changes, levels of interaction and communication, and the formulation of courses of action.

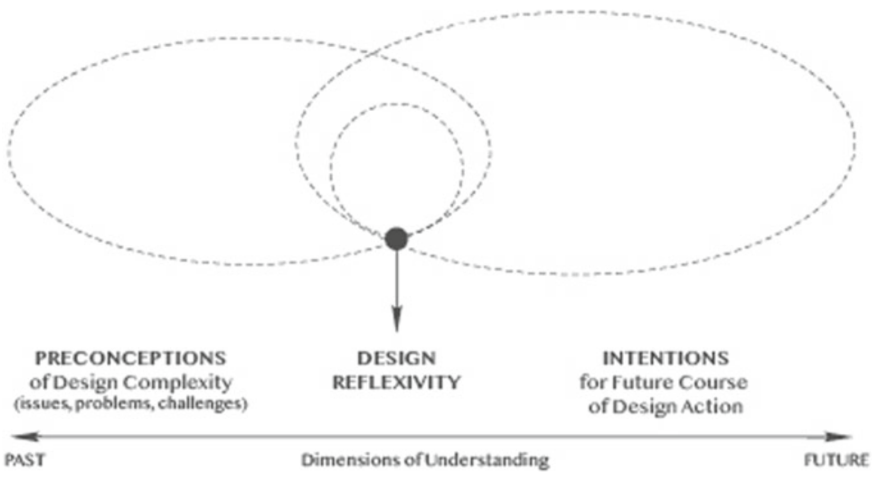


Fig. 22.2 Reflective practice in design

Dewey [18] attributes meaning to experience, as an exacting mode of thought, when relating the acts of thinking, reflecting, and understanding. This implies that the whole of design experience, encompassing the development of a design process and related practices, would require systematic moments of reflection to allow meanings to be established as an experiential outcome. If a reflective practice can facilitate a deeper understanding to transfer preconceptions of a design complexity into intentions by linking thought into action, there is a need to further define the role of systematic reflection as a key component throughout the design process leading towards the design-of-practice.

Thinking-in-design involves the embodied experience of contextualizing and framing the complexities posed by a problem space, making way for reflective activities and practices to further reify concepts and deepen levels of understanding. Design reflexivity positions the process of design as containing reflective conversations with the materials of a design situation [19], contributing to a continual and ongoing form of practice. Kimbell [15] defines four aspects of practice theory in terms of how they are,

(i) understood;
(ii) enacted and shaped through structures;
(iii) materialized through objects; and
(iv) transformed through interactions leading to conceptions of knowledge.

This presents an alternative way of conceiving design activities through the following concepts:

(i) *Design-as-practice*, the embodied, situated experiences of design that constitute a discursive practice through knowing, doing, and saying; and
(ii) *Designs-in-practice*, the emergent nature of design enacted in practice and incomplete beyond the process and outcomes of designing

Design-as-practice suggests that design, in its entirety, is representative of a practice. The outcomes afforded by *designs-in-practice* encompass the ongoing impact, interactions, and materialization of design. This leads to the question of when practice itself is designed and how does experience inform the *design-of-practice*.

Structure is necessary to give form to thinking and reflection, where the intangible qualities of building frames and formulating the boundaries of a design produce a discursive practice. Reorganizing, structuring, and formalizing these tacit experiences strengthen the notion of design-as-practice and enrich designs-in-practice. This devises a design-of-practice as an extension of systematic reflection, translated through form, object, or process. Language is one manner in which the qualitative and dynamic processes of reflective practice can be articulated to present a new form of discourse [20]. It is through practice that the processes of design are conceived and linked to other members, stakeholders, institutions, and end-users. Design practice is necessary to structure and understand how the tacit qualities of reflective practice can be transferred and made explicit.

Design Knowing

Against the ill-defined and ill-structured nature of design problems, the ways of thinking and reflecting inform a knowledge base for design. Cross [21] defines designedly ways of knowing as being embodied within codes that transform thoughts into words and objects, communicating the nonverbal experiences of design. According to Glanville [22], the designer as actor assumes the role of observer-as-participant in making knowledge and constructing the ways of obtaining knowledge. Knowledge in design is broadly referenced as the ways in which the objects and outcomes of design lead to the more active role of producing, organizing, and communicating ideas and solutions. The theoretical dimensions of design knowledge are often presented through categories that are based on the following polarities: tacit and explicit, abstract and concrete, subjective and objective, and personal and universal. Although the epistemological and ontological foundations of design knowledge are often based in other disciplines and fields of study, the situated practices of design organize and formulate contextual knowledge to provide frames for understanding a particular phenomenon. This form of knowledge serves as a precondition to experiential knowledge, which transforms and explicates the modes of thinking and reflection to be communicated and shared. Knowledge in design acts as the representation of experience, constructing and transmitting codes to be read and interpreted.

The design experience involves the active participation of designers and multiple stakeholders, transferring subjective and personal levels of knowledge into tangible forms to prescribe future social situations and relations. Experience is necessary to refine and strengthen one's symbolic activities towards progress in thought [23], producing modifications to transform the natural ability to perceive and categorize the development of perception into regularities of knowledge [24]. Theories of knowledge, arising through the modes of symbolic interaction and being-in-the-world, lead to the production of self-knowledge that develops experience into perception and, eventually, generates design knowledge. Table 22.2 presents the varying perspectives of knowledge across the common theme that perception leads to the construction of knowledge through the modes of human activity and experience.

The theories of knowledge focus on the epistemological underpinnings of how knowledge is formulated, from where it develops into perception, and in what ways human knowing reinforces one's existence in the world. In contrast, design produces its own forms of knowledge when the tacit activities of thinking and reflecting are framed within specific contexts and transferred through representational forms. Polanyi [25] describes the symbolic operation of representing experience through the stages of primary denotation, reorganization, and reading of the result. This shifts the inarticulate elements of thought into explicit understandings, emphasizing the potential role of design knowledge and the subsequent impact of its finished forms when transferred and applied into action. Thinking-in-design generates the subject of *what* needs to be known or made known, as the boundaries

Table 22.2 Classification of knowledge

Author	Mode	Outcome
Theories of knowedge		
Cassirer [23]	Symbolic interaction	Understanding the world Codes of communication Generate meanings
Polanyi [25]	Symbolic interaction	Personal knowledge as tacit and subjective Generate meanings
Hudson and Ozanne (1988)[a]	Symbolic interaction	Social construction of reality Codes of communication Generate meanings
Popper [24]	Sensory ability	Ability to perceive Understanding the world
Self knowledge		
Scheler (1973)[b]	Feedback	Ability to perceive Self-expression Organizing the world
Csikszentmihalyi and Rochberg-Halton (1981)[c]	Feedback	Ability to perceive Self-expression Codes of communication
Heinamaa (2012)[d]	Sensory ability	Ability to perceive Self-expression
Design knowledge		
Cross (1999)[e] and (2000)[f]	Experience	Creation and maintenance of the artificial world
Friedman [27]	Feedforward and feedback	Experience Ability to perceive Belonging in the world Reflective practice
Hoadley and Cox (2009)[g]	Experience	Creative processes Meta-knowledge
Narvaez (2000)[h]	Social influence	Projective ability Design thinking Dialectic relationship between designer and user

[a] Hudson LA, Ozanne JL (1988) Alternative Ways of Seeking Knowledge in Consumer Research. Journal of Consumer Research 14: 508–521
[b] Scheler M (1973) Formalism in Ethics and Non-formal Ethics of Values. Northwester University Press
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[h] Narvaez LM (2000) Design's Own Knowledge. Design Issues 16(1): 36–51

of problem spaces and complexities are framed through design perspectives, theories, and approaches. As an extension of reflective practice, the experience of design practice lends itself to articulate *how* knowledge is developed—this concept of knowing *how* is what formulates knowledge-through-design (Table 22.3).

Buchanan [26] describes the experience as being found in the relationship between the individual and environment, not in the internal process of accumulating sensations and perceptions. If knowledge is contingent on the value and quality of experience, this definition of experience positions the role of design as creating environments within which human intent moves into interaction, producing meaning as the fulfillment of original intent. These environments can be created through deeper purposes of unity in design, clarifying human experience as:

- Practical action: the simple, overt physical gestures used to gain access to a product, fulfilling the purpose of the experience;
- Intellectual understanding: the information or obstacles to the cognitive and intelligent understanding of action; and
- Emotional engagement: the feelings arising from interaction with an environment

Design knowledge can be comprehended across different frames and domains to embrace, enlarge, internalize, transmit, shift, recontextualize, and transform thought into action across the dimensions of knowing [27]. Knowledge, as it shifts from tacit to explicit, requires new frames and contexts for its values to be realized. Buchanan [28] defines four orders of design as a place for rethinking and reconceiving the nature of design across graphic, industrial, interaction, and systems

Table 22.3 Five types of knowledge-through-design [29]

Attribute	Domains of use	Function
Explicit	Designers, individuals, communities, institutions	To be made known and cognizable To be clearly expressed through a form
Discursive	All relevant persons/contexts	To stimulate discussion To negotiate and establish a shared understanding To explore propositions and possible strategies
Transferrable	Designers, design groups, education, research, communities of practice	To be applied through processes and actions To be formalized as practice To propose tools, models, and frameworks
Accumulative	Researchers, future contexts of design	To build research and future knowledge To theorize design practice

design professions. The four orders of symbols, things, actions, and thought are shown across the explicit/concrete and implicit/abstract dimensions of design in Fig. 22.3. As design practice moves away from analytic and synthetic aspects towards the intentional placements and situations of use defined by the four orders, design assumes the mediating role of negotiating between design intent and user expectation. These new interactions and experiences require different kinds of knowledge and suggest that while design produces knowledge stemming from and relevant for other disciplines and fields, design knowledge is the knowing that materializes, transforms, transfers, and acts *through* design.

Design knowledge, according to Manzini [29], is the knowledge that can be used by designers and non-designers in their processes of designing and co-designing. The cognitive functions of knowing are materialized through tangible forms, such as visions for strategic discussion, proposals for integration, and tools for understanding and implementing. This emphasizes that design knowledge needs to be made communicable and clearly expressed to be applied and used by others.

Design ability can be defined as a form of intelligence and a multi-faceted cognitive skill [30]. However, Manzini [29] argues that traditional design knowledge accumulated through the implicit knowledge of professional design is no longer sufficient to deal with the plurality of design that is influenced by systems of change and dynamic problem contexts. Design knowledge needs to become more robust in the ways that it is ontologically categorized within the contexts where design can produce more meaningful and sustainable impact. This requires different networks of actors to work together, allowing the various domains and attributes of design knowledge to be continually shared, exchanged, transferred, transformed, altered, and applied.

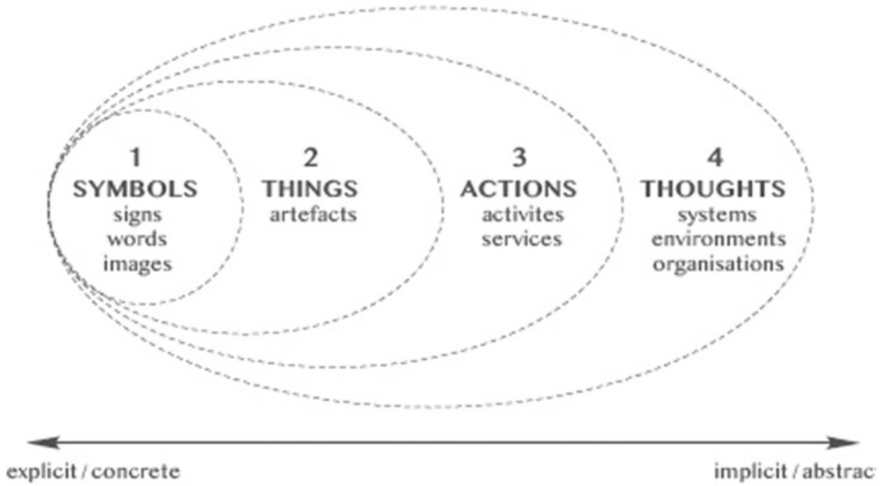

Fig. 22.3 The four orders of design [28]

The Implications of Design Thinking, Reflecting and Knowing

There is a clear shift occurring in the areas of design study, education, and practice. The forms of design that conform to traditional skills and crafts will represent the past, while design comprising the ability to lead and transform future design requires further knowledge through the exploration of technology, social sciences, and the complexities of the world [5]. The future design will transform practice through modes of thinking, emphasizing the focus of design on people and human-centered approaches when dealing with complex problems. This will contribute to a body of knowledge that builds upon all the knowledge of all specialized fields.

Manzini [31] argues that design has shifted from a focus on objects toward ways of thinking and doing as part of the human-centered approach. Against this implication, that all design activities are forms of co-design and involve groups of multi-skilled actors, the following three meanings of design can be established:

(i) Diffuse design: "the natural human ability to adopt a design approach, which results from critical sense, creativity, and practical sense;"
(ii) Expert design: "the professional designers who should, by definition, be endowed with specific design skills and culture;"
(iii) Co-Design: "the overall design process resulting from the interaction of a variety of disciplines and stakeholders"

These three meanings of design represent what Manzini refers to as emerging design, which establishes dialogic cooperation where the willingness to listen and converge towards a common view results in collaboratively obtained outcomes.

Dorst [2] presents two issues confronting design within complex situations:

- the starting point is difficult to discern, making it challenging to interpret a problem situation; and
- the interrelated relationships within systemic complexity further complicate the shaping of appropriate ways forward.

Adopting an exploratory, reflective practice for design presents a new paradigm for the future design that is highly iterative and intentionally indeterminate. This allows for a flexible system of design marked by resilience and adaptability, reinforcing the dialogic and dialectic processes of design.

Meyer and Norman [6] outline eleven design challenges into the four cumulative groups: performance, systemic, contextual, and global challenges. It defines the future of design and calls for new ways to address the different levels of design problems. The first group, *performance challenges,* can be addressed through traditional skills and knowledge. *Systemic challenges* require systems thinking skills, multidisciplinary knowledge, and management and leadership training. *Contextual challenges* are situated challenges that necessitate a form of co-design, allowing the community to be involved in the process. Finally, *global challenges* are is a team effort that may call on design skills but will involve bottom-up collaborations and knowledge across all relevant domains. The eleven challenges of design are outlined in Table 22.4.

This chapter has discussed design as relying on experiences to produce the dimensions of thinking, reflecting, and knowing in design. These varying perspectives and theories of design reveal current gaps in research and practice, suggest areas in which professional designers can contribute to the theorizing of current and professional practices, and propose future areas where the frameworks and models of design research can aid in formalizing design activities. There is a clear

Table 22.4 The challenges of design [6]

Category	Description	Challenges
Performance challenges	Relating to what designers must do	1. Design acts on the physical world and the linked world of intangibles; 2. The design addresses human needs and desires (specific and abstract); 3. Design generates tangible and intangible built/social environments;
Systemic challenges	Relating to addressing the entire system and not just a single part	4. We live in a world marked by ambiguous boundaries between artifacts, structures, systems, and processes; 5. We work in a world of large-scale social, economic, and industrial frames; 6. We design for a complex environment of ever-shifting needs, requirements, and constraints; 7. We design for a world in which intangible content often exceeds the value of physical substance;
Contextual challenges	Relating to dealing with complex systems that are strongly affected by their environment, local culture, and political concerns	8. The projects, products, and services we design often cross the boundaries of other organizations, stakeholders, producers, and user groups; 9. The projects, products, and services must meet the expectations of other organizations, stakeholders, producers, and users; 10. These projects, products, and services must meet the demands at every level of production, distribution, reception, and control; and
Global challenges	Relating to dealing with complex sociotechnical systems	11. Address the major social issues facing the world

shift in design that is driven by the interconnectedness of human experience, moving discourses from traditional practice towards the ambiguity posed by the systemic challenges of complex design problems. The discussions throughout this chapter have examined the current challenges of design amidst the growing complexities posed by design problems, leading to a review of how design constitutes thinking-in-design to frame concepts and problem spaces, presents moments of reflection to reify and deepen understandings of the design context towards the design-of-practice, and formalizes experience to produce knowledge-through-design. The dimensions of thinking, reflecting, and knowing in design are illustrated in Graphical Abstract.

Design shifts thinking, reflecting, and knowing across the situated practices involving the mind, body, things, structures, knowledge, processes, and agency. In consideration of the ways that design knowledge and its practices are being utilized and applied in non-design fields, there is much to be defined in the agency of design knowledge against the social, co-created, co-designed structures of design collaboration. This proposes future discourses of social design and the role of design in multi-stakeholder collaboration, furthering research on the implications of decolonizing and democratizing design knowledge, building on the implications of Manzini's [29] call for new design knowledge that is explicit, discursive, transferrable, and accumulative.

Conclusion

Design problems are growing in complexity, and clarifying the ill-defined and ill-structured problem spaces requires intentional levels of thinking. The mode of shifting design thinking from problem definition to a solution focus relies on reflexivity, giving form and structure to understand design practice's positioning deeply. Reflective practice reiterates the frames and perspectives of thinking to deepen understanding, reposition the role and function of design, and transfer thought into action through the design-of-practice. Design produces its own knowledge through designedly ways, which serve as representations of contextual and experiential knowing. Knowledge-through-design provides the premise for design to produce explicit, discursive, transferrable, and accumulative forms. The dimensions of thinking, reflecting, and knowledge in design have been examined against the paradigmatic shift of design from traditional practice to systems-led domains that require more robust and resilient implications of design.

This chapter has reviewed and presented the experience of design and the entirety of the design process as being developed through the dimensions of thinking, reflecting, and knowing. Design is exploratory in nature and relies on the ability to organize, frame, question, and infer through the use of various tools, models, frameworks, and practices. The implicit and subjective activities of design have been discussed throughout this chapter to clarify how the processes of thinking, reflecting, and knowing transfer the tacit experiences of design practice into explicit forms to be communicated, discussed, and challenged. Broad theories and philosophies of design have reviewed the interdisciplinary roots of design across the fields of art and science, presenting the areas in which design can continue to inform and contribute to its own domains of theory and knowledge. As the future study, practice, and application of design is moved into highly ambiguous, inarticulate, and complex problem spaces, the role of design needs to be re-examined to identify the gaps, in theory, practice, research, and knowledge.

Core Messages

- Thinking focuses on *what* is known.
- Practice articulates *how* knowing develops.
- Knowledge determines *where* knowing transforms.

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Thinking Through Sound: Music Listening as a Model for Enhanced Cognition

23

Mark Reybrouck

"The tonal structure we call "music" bears a close logical similarity to the forms of human feeling—forms of growth and attenuation, flowing and stowing, conflict and resolution, speed, arrest, terrific excitement, calm or subtle activation and dreamy lapses—not joy and sorrow perhaps, but the poignancy of either and both—the greatness and brevity and eternal passing of everything vitally felt. Such is the pattern, or logical form, of sentience; and the pattern of music is that same form worked out in pure measured sound and silence. Music is a tonal analogue of emotive life."

[*1*, p. 27]

Summary

Music is a temporal and sounding art. It is self-referential in the sense that it focuses on itself rather than on external reference. This centripetal tendency makes it possible to assign semantic meaning to sounding elements based on the idiosyncrasies and particularities of their unfolding. There is, however, a tension between the acoustic description of the music and the sense-making by the listeners, with a major distinction between real-time consumption of the sounds and their processing at the level of mental computations. Musical sense-making, however, is first and foremost an experience grounded in our innate disposition

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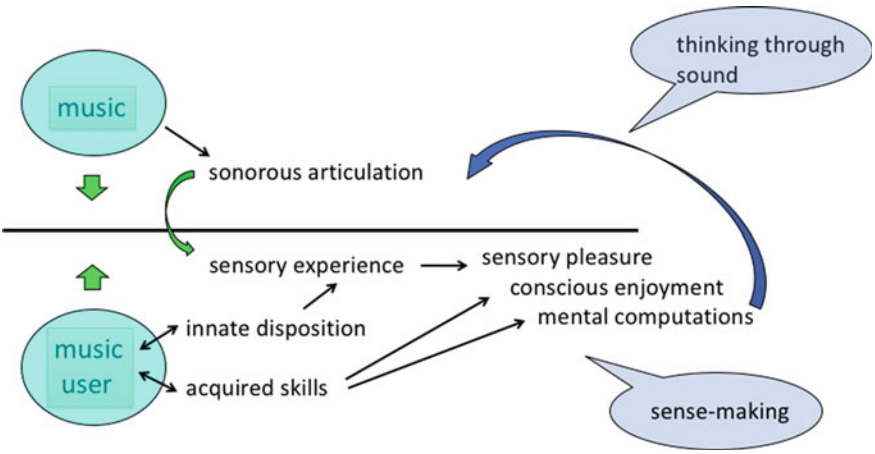
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_23

for coping with sounds and our acquired sense-making skills. Starting from the biological underpinnings of these mechanisms of sense-making, from sensory coding, over psychobiology to neuroaesthetics, it is shown how sensory pleasure can be converted into conscious enjoyment with special attention for peak emotional experiences as chills and thrills. Finally, it is shown how the musical experience can be raised from a mere sensory level to an aesthetic level of experience and how this is related to mechanisms of enhanced processing and cognitive functioning, as evidenced by connected activation patterns in the brain.



Thinking through sound.

Keywords

Chills and thrills · Conscious enjoyment · Cognitive mastering · Musical experience · Musical sense-making · Neuroaesthetics · Psychobiology · Sensory pleasure · Vibrational energy

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

Music is a sounding art. It is basically self-referential in the sense that its meaning is immanent. In contrast to language, which aims at directing our attention away from the text to grasp the meaning that is formed by text written or spoken (external reference), it is characterized by a tendency to focus on the sounds themselves (internal reference) [2]. This is the major distinction between the *centripetal* and *centrifugal* tendency of linguistic meaning, with the former being typical of physiognomized language, which is not oriented primordially to the lexico-semantic field of meaning but rather to the sharing of an experiential field between the music and the listener [3, p. 209]. This could look like a regression to more archaic means of sense-making, characterized by more syncretic aspects of the processing of the sounds, where musical elements are not recognized primarily in their denotative or lexical function but rather as referring to themselves without any reference to something outside of the music [4, pp. 4–5]. However, it can be questioned whether this distinction is indeed so radical and whether it is possible to use these self-referential elements as legitimate candidates for performing mental or cognitive operations on them. As such, it raises the question whether we can conceive of thinking through and in sound [5, 6].

Music as a Temporal and Sounding Phenomenon

As art of time, music has its counterpart in speech, which, though perceptually distinct, shares many commonalities with music in terms of acoustics and cognitive demands [7]. As for acoustics, like speech, music provides a way of conveying information using pitch, timing, and timbre. As for cognitive demands, both speech and music fundamentally depend on memory, attention, and cognitive skills to develop coherence or streaming out of discrete acoustic phenomena [8]. They are typical examples of how evolution has shaped our auditory system to use sound to communicate cognitive representations, internal states, and emotions, which is a highly constrained way. Both speech and music are examples of generative and recursive systems that create complex structures starting from a limited set of primitive ways by applying syntactic rules in a combinatorial and creative way [9].

Besides these commonalities, however, there are differences as well. A text can be read by different voices, quietly or loudly, at a slow or fast pace, allowing many degrees of freedom with respect to its actual rendering. Music, however, is much more constrained. Its meaning is less externally directed because the discrete auditory events can be consumed as self-contained auditory events that refer mainly to themselves. This is an essential aspect of self-reflective semantics with elements that are not denotative or lexical but self-referential [4]. There is, as such, an aspect of semanticity that enters as soon as something that sounds is recognized as being internal to some system. This is the beginning of an act of denotation ("that" sound), which stresses the centripetal tendency to recognize musical events merely as musical events which can be identified as such with their particular and idiosyncratic qualities. Figure 23.1 provides an example. Three sounds are depicted both as a waveform and as a spectrogram. They are clearly distinct from each other, but each clearly depicts a sonic category—respectively a birdsong, a guitar sound, and a human voice—each with their typical spectral and temporal changes, which are recognized as such.

The importance of these idiosyncratic characteristics clearly shows that music's primordial role is not communication, as it usually subserves functions other than representation. Music understanding, as a rule, involves several forms of understanding, communication, and social cognition, as exemplified so typically in the primordial interactions between infants and early caregivers. They can be categorized as embodied, pre-linguistic and emotional-empathic. Suppose this should be understood in terms of communication. In that case, it should be considered as a kind of *primary intersubjectivity* and *participatory sense-making* through embodied affective means rather than by referring to an existing lexicon of semantic meanings [11, 12].

This brings us to the most primary quality of the music: it is a sounding phenomenon that accomplishes vibrational energy transfer and gathers our senses and minds. Yet, it is not merely an acoustic structure but also a phenomenon of

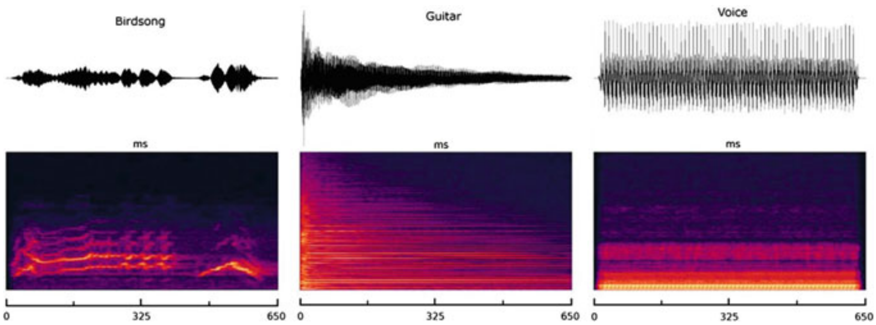


Fig. 23.1 Three examples of complex sound stimuli: waveform and spectrogram of birdsong, a guitar note played at C3, and a male human voice pronouncing the vowel /ɑ/. (Adapted with permission from [10], © Elsevier B. V., License Number 4900681449102)

subjective human experience [13]. There is, as such, a tension between the acoustic description of the music as a stimulus and the sense-making by the listeners. The latter can occur at distinct levels, such as the perceptual, cognitive, and affective levels, which mostly do not work separately but together. Music, in that view, is to be considered as a temporal succession of sounding events, which the listeners can structure using "a temporally extended, exploratory activity that brings together perception, manipulation and appropriation of different sonic affordances offered up by sonic invariants that are present within the music" [14, p. 6]. It defines experience as cognition as exemplified in what Krueger has called the *world-making power* of the music as "a sonic world that affords possibilities for creating, organizing, and regulating listeners' experiences, emotion regulation and social coordination" [15, p. 7].

Dealing with Music: From Structure to Process

Music is not merely a sounding art. It is also a temporal phenomenon that displays its structure successively during its unfolding over time. As such, some minimum time is needed to grasp its temporal design, which is not a static artifact but a dynamic structure. There is, as yet, a distinction to be made between the moment-to-moment engagement with the sounds and the synoptic overview of those sounds that are merely recollected in memory or imagination. It enables us to treat music as consumption of the sounds, which happens in real-time, or as a form of a more detached and distanced stance that conceives them outside of the time of actual sounding. This is the distinction between music as structure and music as a process, which has its counterpart in the "in-time/outside-of-time dichotomy, which has challenged to some extent the disciplinary history of musicology [16]. It is possible, in fact, to study music as an artifact, as a kind of petrified structure, as exemplified most typically by the study of the score. This is the realm of music analysis, which proceeds mainly outside of the time of actual sounding, as the score provides a lasting trace or symbolic transcription of the sounds. It makes it possible to perform mental operations on mental replicas of the sounds and to navigate through the music as in a virtual space, referring back to past events or anticipating future events. Real-time listening and performing, on the contrary, are more constrained in the sense that the attentional focus is directed at the temporal window of the actual sounding now-moments.

As such, there is a distinction between listening, performing, improvising, or composing, and even analyzing music. Each of these distinct ways of musical engagement can have a place on the continuum between in-time and outside-of-time processing of the sounds with the possibility to be completely immersed in the actual now moment as well as to take distance from the sounding music. Both approaches, moreover, do not exclude each other but are complementary to some extent. Take the example of a jazz improviser who plays some notes on his saxophone. While performing the needed handgrips on his instrument as well as the accompanying breathing techniques and the appropriate tension of the lips, he must not only produce the tones he is actually playing, but he must also anticipate the successive ones and bring them in relation with those just played in order to make something coherent out of it. This is the tension between the discrete particulars of the actual performing and the relational continuity of the more encompassing overarching overview. Improvising, moreover, not only requires playing of notes which are depicted on a score, as in sight-reading, or which are stored in memory, but it involves on the spot realization of newly generated sounds that must be embedded in a continuous flow of past and future sounds. What is going on in the head of the performer is thus an amalgam of multiple processes, which makes dealing with music a complex of skills that can be improved by repeated musical practice. It embraces perception and action and general cognitive processes such as memory, executive functions, and attention [17]. But even in the case of mere listening, multiple processes are going on. Some of them proceed at an internal level of imagery rather than being externalized in manifest behavior. The whole picture, therefore, is that of musical competence being defined as a multi-layered phenomenon, which, in more operational terms, can be translated in terms of perception, action, and cognitive processes—sometimes called computation—which has been studied both in isolation (music perception studies, music performance studies, and music and cognition studies) and jointly. They make up a major part of studies in cognitive musicology [18–20].

This extended approach to dealing with music, however, has been criticized as being too cognitive and too detached with respect to the sounding music. Much of this research has centered mainly on the computational part of dealing with music, with music processing remaining enclosed within the brain with no connections to the real world [21–23]. Cognitive science, therefore, has seen a major shift from a mere computational to a neurobiological approach. This holds for cognitive science in general, but also for the domain of music listening, with corresponding new topics of research such as the conception of music as experience [24, 25], the exploding domain of music and emotions [26, 27], research onto the dispositional toolkit for coping with music and the related question of the evolutionary origins of music [28, 29], and, more recently, also the whole bulk of music and brain studies [30]. Music, in this evolved view, cannot merely be equated with a set of structures. It also involves the ways how we make sense of music, and this involves mechanisms underpinning the biological basis of our behavior and our cognitive skills.

Coping with the Sounds: Biological Underpinnings of Musical Sense-Making

The reluctance to rely on the lexico-semantic field of meaning has shifted the theorizing about musical sense-making into the direction of non-referential semantics [31]. Music, in this view, is preverbal and preconceptual, relying on inductive power rather than on propositional or lexical content. It invites us to think about how listeners cope with the sounds that make up the music [30] and investigate the underlying mechanisms that enable the transition from sound to music. No simple mechanism can likely attain this goal. What should be argued for, on the contrary, is a multi-layered complex of three mental and neural systems, namely a sensory-motor, a knowledge-meaning, and an emotion-evaluation system [32]. These distinct levels of processing are related to the distinction between lower-level perceptual-emotional stages and higher-level processes, which involve reflection and cognitive control. The lower levels of processing have received considerable attention in the context of sensory physiology, psychophysics—and in the case of music, psychoacoustics—and psychobiology [33, 34].

The domain of *sensory coding*, in particular, is an example of low-level automatic and elementary processing of information. It is characterized by relative simplicity with an initial isomorphism between the stimuli and receptor responses, with a unidirectional flow of information and a kind of mapping between the perceptual input and behavioral reactions that are elicited by them, which may suggest a kind of causal relationship. This is one of the major claims of psychophysics which is concerned basically with a search for a functional relationship between the working of the body and the mind and the investigation of how the dimensions of physical stimuli may relate to those of sensory experiences [35, pp. 16, 356]. These low-level reactions, further, are innate rather than acquired and are reducible to wired-in reactivity to stimuli from the environment with genetically programmed codes that function as a kind of lock-and-key. As such, they are primitive in a radical sense: they are rapid and efficient but act under a limited scope and function. Listeners, then, can rely on neural coding strategies, which by evolution direct the adaptation of signal processing systems to process and provide an optimal representation of sensory information. In this context, we have roughly similar basic body plans, particularly, sensory organs and neural representations that allow us to "see in different colors, hear in different frequency registers, and smell different odors" [36, p. 252] and [37].

The *psychobiological approach*, on the other hand, is more challenging as it is mainly directed at the relationship between mind and brain and the particular ways to encode and represent mental processes: "the nervous system provides the immediate, necessary and sufficient mechanisms for the embodiment of all mental processes" and "the key to the particular ways in which mental processes are encoded and represented lies in the function, arrangement, and interaction of neurons, the constituent building blocks of the nervous system" [35, p. 355]. This is, in a nutshell, the principal claim of the "axiom of psychobiological equivalence, which claims an equivalence of maintained information from the neural to the psychological state."

As a whole, this lower-level approach has foreshadowed somewhat the current rapprochement between the field of music and biology as an example of a paradigm shift in musicology that conceives of thinking of music as universals of perception and cognition [33] with emerging new disciplines such as *biomusicology* [28, 38] and *neuromusicology* [29, 39]. But even these new emerging fields have shown to be somewhat reductionistic at times, in the sense that the biological underpinnings are restricted too narrowly to the nervous system and the brain. Therefore, it has been argued that there is a need to widen the scope and include broader bodily activity as well as the assessment of subjective valuing of the music-as-heard. The latter belongs to the philosophically oriented realm of phenomenology. The proposed widening could lead to a kind of *neuro-physio-phenomenology* [40, p. 143] with the study of neurobiology and neurochemistry of musical emotions as its central focus. By including several kinds of methods for recording bodily activity, it should then be possible to extend a rather narrow conception of *neurophenomenology*—as integration of self-reports to collect first-person descriptions of the experience and objective data of experimental measurements—to the rest of the organism. The study of the neurobiology and the neurochemistry of musical emotions is likely to be promising in this regard [41], with already many studies on the role of dopamine release and/or endogenous opioids during musical pleasure [42–45].

There is, in a similar vein, a related broadening of the field that tries to understand the mechanisms of musical sense-making through the lens of *neuroaesthetics* as the proper research field that investigates the neurobiological substrates of the so-called aesthetic experience [32, 46–49]. As a scientific discipline, it builds on an interdisciplinary framework that includes philosophical, psychological, neuroscientific, and evolutionary approaches [50]. Conceived primarily in the context of visual art by Zeki in the 1990s [51], and relying heavily on the methodology of cognitive and affective neurosciences, it has become a research field in its own right with the aim to understand those neural principles that underlie the different processes that are involved in "a human aesthetic experience with an artistic object," an experience, that Brattico says, is "a psychological state determined by interaction with an object to which we intend to attribute (evaluate/appraise) positive or negative qualities according to perceptual, cognitive, affective, or cultural criteria. It is intrinsically different from other affective experiences due to a special attitude (also referred to as focus, stance, or pre-classification) toward the object" [52, p. 367]. Or put differentially: an aesthetic experience is different from other affect experiences in the sense that such an experience has been designed so as to produce this typical experience [53]. It means that we attribute a meaning to the stimulus based on aesthetic evaluation and that the intentional relation and attitude of the perceiver to the stimulus is the actual source of our aesthetic experience. It is an approach that values the perceiver's internal state, importantly [italics are mine] "*his/her* personal experience of previous encounters with the stimulus and the attitudes towards the stimulus, the current mood and the innate biological predispositions for processing the stimulus and for having an aesthetic experience as a whole" [54]. Musical sense-making, then, seems to balance between lower-level and higher-level processes of coping with the sounds, in the sense that a full musical experience should include some final outcomes, such as aesthetic emotions, aesthetic judgments, and the formation of musical preferences and taste [55].

From Sensory Pleasure to Conscious Enjoyment

It can be asked to what extent aesthetic experiences are constitutive of the process of musical sense-making. It is possible, in fact, to listen to music at a lower level of pure reactivity without solicitation of the higher brain functions. As such, the question is related to what has been called the *coupling/constitution fallacy* in discussions about the extended mind in the respective fields of cognitive science and philosophy of mind [56]. There is no space to go into detail here, but the extended mind hypothesis basically means that our mind can be extended by including external non-biological elements (such as a notebook, a smartphone, a computer, etc.) in our cognitive system. Then, the coupling/constitution fallacy is concerned with whether such an extension qualifies as an equivalent part of the cognitive system or whether it should be considered only as an external extension or attribute to it. Its basic claim is that when something is coupled to a cognitive system, this does not necessarily mean that it is also constitutive of that same system. It also means that the causal coupling of external elements should not be confused with the constitutive basis of cognitive processes, calling forth a distinction between causes and constituents [57].

The aesthetic experience, as we can conceive of it, is not mandatory or constitutive for the process of musical sense-making but is a welcome addition to the sensory experience proper. It raises the experience above the level of mere reactive behavior, which does not mean, however, that these lower-levels reactions do not matter. There is, in fact, a continuity between lower- and higher-level processing, with levels of the processing being complementary rather than opposed. Moreover, two kinds of behavior are of particular interest: mere reactive behavior and those emotional peak experiences known as *chills and thrills*.

Mere reactive behavior is positioned on the lower level of the continuum. Yet, it can even be rewarding, as evidenced by the pleasure that some listeners experience while listening to extremely loud music. This is the celebration of the bass culture with its conception of "sound as power" [58–61]. Music, in that case, is to be perceived as vibrational transduction of affect, rather than a mere translation of meaning, with powerful frequencies—mostly in the lower range—that impinge upon our body in a haptic way. Yet, loudness is only one criterion for reactive responses. It is an important one, however, as loud and sudden stimuli are able to swamp our senses, as evidenced in the *acoustic startle reaction,* which is a simple acute defensive or protective reaction to sudden sensory stimuli, mostly in the acoustic, tactile or visual domain, that may signal a proximal threat from potential predators or blows, and that prepares for fight and flight. It is a low-level reaction to the sounds—it is actually a reflex—which is basically innate. We see it:

(i) "as a fast twitch of facial and body muscles;"
(ii) accompanied by "an arrest of ongoing behavior and changes in some autonomic functions such as heart rate;" and
(iii) it has a rather simple design but depends upon external and internal factors [62].

This reaction has been extensively described in the research literature as it leans very well to quantitative analysis [63–67]. Further, the startle reflex is part of our hereditary disposition for coping with sounds, with about no need for cognitive mediation. This is not the case for those more refined pleasure experiences, which are known as *chills and thrills*. Aesthetic chills, in particular, have an experimental and individual difference side, with the experimental side focusing mainly on how features of the music affect the way how people experience chills [68, 69] or how changes in physiological parameters correspond with the experience of chills [70, 71], while the individual difference side has been examining the personality characteristics of those people who tend to experience chills [72]. The concept of chills, however, is somewhat ill-defined. As a construct, it can be split into a positive and a negative approach, somewhat contrary to the understanding of chills in terms of a holistic approach and avoidance behavior. Generalizing a little, the experience of chills may involve distinct feelings such as "awe, surprise, tension, pleasure, being moved, elevation, nostalgia, and may also be characterized as positive and desirable, or negative and aversive." In an attempt to provide a more operational definition, a multiple component analysis has been carried out on the chills concept, with correlations for three main dimensions:

(i) a dimension for "frowning, smiling, feelings of warmth, and feelings of cold;"
(ii) a dimension for "tingling, shivers and goosebumps;" and
(iii) a dimension for "tears and feeling a lump in the throat" [73].

As such, three distinct chills categories may be constructed based on grouping in and between bodily activity and emotional experiences, with a distinction between "warm chills," which are accompanied by feelings that are positively valenced and bodily activities (joy, relaxation, stimulation, smiling, and feelings of warmth), "cold chills" with negatively valenced feelings and bodily activity (sadness, anger, frowning, feelings of cold) and "moving chills" with "bodily activity such as tears and a lump in the throat," as well as "feelings of tenderness, affection, intensity, and being moved." From this perspective, at least three distinct chills constructs must be present for taking affective valence, elicitor quality, and individual differences into account [74].

The study of chills is interesting but challenging, as it refers to both the objective bodily processes and the subjective sensations of these bodily processes. With regard to musical sense-making, the subjective bodily sensations seem to be most fruitful as they are closest to the laypersons' self-report on getting chills. As such, they have face validity regardless of what is going on in the body and can attain a level of semanticity with respect to the sounding music, which is valued at a preconceptual and mainly affective value.

This holds in particular for the category of chills known as "aesthetic chills," which can be considered a reliable indicator of so-called peak emotional experiences [71]. They are supposed to be a reflection of the experience of "awe." We know this category for its main characteristics as:

- an effect of "the perception of "vastness" (i.e., larger than the self's frame of reference) and the "accommodation" (adjustment of mental structures) to that perception" [75];
- an association with "dramatic shifts in musical features (e.g., crescendo, disharmonies)—in other words, novel events or features that may run counter to expectation" [69, 76]; and
- an accompanying activation of the sympathetic nervous system and their corresponding physiological responses such as goosebumps and piloerection [77].

Moreover, it has been found that these physiological, emotional correlations could be considered a marker of the personality trait, which is known as "openness to experience." This concept is related to "the breadth, depth, and permeability of consciousness, and in the recurrent need to enlarge and examine experience" [78, p. 826] and [79]. It is perceived as feeling more comfortable with novelty and being more motivated in cognitive exploration [80]. Of course, individual differences exist and are important to proneness and sensitivity to aesthetic engagement and chills and the emotional and physiological responses that this engagement might elicit [81].

These differences in engagement can explain the great variance between the degree of chill experiences between subjects (some listeners never experience chills while others experience them frequently). They point in the direction of a complex process that relies on levels of processing, with a distinction between sensory, physiological, behavioral, and cognitive contributions. Hereditary (innate) characteristics are involved as well as learned (acquired) characteristics. It explains why the connection between the acoustic signal and listeners' reactions is complicated and even complex rather than simple. What does matter to some extent is the question of how emotionally arousing experiences can facilitate the experience of pleasure, chills, and thrills, to the extent that they cause listeners to actively look at auditory cues, somewhat analogous to the way they may explore their sound environments. These lines of evidence put forward that listening is a process concerned with an innate desire for coping with the surrounding natural environment and acquired skills for understanding music. This process is not confined to a primitive coupling of action and reaction but belongs to the domain of higher-order variables that have an intermediary position between the sensory input and the behavioral or effector outcome.

Thus, it seems that top-down influences can modify chill experiences, which raise the level of music processing from a mere "sensory" level to an "aesthetic" level of engagement with the sounds. The role of attention and conscious listening seems to be important here, with techniques known as "cognitive mastering" and the "knowledge instinct." *Cognitive mastering* occurs when a hedonic response derives from understanding the formal structure of the music. It illustrates the transition from sensory pleasure to conscious enjoyment as a crucial stage of information processing that may ultimately lead to aesthetic processes of judgments and emotions [82]. The related concept of *knowledge instinct*, as a mechanism that generates aesthetic pleasure from knowledge and understanding, states that aesthetic emotions reflect the needs of the mind to understand the ever-changing world by thinking conceptually, as opposed to basic emotions, which are considered mainly as bodily instincts [83]. Cognitive mastering may thus modify an individual's affective state when facing musical engagement, in the sense that the positive affect derived from understanding might be related to an aesthetic brain response [84].

Enhanced Processing and Auxiliary Representations

Conscious enjoyment of music is not gratuitous. It entails an "active engagement with the fine-grained acoustics of music and the concomitant development of 'sound to meaning' connections that may result in enhanced processing in the speech" [7]. Even considering enjoyment of music as a common phenomenon, it is not necessarily meant to be yielded from attentive listening. More precisely, when we hear in a casual and unfocused way, it is our unconscious thought that takes on for making sense of music and understanding it as the aesthetic appreciation of beauty, mastery, or structure [55]. Such enhanced processing has been found to be the case in trained musicians and experienced listeners, who rely on different cognitive strategies compared to amateurs and non-musicians. This is evidenced by the distinct brain activation patterns that reflect their listening and processing ways [13]. Contrary to earlier views of more-or-less fixed centers in the brain—with a simple left versus right dichotomy as a typical example—it has been shown that there is a profound influence of professional training on hemispheric lateralization during music processing in the sense that non-musicians exhibit a preponderance for the right hemisphere, where professional musicians show a left hemispheric preponderance [85]. Professional musicians process demanding harmonic and melodic discrimination tasks mainly in the left frontotemporal lobes; non-musicians, on the other hand, activate both the frontal lobes, bilaterally, as well as the right temporal lobe. This difference has been related to covert inner speech, as music professionals are inclined to name more or less automatically the intervals and harmonies. They allegedly have access to so-called "auxiliary representations" of music, which are the outcome of years of training [13]. Yet, besides this reliance on inner speech, there is another distinction that sets musicians apart from non-musicians, namely the possibility to re-enact the sound-producing physical acts while listening. Empirical studies have revealed that music listening can facilitate motor processing, allowing listeners to simulate the same motor actions that are required to perform the music that is heard, which means that they may perceive music through motor engagement [22, 86]. It is a welcome extension of the rather reductionist approach of the prevailing cognitive and detached approaches to music listening of former decades. What is suggested, on the contrary, is that musicians experience the music more intensely and more proprioceptively compared with non-musicians [87]. Proprioception, in fact, is highly relevant during the course of musical practice, and prolonged musical experiences—either active ones during performing or passive ones during listening—may lead to a kind of "performative awareness" of our body [88] and [89, p. 220]. It explains to some extent the deeper awareness musicians may have of their own bodies [90]. Recently developed new neuroimaging techniques—measurement of full-brain connectivity analysis—moreover, have been used to examine the coordinated patterns of neural activity that is distributed across multiple regions of the brain, with the identification of brain networks, such as the default mode network (DMN), the salience network (SN), and the executive control network (ECN), which, when working together, provide an enhanced kind of processing that engages several types of attention, target detection, working memory, semantic processing, and motor function, which all interact dynamically to support creative task performance [91–93]. They have also shown that musicians are better at integrating motor and sensorimotor regions of the brain, even during passive music listening [94], which confirms the conviction that musical expertise strengthens those brain mechanism that links *action and perception*, which means that musicians process music via an "action-based" approach whereas non-musicians rely more likely to rely on a "perception-based" approach.

Conclusion

Dealing with music is a multi-layered phenomenon. It is a process concerned with an innate desire to cope with the natural environment and acquired skills for understanding music. This process is not confined to a primitive coupling of action and reaction but belongs to the domain of higher-order variables that have an intermediary position between the sensory input and the behavioral or effector outcome. There are, however, levels of sophistication with the overall picture that "skilled listening," as we coin the term, seems to be a complex process that involves cognitive demands and couplings between distinct areas of the brain. It calls forth the real-time consumption of sounds, relying on lower levels of sensory processing and higher cognitive and affective-emotional processing levels. The possibility, further, to process musical signals both in-time and outside-of-time makes it possible to engage in creative processes that help generate novel and useful ideas for dealing knowingly with the sounds. It also invites listeners to engage simultaneously distinct large-scale brain systems, with music training resulting in an increased skill to simultaneously recruit the brain's DMN, ECN, and SN. Such simultaneous engagement may be considered a neurophysiological marker of creative thinking, suggesting that creative brains recruit these networks simultaneously to a greater degree than brains that are less creative [95].

It has been hypothesized, in this context, that creative cognition is a dual process where the DMN supports idea generation and the ECN their evaluation [96, 97], somewhat analogous to their known roles in mental simulation as well as executive cognition. Recent findings in the neuroscience of creative cognition, moreover, have highlighted the roles of cognitive control and self-generated thought, as it is assumed that creativity involves the generation of something that is simultaneously new and useful [98]. Creative cognition thus involves thinking processes leading to idea generation and evaluation. For such processes, when they are self-generated, a form of mental activity is important that is internally focused and largely free of external input. When they may emerge spontaneously in the mind, goal setting and cognitive control are most important [99].

The above can be effectively entered into the realm of music. Creative processes are obvious in improvising and composing, but even in the case of active listening, it is possible to engage with the sounds creatively. Creativity, then, can be located at the level of reception and performance of music, as well as at the level of internal processing [100]. It allows for a conception of music in computational terms as thinking in and through sound.

Core Messages

- Music is a sounding phenomenon that conveys vibrational and transferable energy.
- There is a tension between the acoustic description of the music as a stimulus and how listeners make sense of it.
- Music cognition is perceptual as well as conceptual.
- There is a continuity between lower- and higher-level processing, with the processing levels being complementary rather than opposed to each other.
- Listening is a process that relies on innate dispositions and the outcomes of acquired skills.

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Poetic Thinking and the Constitution of Our World: On Language and Reality

24

Marko Pajević

> "*Das Poëtische, ein aufglimmender Funke in der thierischen Dumpfheit*"
> "*The poetic, a glimmering spark in the brute dullness*".
> (All translations, if not otherwise stated, are the author's own (M.P.)).
>
> Wilhelm von Humboldt (VI:156)

Summary

This chapter presents the author's concept of poetic thinking and its relation to how humans constitute their world and their reality, which is always mediated by language. The chapter frames the inquiry with reference to quantum physics, which has shown that materiality is less solid than expected and draws connections to philosophical anthropology and contemporary human vision changes. In line with recent evolutionary anthropology and neuroscience, and combining thinking language and dialogical thinking, poetic thinking considers the world in its togetherness, its texture, offering an alternative to the opposition of subject and object. Thinking language shows a transformative power in the interaction of the form of life and the form of language. It operates when a subject constitutes itself creatively and dialogically, transforming its ways of feeling and thinking, in short, its way of perceiving the world. This process here I call poetic thinking.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_24

The calligraphy for the poem called Bani Adam (human kind);

“Human beings are members of a whole
In creation of one essence and soul
If one member is afflicted with pain
Other members uneasy will remain
If you’ve no sympathy for human pain
The name of human you cannot retain”
[Adapted with permission from the Association of Science and Art (ASA), Universal Scientific Education and Research Network (USERN); Calligraphy: Alireza Ghanadan; Poem: Saádi Shirazi.]

Keywords

Martin Buber · Dialogical thinking · Henri Meschonnic · Meaning-making · Poetic thinking · Poetological anthropology · Reality · Thinking language · Wilhelm von Humboldt

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keywords, which are intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction: Reality and Poetic Thinking

It is a tenacious prejudice that we know what reality is. The word 'reality' comes from Latin *res*, that is, things. Reality in this sense is the world of things, real objects, materiality. For most people, that settles the issue: they do not question this reality of things. The so-called hard sciences are in charge of this reality, whereas the humanities deal with much softer things, say, imagination. It may well be that things are more complex and that 'in reality,' this neat separation is delusional.

In 1781, there was an earthquake in humanity's ideas about reality. It was caused by Immanuel Kant's transcendental idealism, elaborated in his *Critique of Pure Reason*, in which he states that our perception of things says nothing of these things in themselves [1]. We perceive objects merely as appearances, which are very much dependent on ourselves and our ways of perceiving them. The twentieth century, following Edmund Husserl, saw the triumph of this phenomenological approach; things are phenomena, that is, appearances, and understanding our perception is the closest we can come to them. There is no direct access to reality; we have to understand how we go about accessing it to understand our world.

This is rather the domain of the humanities, but our societies do not grant them much importance. In English, they are not even considered to be 'sciences;' rather, it seems, some luxurious pastime which, as such, can be axed in profit-oriented university businesses. It is ironic that our world, with its atomic physics, chemistry, electronics, and wide-ranging information technology, builds on tenets according to which the hard sciences are far from being hard in the sense of firm, solid, and that materiality is not even built of material but of something which comes closer to what the mind is made of.

In contemporary physics, the theory that things are built of material particles, i.e., atoms, is obsolete and has been for more than a century. Planck observed in 1900 that light waves behave like particles, Einstein developed his theory of relativity in 1905, Rutherford discovered elementary particles in 1911, Bohr theorized the smearing of electrons in 1913, de Broglie spoke of immaterial vibrations in 1923, and Heisenberg's uncertainty principle followed in 1927 [2]. Yet, all these discoveries that fundamentally shape our everyday life have hardly impacted our conception of reality. We would do more justice to reality to conceive of it in terms of processes and effects. In German, there are two words for reality, *Realität* and *Wirklichkeit*, commonly used without differentiation. The latter, however, comes from the verb *wirken*, to act, to effect, or bring about. *Wirklichkeit* is not static and, to me, seems more in tune with the state of the art of physics than *Realität*. Quantum physics has shown that relations and ephemeral forms are primordial, and materiality comes only after that. At the basis of all materiality is the process of life itself, a constant flow.

As early as the 1960s, physicist Werner Heisenberg claimed quantum physics could only be described in allegories. In other words, our linguistic logic does not have the concepts to grasp this model. It seems that there is a specifically poetic quality of language that can do better justice to reality [3]. Another physicist, Niels Bohr, refuted the objection of reality as more fundamental than language by saying: "We are suspended in language in such a way that we cannot say what is up and what is down" [4]. This insight anticipated what Lakoff and Johnson, both linguists, termed *conceptual metaphors*, demonstrating how much "our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature" [5]. Our concepts, that is, our language since concepts are necessarily words, structure what and how we perceive reality and how we relate to the world. Our language thus largely defines our world, mostly without us being aware of it. This view has received strong corroboration in recent philosophy, specifically in the *Dictionary of Untranslatables: A Philosophical Lexicon* [6] that analyzes philosophical concepts in various languages, pointing to the inherent differences. It is impossible to translate such concepts directly without modifying their value since languages do not consist of independent signs but are complex interrelated systems. Hence, such concepts are to a degree 'untranslatables.' This implies that languages are not simply tools for communication but are cognition itself, which is why Wilhelm von Humboldt famously called languages *worldviews* [7]. They provide us with our perspective on the world.

Poetics could be seen as a test of how we conceive of reality. I would like to offer the following definition: the poetic is what cannot be said differently, or, if we want to extend it beyond language, that which is only in exactly this form. Consequently, a poem makes sense only in its togetherness. We can, of course, analyze it, take it apart, and look at its separated elements, but we cannot find its meaning in its constituents, only in its entirety. If, for instance, we want to make order in a poem and rephrase 'what we think the poet is saying' or attempt to work out what each image or symbolic use of language in it means and how they connect to each other, we would be in the process of destroying its meaning and its poeticity. A poem is its form as a whole and not a combination of elements; it is more than the sum of its parts, and its meaning is not the addition of its individual parts. Goethe, in his *Faust*, has Mephistopheles say:

Wer will was Lebendigs erkennen und beschreiben,
Sucht erst den Geist heraus zu treiben,
Dann hat er die Teile in seiner Hand,
Fehlt, leider! Nur das geistige Band.[1]

We can transfer this to technology. Genetic manipulation, for instance, functions according to the principle described above: one element in a whole is changed. Not only this one element will be affected, but the whole arrangement will be altered. As in a poem, when we change one word, the text will be changed altogether, its *texture*. That can work out; a poem where we change a word is not necessarily worse. However, it is different. It is difficult to grasp phenomena in their entirety; it is much easier to look at certain aspects, one at a time. Doing that, however, is not necessarily doing justice to reality.

This chapter will outline my notion of poetic thinking and its relation to our conception of the subject and reality by presenting first our anthropological situation and then the main features of poetic thinking: thinking language and dialogical thinking.

Poetic Thinking: A Poetological Anthropology

Evolutionary anthropology has by now realized that our brain and its functioning are biologically, i.e., genetically, determined only to a very limited extent and much more so socially. The brain develops cumulatively, and that means culturally. The decisive step in humanity's development was acknowledging other humans as intentional minds, beings as oneself. This particular social understanding, shared intentionality, enabled cooperative social interaction and thus cultural inheritance and accumulation. This led to more socially complex forms of life and more conceptually complex forms of thinking [9]. The brain is open and flexible; at birth, humans' synapses are not yet fixed and can take various forms, depending on their individual experiences and perceptions. Consequently, humans can 'program' their brains through the way they use them [10]. That presupposes, however, an awareness of one's environment. We must feel concerned and be flexible in our ideas about the world to cope successfully with the challenges we meet. It is about being in resonance with the other, as in the by now well-known idea of mirror

[1] He who would study organic existence,
First drives out the soul with rigid persistence;
Then the parts in his hand he may hold and class,
But the spiritual link is lost, alas!
Goethe JW von. Faust. Scene The Study, v. 1936–39 [8]

neurons: being empathetic activates these neurons. If we do not stimulate and cultivate them, they degenerate [11]. We need others for our development. In the thirteenth century, Frederick II, Holy Roman Emperor and King of Sicily set about finding out which language is the natural language of humanity. He devised an experiment that involved isolating children and feeding them without any other human interaction or communication. Obviously, they did not 'naturally' speak a language; they simply weakened and died. Humans need society and language. It is not only actions but also language that makes mirror neurons fire. Language acts are acts; they do things. They leave their mark. Everything we do, perceive, experience, and say forms us. We are part of a vast, complex whole.

Such reflections on human thinking and human reality are the core of the anthropological question: what does it mean to be human? Asking this question is a crucial part of being human; it is self-reflection, the antique imperative 'know thyself!' or *gnothi seauton*! We constantly develop ideas about humanity, more or less consciously, and technological and media developments play a major role in this. For some time now, due to accelerating changes in our knowledge and life forms, new visions of the human have been emerging even more rapidly than before. Such visions are no mere fantasies but highly relevant to our actions. Depending on the image humans have of themselves, they act differently. It makes a difference whether one considers oneself God's creature, a highly-developed ape, or a flawed machine. It also matters whether we see ourselves simply as biological beings with urges or whether we wish to cultivate our minds and aspire to higher realms. The visions we have of ourselves direct our energies and decisions; they have concrete, practical effects on life. Humans do not only have natural dispositions, they can also form themselves—this is called the process of civilization.

Poetic thinking is an account of human thinking and, at the same time, contributes to our vision of the human and of human thinking, and it acts on these processes by changing our ideas about them. It is the cultivation of a particular vision of the human. The term 'poetic' comes from the Greek *poiein*, making/creating. Poetic thinking reflects, therefore, on how humans make their world.

The subtitle of this volume is *Bioengineering of Science and Art*. Poetic thinking takes issue with the idea, often suggested by the term 'bioengineering,' that humans do not work themselves, mentally, on creating the human world, but that this is done purely from the outside, via technologies.

Our era has developed countless and extreme possibilities of interfering with the human body, which has led to a largely technical idea of the body. Science looks at the body analytically, dissecting it to understand its functioning better. This implies a separation of mind and body. It would serve us better to distinguish instead, as the German language does, between *the body that we have* (*der Körper*) and *the body that we are* (*der Leib*) [12]. Even if it is helpful for specific purposes to look at the body as an object, it becomes problematic when this shapes our understanding of ourselves. If we can buy our own body via plastic surgery, body and mind are no longer unified. Over a century ago, Oscar Wilde described the dangers of such a separation allegorically in *The Picture of Dorian Gray* (1890). Dorian makes a pact with the devil. He sells his soul to keep his youthful beauty while a portrait ages in his stead. Corrupted by the freedom from the consequences of his actions for his appearance, he becomes more and more ruthless, while his enduring innocent looks help him deceive people. After many years of vile living, he sees the portrait that had remained hidden, and, shocked by the ugly grimace confronting him, he kills himself [13]. This moral tale exemplifies Wilde's aphorism that after 30, we ourselves are responsible for our looks. Friedrich Schiller had put it like this: "Es ist der Geist, der sich den Körper baut" (It is the mind that builds its body) (Wallensteins Tod III:13), and that is a good state of affairs. Should we indeed shape our body independently of our mind, we would be threatened by ethical degeneration and an inhumane society.

Nowadays, Wilde's allegory seems within reach. The rich can buy their looks; however, looking at those 'enhanced' faces close up often reveals the grimace of the picture rather than the beauty sought by the buyer. Likewise, the products of cosmetic breast surgery are intended more for admiration from afar than proximity and touch. All of these measures are not for close human interaction; they are about image. However, the self-image must be quite damaged when outer manipulation is considered the way to youthfulness and beauty. The connection between mind and body seems lost; the desires are out of touch with being. Once the world is reified, we can regard even our own body as material to be technically optimized. These hominal technologies promote an ideal body by means of various media, first of all, the omnipresent porn sites, which present humans unabashedly as "fucking machines" and sexuality as a mechanical activity, detached from erotics and attraction based on a connection of minds [14].

The same reifying tendency is apparent in mainstream medicine, which seems to think mostly in terms of symptom suppression; the human as a bodily object is reduced to biochemical processes. One pharmaceutical remedy leading to the next, humans get drawn into a lifelong consumption of pills, and the industry thrives. This is a working system. The medic has become a technician and salesperson, the patient a client, the hospital a business, bodies commodities. When the eighteenth century Enlightenment medic Julien Offray de la Mettrie spoke of *L'homme machine*, the *Human Machine* [15], that was emancipatory in the context of that century: suddenly all humans were presented as equal, a move that countered both the social and religious determinism of that time. Nowadays, however, such an approach has become a tool of inequality since those with the most economic power can afford the best enhancements, allowing them to manifest and reinforce a sense of superiority. This is a new form of determinism based on financial means.

The hominal technological vision of humanity with its ideal machine body has psychological and social effects. Not only does it weaken the self-esteem of real people who can never achieve the virtual ideal, it also weakens inter-human relations since the other is never as good as the image we are after. When relations are governed by market forces, everybody is constantly looking for a better deal. Internet dating sites are stock exchanges for humans. Potentially, there is always someone better. Nobody is ever good enough, which means that, in reality, there is never really any relationship.

In sum, this new vision of the human is no longer about education of a subject but instead about optimization of an object. As opposed to the humanistic tradition, the perfection of the human no longer functions culturally and educationally but via bioengineering. That is why the natural sciences have captured the term *life sciences*. This is a problematic usurpation since these sciences have not much to say about crucial aspects of human life; they deal exclusively with biological and chemical processes. Human life, however, goes beyond this level; it is social, philosophical, artistic. It is the life of an embodied mind. Brute life as organic existence can do without meaning; human life implies meaning. That is why the humanities and social sciences are indispensable. Facts need interpretation; on their own, they do not mean anything. As we can see, in any argument, facts can be perceived very differently: the opposing parties are in disagreement about the meaning of the experienced facts. It is only culturally and subjectively that we grant meaning to the phenomena of the human world. This is why we need theories about the processes of meaning-making. The intellectual processing of the diverse sensually perceived phenomena needs language. It is in language that humans elaborate their vision of the world, always in connection with other humans. That, of course, also takes place within the natural sciences. Poetic thinking is concerned with a holistic understanding of these processes.

The human world, including human beings, is the result of these cultural processes. There are various *anthropotechnics;* Peter Sloterdijk suggests this term for the technics humans develop to create themselves [16]. He speaks of bestializing and cultivating tendencies [17]; new media often act in bestializing ways by addressing primitive urges, violence, and pornography. However, how can humans be enticed to cultivate themselves and develop systems of ascesis, as Sloterdijk calls it, that is, exercises, instead of simply following easy entertainment? Ascesis is, evidently, an old, often religiously motivated, approach to life. Ignatius of Loyola, for instance, spoke of such exercises [18], mostly mental, not for physical skills but spiritual refinement. Michel Foucault devoted his late work to analyzing such systems and the *souci de soi*, the care of oneself. He focused on sexuality as a means of defining and refining oneself [19]. There have always been technics of self-cultivation. It is these ideas of self-refinement, cultivated in exercises or asceses, that are behind social and cultural evolution. However, this demands sacrifices. Humans have to forsake simple pleasures to reach cultural refinement, and that is hard, as Freud very clearly explained in *Beyond the Pleasure Principle* [20]. Sloterdijk uses the term *vertical tension* to describe the necessary aspiration towards higher goals. The question is only how a society agrees on the value of such aspirations and specific things to cultivate. Society needs to make the commitment to such striving attractive. Without such goals for the general good, a democracy cannot survive.

If self-enhancement or anthropotechnics is now no longer achieved through exercises/asceses, but through biotechnical or surgical procedures, the I becomes dependent on technologies and the owners of these technologies. The only criterion of value and superiority is then financial power (which is most often the result of inheritance) to purchase self-enhancement. People drift farther and farther apart, with a growing chasm between the financial elite, which has the means to purchase power on all levels, and the rest of the population, which is more and more powerless; a development endangering the emancipatory, democratic tendencies of the last century. The human psyche suffers and with it the development of the individuals and society as a whole. Humanity splits up again.

The consequence of all of this is that we need to acknowledge the inescapable necessity of cultivation for emancipatory progress. I believe that poetic thinking can contribute to an awareness that supports such progress. Poetic thinking cannot be trained as an exercise since it is no technique. It is a mode of being. To enter it, one can, however, train an attitude that allows for accessing this mode. We cannot perceive what we do not allow for. That means that we have to make space in our conceptual framework for the poetic to let it happen. That is what poetic thinking promotes. It does so via a specific way of thinking language and dialogical thinking, which will be presented in the following.

Thinking Language

Thinking language is a precondition for poetic thinking simply because any thinking conceived of as mental labor on the world has to take place in language. Thinking language is based on the conviction that our access to the world is in language, which means that our ideas about language shape our ideas about the world and about being in the world. However, thinking language is not only a theory; it is an activity; it is the process itself of this thinking.

Therefore, thinking language implies an historical anthropology of language: language is fundamental to being human; language and being human are historically and culturally conditioned. That is neglected by a simple biologism, as it is by a naturalist or universalist approach.

The great language thinker Wilhelm von Humboldt defined human language as "Verstehen durch Mitdenken" (understanding by thinking together) instead of at best "Handeln durch Mitempfinden" (acting by empathizing) [21]. Humboldt thus insisted on the specificity of human language as that which goes beyond communication and is also cognition. This surplus to summoning and inciting or communicating feeling is what I call poetic because it creates something. Humboldt's definition unites cognition and communication: thinking and mediation are one.

The Western tradition has difficulties grasping this; for thousands of years, we have been very critical of language. Even when the importance of language is recognized, it is most often cursed for being ambivalent, imprecise, or conceitful. We have probably all complained at some stage that language seems to refuse to express what we want to say. From the poetic thinking perspective, that is erroneous. We might have some notions of states of being that withdraw from us, but these states exist only through language, and when our linguistic skills cannot do justice to them, that is not the fault of language but our personal world not being sufficiently developed. Ludwig Wittgenstein said: "Die Grenzen meiner Sprache bedeuten die Grenzen meiner Welt" (The limits of my language mean the limits of my world) [22]. We build our world by mentally laboring on it, and that means using language.

In our European tradition, however, most saw this very differently.[2] We all inherit Greek philosophical conceptions, and Plato wanted to think without language. Of course, he did not do that at all. His texts are linguistically elaborate, and his dialogues are more or less theatre sketches. So even if philosophers pretend to be language-neutral, that is an impossibility. Plato believed in ideas existing for and in themselves and to which we have only indirect access. Language for him was an additional mediation, that is, another step away from the ideas. As a result, he did not like language. Aristotle reinforced this Platonic separation of thought and language. According to him, people first think something and then use words to communicate what they already thought without words. He believed that cognition is possible without language, and language is exclusively for communication. Our discourses have left such a conception of language far behind, but it is still very present in everyday life; the phrase *I know it, but I simply cannot express it* betrays an outdated language theory. It makes far more sense to say *I know that there is something to know, but I cannot think it yet since I have not sufficiently developed my language and my world*. Such an awareness of a lack is indeed the first step towards the ability to think what has not yet become world.

Christianity is the other foundation of the occidental tradition. It likewise does language a disservice. Even when the Bible states, *In the beginning was the word* (John 1:1), this *word* is the translation of the Greek *logos,* which allows for different interpretations. Goethe's *Faust* ponders this difficulty of translating *logos* and decides, in the end, to translate it as *action*. This explains Faust's striving for knowledge by shaping things, which contains, in short, all the problems of modernity. The Greek mind, due to its language theory, could not grasp Hebrew thinking and its very different language thinking. Biblical Hebrew works with a strongly differentiated system of hierarchical accents, where the semantics are not situated in the single word but always only in the entire utterance, a connected unity through these accents.

In the biblical Genesis, language does proffer mastery over the world; by naming objects, Adam can become the world's procurator. Communication, however, then leads to disaster. The fall of man becomes possible by way of conversation. However, it is only through this original sin that humans acquire knowledge and awareness. The conversation, first between the snake and Eve, then between Eve and Adam, leads to the desire to eat from the tree of knowledge and thus become godlike. Indeed, to some extent, humans achieve this goal; they become creators as well, productive and aware individuals. However, it comes at a high price: they are banned from paradise. Paradise in this vision is actually unaware existence. Without language, humans are animals, pure nature, free of worries. Awareness, that is, language, drives us out of the paradise of a simple, unreflected being. The desire for

[2] Cf. for the following references to the history of European language theory [23]

paradise is, in the final instance, the desire for a mindless life. Before opting for this, maybe we should think again…

Today, with genetic engineering, we are picking the fruit of the second tree of paradise, the tree of life. One day, humanity will long for a state before this second fall of man, when we could not interfere in the secret of life. However, it is questionable whether the advantages to be gained from this new skill will be as fantastic as those brought by language.

In the biblical story, God's punishment of humanity for striving for godlike knowledge was to make life hard and painful, but that could not keep humans from their desire. Seeing that they wanted to be close to him in heaven by building the Tower of Babel, God interfered with humanity's communication possibilities by creating many languages.

At the core of European intellectual history are thus two desires: the desire for linguistic unity to communicate without difficulty and the desire for cognition without language. The consequence is that the existing culturally developed languages have an enduring bad reputation. At any rate, modern science persists in its animosity towards the natural languages and develops its own technical languages to avoid contamination with what it sees as unclear vernaculars. Science strives for objectivity, without any subjective, historical, or cultural elements; it is about pure communication of facts; language is considered a simple means to that end. This prejudice can be seen in the work of Francis Bacon, who wanted to cleanse language of its false usage by the people and called words "idola fori," that is, illusions of the marketplace, full of stupid prejudice and unqualified for true thinking (Novum Organum 1620, aphorism 43).

John Locke considered language "a mist before our eyes" [24], an obstacle, a nuisance. Analytical philosophy of the twentieth century tried to get rid of this obstacle to clear vision, and recent decades have seen an enormous increase in the power of this approach. Analytical philosophers have understood with Bacon and Wittgenstein that philosophy is taking place in language, but that does not mean that language finds grace in philosophy's eyes. On the contrary: Wittgenstein talks about the "footstrings" (Fallstricke) of language, the reason is "bewitched" (verhext), and thinking gets "bruises" (Beulen) by running against language [25]. Poor thinking, a victim of evil language!

This conception only works on the premise that there is a universal truth hidden behind the conceitful language. Even though Nietzsche had debunked this idea as ridiculous and showed that truth is always constituted in language, which is historical and cultural [26], our contemporary analytical philosophy still seems to think like Plato in this respect. The time seems ripe to develop a different attitude towards language.

There is, in fact, already another tradition to build on, true thinking language, a tradition that considers the polyvalence and diversity of language not as evil but rather as the richness and indeed foundation of our existence. Leibniz could be considered as the inceptor of this tradition. His idea of the mind is of a *pneumatics*, a conception based on breath, with the motto *sympnoia panta*: everything breathes together. In this conception of togetherness, in which the mind is breath, language is part of the global sounding: languages are no longer an obstacle to clear vision and thinking but part of the world's breathing. Thus, the world is conceived of as a sounding together, as harmony and diversity is no longer something terrible but the rich harmony of the world.

For Leibniz, the study of language served the knowledge of the human mind. He called languages "the best mirror of the human mind," allowing for the "wonderful variety of its linguistic operations" [27]. From this vantage point, the arbitrariness of meanings becomes something wonderful. What is needed, then, is a plurality of perspectives to sound together and enrich the world.

As with Leibniz, it is not vision but hearing that is at the center of Herder's conception of language. Reason is not pure but linguistic reason: thought and word emerge in unison with the encounter with the world. Consequently, our thinking is dialogical. Wilhelm von Humboldt took these ideas further: language is "the forming organ of thought." That means ideas are created in language, and in this "Arbeit des Geistes" (labor of the mind) [28], any thought is unique in being uttered. Humboldt understood that also grammatically: namely by the sheer utterance of an I addressing a You, human language presupposes dialogism, but he saw just as well the necessity of another person's reaction. The synthesis of language thinking is only completed by my having someone else confirm my words. That implies that we can think only in common with others, which implies, in turn, that each language act is historically unique, bringing in personal background. Thus, everybody brings in their own individual language, and this infinite variability forms the richness of our *worldviews,* to come back to Humboldt's term for languages, meaning perspectives on the world. By talking together, merging different perspectives, humans create new perspectives. Poetic thinking is, therefore, a collective creative process. This is a question of attitude. Accepting and welcoming the diversity of languages and individuals, we cannot define truth as single or 'objective' anymore; truth becomes rather the entirety of perspectives, never completed. This makes totalitarianism impossible.

Speaking is always a friction between the power of language with its conventions and the dynamic force of the speaking person, who, in each real moment of speaking, transgresses predefined ideas and shifts the mind's limits. The more that happens, the more the speaking is poetic. That means there is no specific poetic language understood as fancy words or syntax, but poetic speaking takes place when historicity and the cognitive combine.

When we consider language merely as signs, the creative process is ignored. A sign is beyond this; we are already in knowledge mode. That is not at issue; what is, is that we should not reduce language in that way since in language, we do not only pass things on that we know, but language itself is also cognition; we create the things to be passed on. Saussure defined the sign, consisting of signifier and signified, "as two sides of a piece of paper" [29]. Nonetheless, the term implies something static and hierarchic: the signifier is secondary to the signified, which is considered to be there already and then named. The *value* of a word, however, another important term in Saussure, is not fully covered by the sign. Its value depends on its environment, on historically grown and subjective associations, and on its interaction with other linguistic elements within the utterance. The sign cannot think any of this. That is why it cannot think the literary either, and that, in turn, is why literature is so revealing for our processes of meaning. Poetic thinking thinks this surplus of the sign. Language is always only really happening in connected speech; Humboldt held that grammar and the dictionary are nothing but a "todtes Gerippe" (dead skeleton) [30]. He went so far as to claim, "In reality, speech is not the connection of words that exist prior to it but, on the contrary, words emanate out of the ensemble of speech" [31]. Poetic thinking thinks this togetherness (Zusammenhang), not abstract elements put together. It is the togetherness that makes sense; semantics not pure semiotics.

The French scholar and poet Henri Meschonnic developed a theory of rhythm to think the organization of this togetherness better (see, for example, [32]). We should not think of rhythm here as metrics, a fixed and regular beat, Meschonnic builds on Émile Benveniste's discovery that rhythm originally comes from the word *ρειν* (rein), that is, to flow, and was not applied to the waves but the flowing of a river. Consequently, rhythm is designated as a "form in movement, without organic consistency and always subject to change, improvised, momentary and variable" [33].

It was only Plato who made of this non-fixed, ephemeral form a fixed structural principle. In thinking language, we use the term 'rhythm' to refer to this unfixed form in movement. Following Benveniste, language has a double signifying function. On the one hand, it is considered in its units, each unit taken one by one, independently from all other units, that is, semiotically, as sign. On the other hand, it is considered in the entire utterance semantically. The sign of semiotics is recognized; the discourse (that is how Benveniste defined this smallest unit of language, the utterance) is understood [34]. We can see the difference by considering how Stanislavski, the famous dramatist, made actors repeat *sevodnja večerom* ('tonight') in forty different ways, each time with another meaning, such as surprise, fear, joy. The sign in itself does not make sense. The same word can mean all sorts of things, depending on the context.

In discourse, the speaking persons manifest themselves as subjects. In saying I, subjectivity takes place, each time a new one. We become subject by using language. Since saying 'I' necessarily refers to a You, there is always another subject in speaking; only an I and a You together can speak (there is at least an imaginary You). Meschonnic formulates this as follows: "est sujet celui par qui un autre est sujet" (subject is he/she by whom someone else is subject [35]. Full speaking means to be subject to one another. There are ethical consequences of such thinking language; people are in a mutual relationship. I will develop further this decisive dialogical dimension shortly.

Poetic thinking allows us to think the literary of literature, which can be extended to the arts in general. The arts are an essential part of humanity, even though they will never take a central place; they are marginal by nature. They cannot be fully integrated into social contexts because doing so would suspend their freedom from society's criteria. It is exactly this marginality, which allows for the development of new visions of life forms, new options for thinking and acting. The faster the conditions of life change, the more we need this laboratory of the mind and senses to develop something new. This is why every society should foster and promote the arts.

In poetic thinking, it is not the practical context that is decisive but rather the contemplation and perception of the phenomena as such. However, concerning language, literature is far from being extraordinary. Instead, while we mostly reduce language to sign communication, only poetic speaking uses the full potential of language. Poetic speech is full speech. When we use formulaic language or automatism, we are not poetic. Without poetic thinking, social life would be impoverished, reduced to functional existence. The human and the poetic are inseparable. The poetic is, with Humboldt's words, "ein aufglimmernder Funke in der thierischen Dumpfheit" (a glimmering spark in the brute dullness) [36].

The constant battle between the regularities of language and the liberty of each speaking is fought the most intensely in literature, which means the literary is this *labor of the mind*. The poetic, then, is this human creativity, beyond functionality. The poetic is ultimately language in which the human coincides with itself. Poetic thinking means to think the process of being; as Humboldt said about language, it is not *ergon* (product) but *energeia* (activity) [37]. In this process, a transformation occurs: the relation between the human being and the world changes. The form of language and the form of life condition one another. Since our world consists largely of our relation to it, the transformation of our relation to the world also transforms our world.

Dialogical Thought

Dialogical thought is the second pillar of poetic thinking. It relies on a tradition that goes back to the eighteenth century and peaks in the first third of the twentieth century, probably triggered by World War I and ended by Fascism. It is based on the idea that we can fully think humanity only in the relationship between an I and a You, that is, dialogically. The philosopher Ludwig Feuerbach called this "the philosophy of the future" in 1843 [38]. It still remains in the future, it seems; hopefully a not too distant one.

More recently, there have been some indications that dialogical thought is gaining importance. Jean-Luc Nancy explained that coexistence precedes existence, and each I comes out of a We; our singularity is consequently always plural [39]. Peter Sloterdijk, in his major Sphere-Trilogy, developed the idea of the original space being a bubble of two, duality thus being the fundamental human condition and humans are more *dividuals* than individuals [40]. Being human always means *being-with*. There exists no humanity in the abstract but always only concrete human beings, an I and a You.

In my view, even though Nancy and Sloterdijk do not refer to him, dialogical thinking has been best developed by Martin Buber [41]. Buber's roots lie in Eastern Jewish Hassidism. This community wanted to overcome the distance between the holy and the profane; humans need to reach the divine by their everyday actions. This aspiration is based on the belief that God needs humans in order to come into the world. That means that it is the responsibility of humans to give the world divine form and secure God's existence on earth. For this, one needs to be in relation to people and the world. It is about the With-World (Mit-Welt). Consequently, dialogical thinking thinks and cultivates the *in-between*.

Being, says Buber, appears in the "Wirbel des Geschehens" (whirl of the events); we are exposed to it and cannot control it. We can protect ourselves against it by blocking it or harnessing ourselves, or we can expose ourselves to it and enter into being. When we do this, we *realize* reality and thus really become [41, p. 17].

For Buber, there are two "fundamental words": the I-You and the I-It. Depending on which we speak, we take a different general attitude. When saying I-You, we speak "with our entire being," when saying I-It, never. Our general mode of being is in the I-It; this is the way we experience the world. We are an entity that separates itself from a world of objects which we can deal with. This is useful and functional. However, if this mode becomes too dominant, we cannot realize the world anymore since our attitude does not allow it.

In order to realize, we have to be in the I-You. Then we are not separated from the world, there is no opposition between our subjectivity and the objects, but it is the relationship itself that becomes our subjectivity. There is no longer any subject-object division. Instead, we are in a subject-subject relationship with the world. Only then, Buber says, are we real *persons*.

We cannot voluntarily decide upon which mode we are in, but a certain attitude can help enter this I-You relationship. Intending this relation can support its happening; when we protect ourselves against it, it will be less likely. The I-You can be compared to a moment of real presence. As such, it escapes the dimensions of time and space. It disappears when we want to grasp it. It is like Derrida's *différance*: the unavoidable shift between the phenomenon or event and its representation [42]. This is why we can bear the presence of the You only momentarily; the You has to become It, object, again. There is no durable being in this charged sense. We also cannot make the You an object of knowledge; it then becomes an object, an It, automatically. The I-It is the normal world; the I-You erupts only ephemerally, rarely.

However, these I-You-moments are indispensable for being human. It is only then that humans find their real being, real life. This does not take anything away from what is conceptually graspable, objects; we should, however, not forget the existence of a beyond. In the I-It, we have no such opportunity. We should develop a discourse and terminology to allow for the integration of the I-You in our lives. This is what poetic thinking tries to do, making presence intelligible, immanently, in an *immanent transcendence* [43]. The poetic is this in-between having taken shape. That is why it touches us when we enter the I-You again. Poetic thinking cannot solve the problem of the awareness of being, and that is not its purpose, but it can integrate it into a philosophy of life that does not ignore key elements of human life. It is a question of attitude.

Conclusion

Poetic thinking thus combines thinking language and dialogical thinking to cultivate a different approach to the human. I define it as the transformative power in the interaction between the form of life and the form of language that operates when a subject constitutes itself creatively and dialogically, transforming its ways of feeling and thinking; it thus transforms how the world is perceived.

Poetic thinking cannot be achieved once and for all; it is to be done over and over again, moment by moment, the constant labor of the mind. Mostly we have to function within clearly defined contexts, which is fine. However, poetic thinking is a corrective, reminding us again and again that we should not lose sight of what it means to be human. For that, we need to be aware of the processes of meaning-making in language and the I-You relationship.

Since we do not have any direct access to reality, what is at stake in our thinking is less reality than our access to reality, which determines our reality. When talking about reality, we have to talk about our access to it. We have to gain our reality. Poetic thinking opens up paths via dialogical thinking and thinking language. It does not fit into existing categories. That is why it is an agent of change and transformation, and that makes it necessary and dangerous at the same time. Recognizing all this, functional thought gets destabilized and wants to suppress it. However, without the meaning-making force of poetic thinking, humanity would lose not only its specificity but also its chances for survival.

Poetic thinking is not against conceptual thinking; it simply rejects its exclusivity claims. They are complementary; one cannot survive without the other. Poetic thinking aims at bridging the gap between conceptual thinking and immanent transcendence. A certain attitude is a precondition, as is paying the necessary attention to language and the in-between. It involves opening up to the world to be embraced by it. We have to develop exercises to cultivate what we want to be. We also need to know what we want to be and what we gain and lose by it, and then decide each time again. By integrating poetic thinking into our worldview, we grant it forming power over our reality. By cultivating this attitude, we do exercises that shape our being. If we want a more human world, we have to grant more space to what we consider our human specificity, by thinking poetically.[3]

Core Messages

- We do not have direct access to reality; our perceptions are shaped by our concepts, that is, by language.
- Poetics looks at phenomena in their togetherness and thus does more justice to reality than pure analytics.

[3] This contribution builds to a large extent on my book *Poetisches Denken und die Frage nach dem Menschen. Grundzüge einer poetologischen Anthropologie* [44].

- The separation of mind and body is obsolete, and bioengineering, a technological approach to the human, is erroneous.
- Dialogical thinking fosters subject-subject relationships instead of subject-object relationships.
- Poetic thinking is a transformative power in the interaction between the form of life and the form of language.

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Thinking as the Invention of New Aspects Within Language-Games

25

Cristiane Maria Cornelia Gottschalk

"*Is thinking, so to speak, a specific organic process of the mind—chewing and digesting in the mind, as it were? Can one then replace it with an inorganic process that fulfils the same purpose, so to speak, with a prosthesis for thinking? How should one imagine a thinking prosthesis?*".

Ludwig Wittgenstein. *(The author's translation)*

Summary

This is a philosophical reflection on the concept of thinking, having as a theoretical reference the conception of language by the philosopher Ludwig Wittgenstein, developed in the second phase of his thinking. From this perspective, there is no thought without language, and the foundations of meaning are not extralinguistic but are expressed in the uses we make of words and our linguistic expressions, thus constituting a grammar of uses of concepts, which starts to guide our actions and thinking. Initially, some fundamental concepts of Wittgenstein are introduced, such as "language-game," "family resemblances," "following rules," and "life forms," aiming to relativize the image that the linguistic expression of thinking *must* correspond to a certain organic mechanism, of a physiological nature, or to some process of an ineffable nature. I argue that the "essence" of the concept of thinking is expressed in the

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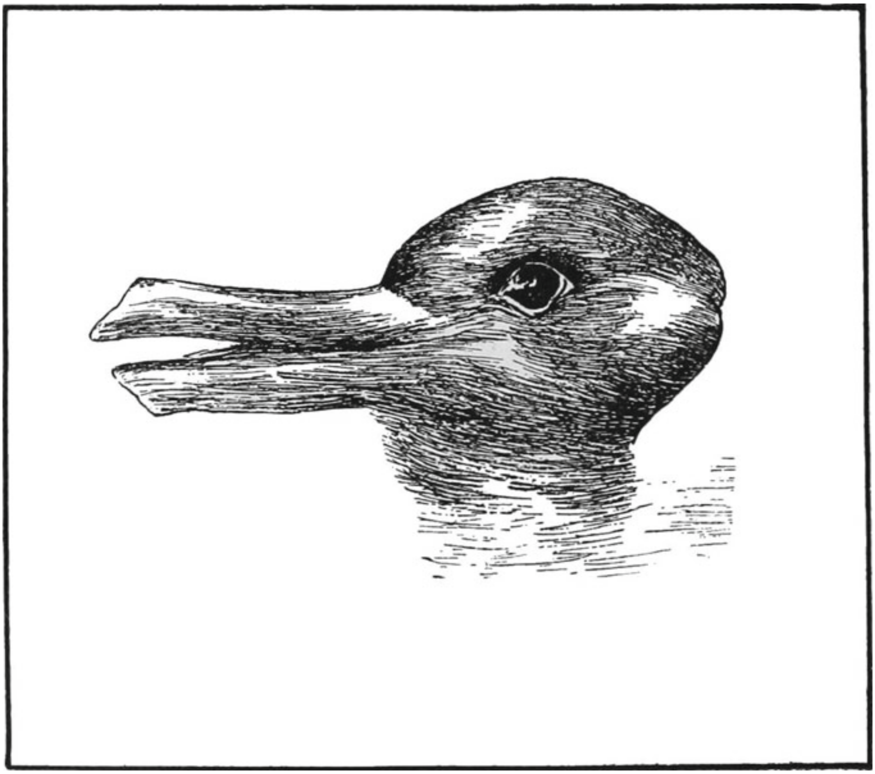
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_25

grammar of this concept, regardless of any brain or mental processes that may occur concurrently. I conclude by suggesting a new use for the concept of thinking, namely, as an activity of following rules learned within a form of life, along which new relations of sense are constituted through a work *of language*.



Rabbit–duck illusion
(Adapted from Wikimedia Commons, the free media repository https://upload.wikimedia.org/wikipedia/commons/1/13/PSM_V54_D328_Optical_illusion_of_a_duck_or_a_rabbit_head.png)

Keywords

Essence · Following rules · Grammar · Image · Language-game · Thinking · Wittgenstein

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

The rhetorical questions in the beginning quote were formulated by the philosopher Ludwig Wittgenstein, with the goal of relativizing dogmatic positions of philosophers (mentalists, behaviourists, logicists and pragmatists, among others)[1] regarding the meaning of the concept of thinking. Despite the different answers to these questions, Wittgenstein's interlocutors shared the same conception of language among themselves; namely, its propositions would always have the same objective: to transmit thoughts about objects in the world in general, whether they belong to the empirical world, or related to the individual's internal sensations, or even, objects belonging to the field of ethics, such as good and evil. The words would, therefore, only have the function of *naming* the objects of the world, as if those were labels that we put on them. It follows, then, from this referential conception of language, the idea that: "every word has a meaning. This meaning is correlated with the word. It is the object for which the word stands." [1, PI 1].[2] In other words, the meaning of a word must be located in an *extralinguistic* domain. For example, it would suffice to point to the empirical object "table" to access the meaning of this word.

[1] Among the main interlocutors of Wittgenstein who addressed the theme of thought, we can mention, in particular, the philosophers Augustine, William James, Bertrand Russell, Gottlob Frege, and surprisingly, also the young Wittgenstein, who in the first phase of his thought had written his first great work, the *Tractatus Logico-Philosophicus*, in which is established, as the purpose of philosophy, the logical clarification of thoughts.

[2] From now on, I will use the abbreviation PI for *Philosophical Investigations*, OC for *On Certainty* and Z for *Zettel*.

However, as one cannot ostensibly point to something in the external world that corresponds to what we call thought, some philosophers started to look for the reference of the word "thinking" within the individual. Was there something corresponding to this word, an *organic* mental process equivalent to a physiological process such as chewing and digesting, but in the individual's brain? The difficulties in finding a specific organic process as the reference of thought make this behaviourist position come to be refuted by mentalist philosophers, who raise new questions: would it then be an *inorganic* process, such as a kind of prosthesis? If so, what would this prosthesis of thought look like? Would it be a gaseous mental entity? All of these questions, when guided by the referential model of meaning, lead us to expect the indication of some entity or process that would be the ultimate reference of the concept in question. My goal will be to show that it is only through clarifying the *uses* we make of the word "thinking" that we can come up with an answer about its essence. Otherwise, the questions only multiply with each hypothesis formulated, posing new problems, for the most part, insoluble.

In this sense, I will resort to Wittgenstein's ideas about the relations among language, thinking, and the world, present in his writings from the thirties, during which a new conception of language emerged. According to him, when we look at how we *actually* use the words of our language, we will see that it performs multiple functions, in addition to its strictly referential use. This panoramic view of language allows the dissolution of metaphysical problems, which are, for the most part, generated by a reductionist and dogmatic view of language. In order to avoid them, Wittgenstein suggests that we fight against the force of images[3] that arise when we privilege a single use of our concepts as if there were the correct application of each word or a single reference that would express the essence of its meaning. In this text, I address the following images resulting from certain interpretations of the concept of thinking:

i. that the word "thinking" *must* refer to a private mental process (yet to be unveiled by cognitive scientists) that is *independent of language*;
ii. that language would have the sole purpose of transmitting or communicating the meaning given to it by a psychological or physiological process of thinking; and
iii. that there would be a *causal* relationship between a supposed mental apparatus (organic or inorganic) and what we think and say.

In contrast to these images, I argue that the fundamentals of the meaning of thinking are not extralinguistic but are expressed in the uses we make of the word "thinking," thus constituting a *grammar*[4] of this concept. This linguistic paradigm

[3] We will adopt here a technical sense of the word "image", used by Wittgenstein (in the second phase of his thought) to refer to statements that express unilateral interpretations of meaning, leading us to postulate extralinguistic entities as being its foundation.

[4] The word "grammar" is used by Wittgenstein not in the sense of the syntax of a language, but as an open system of propositions, intertwined with one another, that play the role of rules. These propositions, in turn, are called grammatical propositions, with a normative or merely indicative

shift, in addition to making it possible to question the broader image that each psychological concept (such as thinking) must correspond to a certain organic mechanism of a physiological nature, also prevents the appearance of false problems arising from this and other related images, in the most varied fields of knowledge.[5] With a view to relativizing them, I present initially some fundamental concepts by Wittgenstein, such as "language-game," "family resemblances," "following rules" and "forms of life" (used by him as tools for the dissolution of philosophical problems arising from an exclusively referential conception of language); and, in a second moment, I use these conceptual tools in order to resume the questions posed by the epigraph at the beginning of the text, clarifying them from the description of the effective uses that we make of the concept of "thinking." I conclude by suggesting that we look at this concept, among other uses, as expressing our ability to invent new relations of *sense*[6] within what the Austrian philosopher calls *language-games*.

Seeing Aspects: Ambiguous Gestalt Figures and Conceptual Perception

Let us consider shown above the image of the duck-rabbit, perhaps the most well-known figure of the *Gestalt,*[7] a movement of psychology that emerged in the early twentieth century that had as one of its objectives to study the phenomena of perception. The ambiguous figures used by this movement to understand how to move from form to psychological content, in my view, inspired Wittgenstein to clarify other enigmatic questions central throughout his work, namely, those related to the relations among language, thinking, and the world and, in particular, to the mechanisms of the constitution of meaning through language.

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function, and which would be distinct from empirical propositions, which have a descriptive function.

[5] In particular, in the field of education. One of the "competences" most demanded by public policies for basic education in Brazil is the development of critical thinking in children, among other competences, assuming the existence of mental structures (which would be the ultimate foundation of a single rationality, universal and natural), yet to be unveiled by cognitive scientists. The pedagogical practices resulting from these premises, then, consider the teacher as a mere mediator and/or facilitator of learning situations, prioritizing the *know how* over the *know that*, and thus depriving the child of the access to meaningful conditions for effective learning [2].

[6] As opposed to cause and effect relations, characteristics of empirical sciences. These can be verified through empirical observation and experimentation, while the relations of sense are connections of a conventional nature, as we will explain below.

[7] This psychological theory was formulated by the German psychologists Max Wertheimer (1880–1943), Wolfgang Köhler (1887–1967) and Kurt Koffka (1886–1940), at the beginning of the twentieth century, having inspired Wittgenstein to reflect on the concept of "seeing aspects", fundamental in his late work, and also contributing to forge another crucial concept for the application of his philosophical method, the concept of "family resemblances".

In fact, if the meaning of what is observed does not depend on language, as it was believed strongly and in a hegemonic way until the beginning of the last century, how is it explained that some immediately see a duck when looking at this figure, while others immediately see a rabbit? If I had asked the reader of this text to imagine a duck, would he/she have imagined exactly the duck seen in the picture above? What, then, makes it possible for *everyone* (or almost everyone) to see a duck in the picture above?

A Platonic philosopher might answer that there would be a duck essence and that this figure would be an approximation of what it is to be a duck, and through a mental process of remembrance, everyone would be able to recognize a duck in the figure above. Neoplatonics would say more that the duck concept is an exact concept with well-defined limits; otherwise, we would not be able to recognize a duck in the figure above. In contrast to these essentialist assumptions, from a Wittgensteinian perspective of language, we are able to see a duck in this figure simply because we have *learned* to use the word "duck" in different situations (we have seen at least some ducks in life, even if only in figures drawn in books or pictures taken of ducks), and we *compare*[8] the different ducks. Throughout this comparison, we do not extract a "duck essence" or something like that, but we see only similarities among them, similarities to a greater or lesser degree [1, PI 66].

These similarities are called by Wittgenstein "family resemblances" because they are analogous to the similarities that are commonly found among members of the same family of human beings. When we are introduced to a new member of a family, for example, we perceive an "air of family" between him or her and his or her family, not because the person has a physiognomic trait common to *everyone* in the family, but simply because he/she has similarities with several of his/her family members in different ways: "stature, physiognomic features, eye colour, walking, temperament, etc." (PI 67). In fact, analogously, a good part of our concepts, even the most abstract ones, also have similarities, such as the concept of number:

> "and likewise, the kinds of number, for example, form a family. Why do we call something a "number"? Well, perhaps because it has a—direct—affinity with several things that have hitherto been called "number"; and this can be said to give it an indirect affinity with other things that we also call "numbers". And we extend our concept of number, as in spinning a thread we twist fibre on fibre. And the strength of the thread resides not in the fact that some one fibre runs through its whole length, but in the overlapping of many fibres" [1, PI 67].

A child who enters school, in general, already knows how to use the word number to count, using the natural numbers already memorized by him/her. However, this is *one* of the possible uses for the word number. Gradually, he/she will learn how to use numbers to measure, and in this process, new numbers, rational numbers, will be introduced. Then he/she will learn how to use numbers to solve equations, and he/she will be introduced to other kinds of numbers, such as irrational and complex numbers. And so on. With each new application of the word

[8] Remembering that the activity of comparing is a learned technique, since it is not something natural, as if we made the same comparisons through intuition or something similar, which would be common to all.

number it does not imply abandoning the previous ones; on the contrary, throughout this process, new *aspects* of this concept are learned by the child, aspects that were *invented* by mathematicians throughout the history of mathematics, involving the mastery of different *techniques*, such as counting, measuring, adding, dividing, etc.

However, if we are tied to a referential conception of language, our tendency will be to assume that the word number *must* refer to something extralinguistic. For example, if we are realistic mathematicians (Neoplatonics), we will believe in the existence of an ideal mathematical world, in which it would be possible to discover the essence of number, which would be common to all these different applications of the word "number," and we start to look for an exact definition of this concept. As if the meaning of the word number was previously given in an ideal world, *regardless* of its conventional uses. A dogmatic image of the word number appears, which is expressed in the idea that there would be an exact definition of the concept, yet to be discovered by mathematicians, so that, once in possession of this definition, we would be able to apply the word number to any circumstance, as if the understanding of the concept given by definition already contained all of its future applications.[9] This analytical conception of the meaning of a concept leads to several problems not only in the field of mathematics but in all areas of knowledge.[10]

These confusions, in general, can be avoided if we look at how we *actually* use language. In particular, the concept of *family resemblances* makes it possible to question a privileged use of the concept of number, or duck, and by extension, of any other concept, and the images that derive from this referential conception of language. If we look at the effective use that we make of our concepts, we will see that there are countless applications that we make of a certain word without a supposed essence corresponding to it, which would be common to all its applications. What we have, as Wittgenstein observes in the quote mentioned above, are just family resemblances, overlapping each other to a greater or lesser extent, which makes the concept more "robust."[11] Consequently, the meaning of a word is being formed as it is *used* in different situations. In Wittgenstein's words: "For a *large* class of cases of the employment of the word "meaning" – though not for *all* – this word can be explained in this way: the meaning of a word is its use in the language" [1 PI 43].

[9] Cf. [1 PI 197, 218].

[10] In the field of education, for example, we know that, in the classroom, the situation of the student who seems to have understood a certain concept is commonplace, and yet, he or she hesitates to apply it in new situations, or even continues to apply it, at a certain moment, in a different way from what his or her teacher expected. As I have already defended in other works, pedagogical practices anchored in a referential conception of language leads to several learning difficulties, insofar as the existence of absolute meanings (as the ultimate foundations of our concepts) is mistakenly assumed, which supposedly guarantee their application in any circumstances.

[11] Cf. [1 PI 67].

Thus, meaning does not have a prior existence to language; on the contrary, it is gradually constituted, based on a work of language, which involves not only words, but also several activities interspersed with elements of the empirical world, such as objects, sensations, feelings, and also involving interlocutors in specific contexts of the application of words. Hence, Wittgenstein starts to use the concept of "language-game" instead of referring only to language to emphasize that words are immersed in our *forms of life*[12] [1 PI 23]. Returning to the concept of number, the word number is used in different everyday or formal situations, or in Wittgensteinian terminology, in different *language-games*. Its meaning is being constituted as this word is applied in an activity of counting, measuring, calculating, etc.; that is, we can talk about different *aspects* of the concept of number, analogously to the different aspects of an ambiguous *Gestalt* figure.

Resuming the image of the duck-rabbit, the meaning of the word "duck" is also not previously given in the figure. Otherwise, how do you explain that some people immediately see a rabbit and not a duck? In order to make sense of what we are observing, we organize our empirical experience based on the words we already know. We will only be able to see a duck if we have already acquired the duck concept, and we only observe a rabbit if we have already learned the rabbit concept. In other words, our sensitive perception is already conceptual. It is through language that we organize our experience in order to focus on *certain* aspects of the empirical world to the detriment of other aspects. A person who has seen a duck immediately will have to shift his attention to other fragments of the empirical world in order to see a rabbit. If he/she finds it difficult to see the rabbit, someone can help him/her by saying: "*See* the duck's beak *as* the rabbit's ears!" Thus, when we are able to see the rabbit in the same figure, a new aspect emerges: we start to look at that same empirical experience in another way.

Similarly, the appearance of a new aspect can occur in relation to the same object, for example, when we meet someone we have not seen for many years, and we do not recognize him/her. And in this case, Wittgenstein imagines the following situation: "suddenly, I recognize him, I see his old face in his changed face. I believe that, if I knew how to paint, I would now portray it in a different way" [1 PI p. 259]. It is as if a new form had emerged, giving a new meaning to what was being observed until then.

Nevertheless, it is not just the empirical experiences that propitiate the emergence of new aspects. A mathematics teacher can introduce his/her student to rational numbers, telling him/her: "*see* rational numbers *as* the ratio of two natural numbers," thus introducing a new aspect of the concept of number, or in other terms, establishing, thus, a new sense for the concept of number. The student may or may not accept this suggestion from the teacher, and here we have an example of an epistemological obstacle in the classroom. The introduction of rational numbers is not mathematical evidence, as if the mathematician had simply discovered

[12] The expression "form of life" is also crucial in Wittgenstein's work, although it is mentioned by him few times, and never defined. However, throughout his work, it appears that this concept is used by him to refer to our habits, customs and institutions.

something pre-existing, but only a new relation of sense that is being established, invented by mathematicians, involving several techniques of a conventional nature. Finally, both in relation to the sensitive experience and in relation to ideal objects, “to see as” allows new aspects to emerge, new senses for what is being observed, said, or thought. New relations of sense are instituted, which start to play the role of rules, rules that we learn to follow in our different language-games.[13]

The Autonomy of Grammar in Relation to the Empirical

Although Wittgenstein has never defined what he means by “language-game,” in paragraph 23 of his work *Philosophical Investigations*, he provides us with several instances for language-games:

- “giving orders and acting on them;
- describing an object by its appearance or by its measurements;
- constructing an object from a description (a drawing);
- reporting an event;
- speculating about the event;
- forming and testing a hypothesis;
- presenting the results of an experiment in tables and diagrams;
- making up a story and reading one;
- acting in a play;
- singing rounds;
- guessing riddles;
- cracking a joke; telling one;
- solving a problem in applied arithmetic;
- translating from one language into another; and
- requesting, thanking, cursing, greeting, praying.”

As we see above, many of these language-games involve activities that do not refer to something in the world outside or inside of the individual but only express certain habits and ways of acting. Greeting a person, giving an order, telling a joke, solving a math problem, or thanking someone are customs and institutions shared by a community. Giving an order, for example, is analogous to a rule that we have learned to follow [1 PI 206]. If I say to someone, “Close the door!” I hope that person will follow the order given; otherwise, I will say he/she has transgressed the order. Similarly, all language-games involve a set of rules, which we *learn* to follow.

[13] The expression “language-game” is fundamental in the mature Wittgenstein’s work, in that it allows us to see more closely the multiplicity of language, which is not reduced to verbal terms, but involves several regulated activities, as in a game. From this new perspective, language is seen as an open set of language-games, which will give rise to a new conception of meaning.

However, the rules are not always explained; a good part of them is learned tacitly. I do not teach a child, for example, that “this is a duck” or that “this is a rabbit” or that “ducks exist” and that “rabbits exist,” but I tell them: “Look at how many ducks there are in the pond today!,” “What a big rabbit!,” “How long the rabbit’s ears are…,” and so on.[14] In general, I do not give a definition of the words duck or rabbit to a small child; he/she will learn the meaning of these concepts throughout the use that is made of them in different situations, thus constituting a grammar of uses of these words.

In general, grammars are interrelated, generating open systems that give rise to what Wittgenstein calls “language-games.” The word “game” in this expression has the purpose of emphasizing the regulated character of the activities that are involved with the words of our language because speaking a language, according to him, is similar to playing a game. Just imagine that the words of a language take the place of the pieces of a board game, such as chess, and their uses are equivalent to the rules we follow to move the pieces (the pawn moves forward, the knight in an “L” movement, the rook horizontally and vertically, and so on). When starting the game, the rules of chess do not determine the move that will be made; they only guide what is possible and what is not possible to do. Similarly, language also constitutes rules that we learn to follow when applying our words and which, when expressed linguistically, are called grammatical propositions by Wittgenstein.

For example, “this is a duck,” “this is my hand,” “the word duck has four letters,” “a thing is identical with itself,” “the Earth exists,” “I have a body,” “human beings see” etc., are certainties that we incorporate and that we take for granted.[15] I cannot imagine that I do not see the duck in the picture above, or that this is not my hand, that I do not have a body, or that the word duck does not have four letters, let alone that not everything is identical to itself! Those statements, in general, are not used to refer to the things in the world. There is no need to verify them. They are neither true nor false; they are *conditions of meaning* for our descriptions of the empirical world. They themselves do not express knowledge about the world and are not always explicit. A good part of them, as already mentioned above, is learned tacitly, making it possible to affirm with meaning that “a duck is swimming in the pond,” or that “the planet Earth is being destroyed by human beings,” that “people go to museums to see works of art,” among other statements with a descriptive function.

We do not explicitly learn, for example, that “human beings see,” but this is a “rule” that we learn to follow to apply the word “see” in propositions with a descriptive use. Nor do we learn that “the Earth exists” and that “mountains and rivers exist;” however, when children read in the geography books about rivers and mountains, it is as if they “swallow” these statements.[16] These come to express our certainties: “when we first begin to *believe* anything, what we believe is not a single

[14] Cf. [3 OC 476].

[15] Some of these examples are given by Wittgenstein himself, in his writings which were organized in the work *On Certainty* [3].

[16] Cf. [3 OC 143–144].

proposition, it is a whole system of propositions. (Light dawns gradually over the whole)" [3 OC 141]. Our most fundamental beliefs, in turn, gradually form a grammar within us, which becomes *autonomous* in relation to the empirical [4]. In fact, I can talk about ducks and rabbits, about internal sensations, such as pain or happiness, or even about ideal objects, such as rational, complex, or infinite numbers, regardless of an alleged extralinguistic reference. I do not need to be in pain, for example, to be able to talk about pain.[17] The meanings of words are given by the rules we learn to follow, which constitute the grammar of their respective concepts. According to Wittgenstein: "Grammar tells what kind of object anything is. (Theology as grammar)" [1 PI 373].

Unlike our empirical propositions, grammatical propositions play a transcendental function, constituting the meaning of what we observe, think and say. While empirical statements are contingent, grammatical propositions are necessary, such as the laws of logic or statements in a geometric system. However, the evidence for their statements is not because they refer to any absolute truths, but simply because we learned to follow them at the same time that we were learning other things. *We* are the ones who attribute necessity to them.

Putting a grammatical proposition into question is equivalent to putting the entire proposition system at risk: "it is not single axioms that strike me as obvious, it is a system in which consequences and premises give one another mutual support" [3 OC 142]. For example, the grammatical proposition "a thing is identical with itself" is considered one of the "axioms" that has guided our thinking since Parmenides. To think, according to Plato's great master, is to follow the fundamental principle of reason: "the being, is; the non-being, is not." In other words, things are or are not; they cannot be a third thing (the principle of *the excluded middle*); there is only what can be coherently thought, following the principles of identity and non-contradiction.[18] This image of thinking has persisted over the centuries in several philosophical strands, having as a correlated image the ideal of the exactness of concepts.[19] From these images, we assume precise limits for the application of our words, and then we look for definitions that cover all possible applications.

Although these images are important in our ways of life, they can cause confusion when interpreted dogmatically [4]. As Wittgenstein observes, our concepts are originally vague; only for some specific purposes do we restrict the domain of their application, establishing precise definitions for them [1 PI 69]. The concept of identity itself is applied in everyday situations in different ways, without having anything in common with all these applications. It can be applied in the color

[17] However, the autonomy of the grammar of concepts in relation to the empirical world does not mean that they are totally arbitrary, as they are based on our forms of life. The expression "following rules" (in the Wittgensteinian sense) only applies to habitual, institutional and public actions, that is, it applies to behaviours inserted in an institution.

[18] Cf. Morente M. G. (1958) *Lecciones Preliminares de Filosofía*. Mexico: Editorial Diana.

[19] For the German mathematician and logician Gottlob Frege, for example, a true concept must be an exact concept. This is one of the images that will be criticized by Wittgenstein, with Frege as one of his main interlocutors [1 PI 68-71].

language-game, when we say that two blouses are the same red color; but it can also be applied in the language-game of mathematical calculation, by stating that "2 + 2 = 4;" or even, when we say that two different musical instruments are playing the same note. Finally, we can apply the concept of identity under different aspects (in different language-games), without a common meaning for all these uses, just family resemblances, to a greater or lesser degree. The problems arise when the expression, "a thing is identical with itself," starts to be used referentially, assuming that the reference is something that is apprehended by the mental representation (as if there were an intuition of the meaning), or it was located in brain mechanisms, and we start to interpret the concept of identity as referring to something that cannot be said, and that only shows itself in the thing itself [1 PI 215–216].

In fact, we do not need to postulate a supposed "redness," which would be common to both red blouses (the "essence" of red); or assume something in common between two terms in a mathematical equation; or even something that is shown when playing two different instruments, as if this *something* were the very identity of the note played. In the first case, we have different shades for the color red, all called red because they have "family resemblances," and not because there is a red common to all manifestations of red (the "redness"). We *learn* to see red from different samples of what we consider red in our culture, just as we learn the other colors, pointing to different shades of red and comparing these samples of red with each other. In the second case, other techniques are used to establish that "2 + 2 = 4," such as the mastery of counting and addition techniques, which are also *learned* by the student. Finally, a musician identifies that two instruments are emitting the same sound because he/she has *learned* a certain tonal system and is able to recognize a certain aspect of what he/she is hearing, although the timbre of the instruments may be totally different from each other ("*See* this note on the violin *as* being the same note on the piano"). In other words, we apply the above expression to behaviors within a given institution, without anything outside the language that corresponds to all applications of the concept of identity, in each of these situations: "*Essence* is expressed in grammar" [1 PI 371].

Now, the word "thinking" also expresses a concept whose grammar is autonomous in relation to the empirical. We can apply this word following the principle of identity, in contexts of logic, without this causing us problems.[20] And, it can also be applied in other ways, in different situations, "I thought today was Tuesday!," "Think carefully before deciding on this.," "My thoughts went far…," and so on, *without anything in common* that permeates all these expressions (such as a supposed identity underlying all the applications of the word "thinking," corresponding to something ineffable, or even originated in brain processes), *but just family resemblances*. The concept of thinking, like other psychological concepts, is a vague concept with no precise limits. We can always imagine other possible applications of this word. Problems arise when a particular use of the concept of thinking is

[20] Recalling that even in the field of logic, modal logics are increasingly prevalent, comprising graduations (a vagueness) that symbolic logic did not allow.

privileged. For example, when a single rationality is assumed in human beings, common to all, and which must satisfy the logical principles postulated since Parmenides, thus guaranteeing the exactness of our concepts. Moreover, when one supposes that this way of thinking would be rooted in organic or inorganic structures, common to all. However, just by looking at other cultures, in other forms of life, we will see that the reasons that are presented for the meaning of their actions and their words (how they think) can be very different from our Western reasoning. There is no common ground (empirical, logical or ethereal) for reasoning/thinking. According to Wittgenstein: “once I have exhausted the justifications, I have reached bedrock, and my spade is turned. Then I am inclined to say: “this is simply what I do.” [1 PI 217]. In other words, reasoning/thinking is an activity based on *praxis*, on an institution, or in Wittgensteinian terminology, on a form of life. Thus, when looking for ultimate foundations for the word “thinking,” we will see that they are of a conventional nature, such as habitual ways of acting and techniques learned in certain language games: “it could also be said that a man thinks when he learns in a particular way” [5 Z 105].

Thinking as An Activity of Constitution of Sense

However, if we are linked to a referential conception of language, which is still hegemonic in all areas of knowledge, we are led to assume that the word “thinking” *must* refer to a mental/cerebral process that establishes causal relations between psychic structures and thoughts about facts in the world. And that language would only be a vehicle for the transmission of these thoughts as if thinking were prior to language. In contrast to these images, Wittgenstein observes that even in a primitive[21] language-game, like that of the denomination, in which an exclusively referential use of the concept is made, the relationship between the word (which expresses the concept) and the object to which it refers is established through various linguistic techniques that are *learned*.

For example, when telling a small child, who is still learning the names of colors, what the color red is, we point to a red object and say: “*This* is red!” But for the child to understand what was said, that we are referring to the color of the object —and not to its shape, or to the quantity, or to any other aspect to be perceived by the child—he/she must already have mastered some linguistic techniques, which are *learned*: the ostensive gesture, for example, is *one* of these techniques. In the denomination language-game, this gesture establishes a sense connection between the word and the object pointed to [6]. They learn to direct their gaze to something beyond the gesture (and not to the tip of the finger of the person who is pointing, for example); and the object itself is not the meaning of what is being pointed to, but a sample of *what it is to be red*. Also, in the case of teaching colors to a child, we can

[21] Primitive in the sense of simpler, considered by him a preparatory game for more complex games.

also use a color chart, establishing a correspondence between the words and the respective samples next to them.

The objects that we use to clarify the meaning of our words are incorporated into language with a paradigmatic function; they become part of the language as samples and no longer as empirical objects. Thus, a connection of sense is established among the pronounced word, the ostensive gesture and the object pointed to, i.e., a relation that starts to have a rule function and that, once learned, starts to be followed in new situations of application of the same word. Finally, we have several language techniques available for these relations of sense to be established, thus introducing the child, who is learning his/her native language, to the various institutions that are part of their culture. According to Wittgenstein: "I want to say: an education quite different from ours might also be the foundation for quite different concepts" [5 Z 387].

It is therefore worth noting that the rules of our language-games are not private, but shared by a community. Initially, we are *trained* to act in certain ways within our language-games, thus constituting the (conventional) ground for what we call thinking.[22] Once learned, the different circumstances in which words are applied oblige us *to decide* which rules should be applied in the different language-games through which we move. In this second stage, a family resemblance begins to emerge among the concepts of thinking, reflection, choice, hesitation, and others, as we establish new connections between language-games, and new concepts are being learned and/or invented.

In other words, the activity of thinking occurs as we become able to act methodically in a given context, beyond performing mechanical activities. The rules we follow do not determine what to do inside a language-game, but only guide our actions, setting limits on what makes and what does not make sense. An illuminating example given by Wittgenstein is his comparison of language to a tennis game [1 PI 68]. The rules of tennis do not determine *the manner* we play; they do not determine, for example, how high or how hard we should hit the ball; they only delimit a field of possibilities, what actions make or do not make sense during the game in question. Thus, the vagueness of the rules is what allows new moves to be made, and in terms of language, to introduce *new senses*.

Resuming the epigraph at the beginning of this text, the rhetorical questions raised by Wittgenstein aim to relativize the image that thinking would be an autonomous process and independent of its empirical manifestation through speech or writing. Instead of looking for something mysterious in the individual's mind, a supposed "black box" that generates thoughts, Wittgenstein hypothesized that there may be nothing on the physiological plane that corresponds to what we call thinking:

[22] In another text [7], I approach the concept of thinking as constituting internal relations of meaning, independent of our animal behaviour, such as our natural or merely instinctive reactions, in contrast to some commentators of Wittgenstein, who interpreted his reflections in *On Certainty*, by naturalizing the foundations of our concepts.

> "No supposition seems to me more natural than that there is no process in the brain correlated with associating or with thinking; so that it would be impossible to read off thought-processes form brain-processes. I mean this: if I talk or write there is, I assume, a system of impulses going out from my brain and correlated with my spoken or written thoughts. But why should the *system* continue further in the direction of the centre? Why should this order not proceed, so to speak, out of chaos? The case would be like the following—certain kinds of plants multiply by seed, so that a seed always produces a plant of the same kind as that from which it was produced—but *nothing* in the seed corresponds to the plant which comes from it; so that it is impossible to infer the properties or structure of the plant from those of the seed that comes out of it—this can only be done from the *history* of the seed. So an organism might come into being even out of something quite amorphous, as it were causelessly; and there is no reason why this should not really hold for our thoughts, and hence for our talking and writing" [5 Z 608].

According to him, both the behaviorist philosopher and the mentalist one are bound by a referential conception of language when looking for organic and physiological causes (in the case of the behaviorist) for thinking, or when postulating that thinking was originally in a kind of gaseous medium (in the case of the mentalist), without any connection to our linguistic conventions, as if thinking were a seed disconnected from its history. Thus, both philosophical positions presuppose an enclosure of thinking: "one of the most dangerous of ideas for a philosopher is, oddly enough, that we think with our heads or in our heads" [5 Z 605], and "the idea of thinking as a process in the head, in a completely enclosed space, gives him something occult" [5 Z 606]. Wittgenstein then concludes that it is "perfectly possible that certain psychological phenomena cannot be investigated physiologically, because physiologically nothing corresponds to them" [5 Z 609].

Conclusion

As we saw above, sense relations are constituted from a work of language, regardless of organic, physiological, or mental processes. A child who is learning his/her mother tongue believes everything we say. Doubt is only possible based on certainties that are gradually acquired by the child, "swallowed," as Wittgenstein says, from what is said in different situations. Here there is no establishment of cause and effect relationships; what gradually develops is a system analogous to geometric systems, in which the premises and conclusions are *mutually* supportive [3 OC 142]. The evidence for the axioms stems from this intertwining, which occurs throughout the individual's history, depending on the culture in which he/she is immersed, the habits they have acquired, and the institutions to which they were introduced [1 PI 198].

Children at birth experience a chaotic world where anything can happen. The way they start to organize it depends on the acquisition of a language, of symbols that, in the middle of different activities, make it possible to assign senses to what they are perceiving. In other words, this "system" that scientists seek to unravel within an individual (the "black box") is actually constituted from the chaos external to the individual: it is from this amorphous medium that, throughout his/her life, through initial training, one learns to follow conventional rules. The words learned become concepts, which intertwined become our most fundamental certainties. These certainties, in turn, start to express the conditions of sense in order to assign meaning to what we perceive, say, and think.

This linguistic (and not mental or physiological) activity clarifies what we call thinking: the ability to follow the rules already learned, in new situations, and seeing new aspects, sometimes unsuspected, as when one realizes that the duck they were observing can also be seen as a rabbit. Or when we see someone and suddenly remember what that person looked like many years ago. In the latter case, which has previously been discussed in this work, when *seeing* this person today *as* the person we remember from years ago, a new aspect emerges from this comparison. One starts to see the person in another way. Wittgenstein takes up this same situation, this time highlighting the strength of the referential language model that forces us to look for something extralinguistic as being the cause of attributing a new sense to what is being observed: "I saw this man years ago: now I have seen him again, I recognize him, I remember his name. And why does there have to be a cause of this remembering in my nervous system? Why must something or other, whatever it may be, be stored up there *in any form*? Why *must* a trace have been left behind? Why should there not be a psychological regularity to which no physiological regularity corresponds? If this upsets our concept of causality, then it is high time it was upset" [5 Z 610].

If we can get rid of this image that there must be a physiological reference to be unveiled by scientists, and look at the effective uses we make of our concepts, we will see that the foundations of our action and our thinking are of a conventional nature; namely, they are relations of sense (and not of cause and effect), built from linguistic work. The comparison itself (between one face and another from the past) is a language technique that we learn within a linguistic context. Returning to the figure of the duck-rabbit, we learn to focus on certain aspects of the figure so that we can see a duck, comparing it with other ducks already seen in the past. Similarly, we can use these same techniques to see a rabbit in the same figure. The sense is not previously given in the experience; we use several linguistic instruments to move from one language-game to another.

The confusion arises when we are stuck with a referential conception of language, in which a previous meaning is assumed in the duck-rabbit figure, which must satisfy the principle of identity, non-contradiction, and the excluded middle: that is a duck, or that is not a duck, it cannot be a third thing. How is it possible, then, to also see a rabbit in the same figure? This is a false problem if we consider that the meaning of what is being observed is given by the grammar of the concept (duck or rabbit) that we activate to describe what we observe. It is through language-games that we organize our empirical and thinking experiences [6]. Therefore, from this Wittgensteinian perspective of language, the activity of thinking can be seen as – beyond the ability to follow one or more rules within a system, that is, in a language-game – being able to modify rules along the way or even abandon them, and, possibly, establish new relations of sense, sometimes unforeseen, and even unusual. That is, being able to *see as*.

Core Messages

- The meaning of a word is given by the rules we learn to follow within a language-game.
- Sensitive perception is already conceptual.
- The grammatical propositions we follow play a transcendental function, conditions of the meaning of what we observe, think and say.
- One thinks when he/she *learns* in a particular way.
- Thinking can be seen as an activity of the constitution of sense within language-games.

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Literature as a Genealogy of Social Sciences

26

Julio Juan Ruiz

> "*What would become of science without metaphors?*."
>
> G. H. Hardy

Summary

I believe that literature and art, in a broader sense, exert an undeniable influence on social sciences. That is why I call this relationship 'genealogical.' This chapter seeks to analyze that bond from its philosophical foundations in the context of postmodernity. To achieve this objective, I will start by examining the traditional concepts of aesthetics and their development through history, considering the worldviews of philosophers such as Kant, Hegel, Kierkegaard, Lukács, and Heidegger. After that, I will analyze the fundamental principles of Georg Gadamer's hermeneutics related to aesthetics. Gadamer, a disciple of Heidegger, differed from his mentor in his conception of aesthetics and proved the legitimacy of the knowledge held by the sciences of the spirit.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_26

The Calumny of Apelles.
(Adapted from Wikimedia Commons, the free media repository https://upload.wikimedia.org/wikipedia/commons/8/85/Sandro_Botticelli_021.jpg)

Keywords

Genealogy · Literature · Social sciences · Truth

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

The epigraph which starts the present work is a quote from mathematician G. H. Hardy that introduces us to the peculiar relationship between science and literature.

This chapter studies a particular aspect of that relationship: the link between literature and social sciences, where the former acts as a genealogy of the latter. In other words, literature exerts its influence on history, sociology, political sciences, and law; that is why I call this relationship 'genealogical.' By using this term, I follow Alain Badiou's typology [1] for literature and philosophy. According to the French philosopher, this typology does not aim at turning literature into an object of study: it intends to show its influence on other disciplines. To exemplify that influence, I can mention George Orwell's novel 1984, which depicts the oppression exerted by a totalitarian state in a more vivid way than any legal or political text could do. Moreover, Orwell's novel could be a source of inspiration for both the jurist and the political philosopher.

When studying the relationship between literature and science, we must take into account that literature, as an artistic expression, is not only a source of aesthetic enjoyment but also a vehicle for truth, just as science is. That connection took a long time to be admitted since the methodological model of natural sciences, which prevailed for decades, condemned the scientist's self-involvement in the analysis of the object. Such methodological requirement was difficult to fulfil both in the social sciences and in art since, as Martin Heidegger observed, understanding is impossible without anticipation. However, the encounter between a subject and a work of art is an experience of knowledge and understanding, as Gadamer [2] pointed out in his work *Truth and Method. Here the author* stated that art is the expression of truth, and reaching truth is not a matter of method.

In my opinion, there is a close relationship between art and truth. This connection philosophically justifies the influence of literature and, generally speaking, of art on science. It is my objective to clarify the nature of such a relation. With this in mind, I will first analyze the decline of the aesthetic discourse, which, in a way, constitutes the most characteristic feature of postmodernity, and then delve into the guidelines proposed by George Gadamer at the beginning of *Truth and Method*.

The Decline of the Aesthetic Discourse

In the early decades of the twentieth century, artistic Avant-Gardes launched an attack against art and aesthetic institutions. The main consequence of that rebellion was an outburst of aesthetic manifestations outside traditional environments such as art galleries, concert halls, or theatres. An attempt emerged to reintegrate art into everyday life, even when that led to a revolutionary utopia. This artistic explosion accompanied a criticism of aesthetics as a discipline. Avant-gardists did not believe that the aesthetic discourse could give a full account of artistic experiences and expressly rejected the analytical categories of idealistic aesthetics.

After historical avant-gardes, which aimed at separating art from its traditional frameworks, there came the time for neo-avant-grades, which focused on the importance of technique over aesthetics. Walter Benjamin thoroughly analyzed this phenomenon in his essay entitled *The Work of Art in the Age of Mechanical Reproduction,* 1936. Under the predominance of technique, the artwork lost what Benjamin called 'the aura,' namely, what made it unique and impossible to undergo mass reproduction; in other words, what made the original different from any copy.

During the twentieth century, the primacy of technique over aesthetics was so overwhelming that it not only dissolved the differences between original and copy but also erased the limits which separated the artists from their public. Artists began to apply machine-like techniques, and, as a consequence, the creative process was no more the work of the genius—as the Kantian aesthetics had defined it- but a mere mechanical act.

That dominance of technique over aesthetics encompassed a hegemony of mass media in the cultural field, which was of such magnitude that the Italian philosopher Gianni Vattimo considered them to "produce consensus, creation and intensification of a common language in the social field" [3, p. 52]. By bringing about consensus, mass media shaped public opinion and defined the aesthetic preferences of the recipient.

The effects of mechanical production and the influence of mass media on our contemporary culture are undeniable. However, it is evident that artistic manifestations still survive in an institutional sense: people attend theatres, concert halls, and art galleries. In light of this, we might ask ourselves whether the crisis lies in art or in the discourse of aesthetics—a philosophical discipline whose object is the artistic manifestation. More precisely, we may wonder if the aesthetic discourse can comprehend opposed realities such as the influence of media and the survival of traditional artistic creations.

Another sign of the crisis in the aesthetic discourse is the question of the work of art as a product of genius. That used to be a fundamental principle of traditional aesthetics, which considered itself entitled to distinguish what was from what was not. It also proved the emphatic nature of the traditional aesthetic discourse, which led in some cases to the apotheosis of an artist.

Vattimo [3] observed that the crisis in aesthetics paralleled a crisis in metaphysics, which no more considered the *being* as something permanent but started seeing it as something finite, that is, something perishable, subject to birth and death. This change of view saw the aesthetic product from a metaphysical perspective, more precisely from Heidegger's idea of the work of art as "a work of truth."

This conception of the German philosopher revolved around two aspects:

i. *aufstellung*, the work of art as "the image of the world," that is, the artwork belonging to a historical world; and
ii. *herstellung, t*he work of art as "the product of the land."

The latter category was fundamental to this worldview since it emphasized the temporality of the artwork. That aspect had never been considered by conventional aesthetics, which used to see the work of art as bound to eternity.

Such conceptual shift reveals that the sign of postmodernity was a crisis in the traditional aesthetic categories rather than a crisis in or even the death of art itself. This crisis tells us about a decline of the aesthetic discourse or the inadequacy of its categories to define the aesthetic phenomenon after avant-gardes' arrival.

The Work of Art as An Experience of Truth

Hans-Georg Gadamer was a disciple of Martin Heidegger. Unlike his mentor, however, he did not focus his studies on the hermeneutics of existence. On the contrary, he made an effort to go beyond Heidegger's methodological monism, which supported the use of the same method of study both for natural sciences and sciences of the spirit. Methodological monism preconized the conceptual separation of researcher from the subject matter and argued that the former's involvement with the latter was simply abominable. Gadamer considered it necessary to outline methodological hermeneutics suitable for social sciences to overcome such a rigid approach.

In social sciences, methodological monism is impossible to apply since researchers become inevitably involved with their subjects of study. To researchers, understanding a subject matter implies understanding themselves. German theologian Rudolf Bultmann called that process 'participative understanding'. That assumption was the basis for Gadamer's questioning about the truth in the sciences of the spirit and his search for an appropriate methodology to approach them. To find such methodology, it was necessary to examine all the social sciences: art, politics, religion, to mention some, because "it is the sciences of the spirit as a whole what will allow finding an answer to this question" [2, p. 140].

In his quest to develop a suitable methodological approach, Gadamer began by searching the aesthetic experience. In the first part of his work, *Truth and Method*, he started by clarifying the question of truth in art. To frame that question correctly, he set about a historical inquiry on aesthetic consciousness. In the first place, he examined the controversial concept of "genius" and then moved on to other considerations.

Historically speaking, the first conception of creative genius was a force able to produce a work of art something different from any other object. That idea was functional to the observers since they saw the artwork as a miracle from creative genius, while its creators saw it as a sheer matter of technique and method. Later on, that conception declined, and the power formerly attributed to the author was conferred to the interpreter. This originated an aporia: there was no rigorous criterion to determine whether one interpretation was better than another.

As those two criteria were invalidated, Hungarian philosopher György Lukács introduced a new idea in an attempt to legitimize the work of art as a result of the aesthetic experience. Lukács defined the work of art as "an empty form, a mere crossing point in the multiplicity of possible aesthetic experiences" [2, p. 136].

Then, a dilemma emerged: focusing on the experience, on the instant, implied a fragmentation of reality, which Søren Kierkegaard had already anticipated.

The Danish scholar held that an existence limited to mere immediacy was void. Through that notion, Kierkegaard wanted to prove that the aesthetic experience could not provide a foundation for the continuity of existence, that is, to offer a context for the human being to avoid fragmentation.

That failure attributed to the aesthetic consciousness led the philosopher to assume that the basis for the continuity of being was in self-understanding as the only possibility of overcoming fragmentation and sustaining human existence. When we humans, who are a world in ourselves, contemplate a work of art, which is a world in itself, and we understand it, we understand ourselves. This knowledge, the product of the encounter between both worlds, helps us, observers, to overcome "the discontinuity and isolation of experience" [2, p. 139] by the continuity of our "being there." In the belief that the aesthetic discourse was unable to account for the artistic experience, in other words, those aesthetics was disconnected from art, Gadamer concluded that art is knowledge. But what is the nature of that knowledge? Undoubtedly, it is radically opposed to that of the natural sciences. However, it is knowledge since it is an intermediary of truth.

This cognitive contradiction was confirmed by the German philosopher Wilhelm Friedrich Hegel in his *Aesthetics: Lectures on Fine Arts*. In that work, the author described the history of art as a history of worldviews. Doing so, he validated the truth of the aesthetic experience. However, he said, this validation gets interrupted when the concept monopolizes the philosophical experience, or in other words, when art gets lost in philosophy. Then, the truth of the artistic experience becomes unknown again.

The previous historical considerations about "aesthetic consciousness" showed the inadequacy of aesthetics to define the true nature of art. Seeing that, Gadamer decided to elucidate it from a broader framework, which was offered by Martin Heidegger's metaphysics, more precisely by his idea of 'being on the horizon of time.'

The author of *Truth and Method* held that the relationship between being and time should not be interpreted radically. On the contrary, 'being on the horizon of time' meant that humans had to understand themselves by referring entirely to their own time and future. Heidegger conceived the 'being' as grounded on finitude, the necessary basis to question ourselves about the 'being' of self-understanding. This questioning would allow us to overcome the fragmentation caused by the artistic experience.

All the previous considerations led the thinker beyond the horizon of understanding and opened the door to a broader experience: the experience of being. With the idea of finitude as a point of departure, Gadamer approached the nature of art from the aesthetic experience, even when it could not offer a definite answer, just as happened to Heidegger in his questioning Metaphysics.

To understand the encounter between a work of art and truth, Gadamer proposed the notion of "game:" in the philosopher's view, understanding a work of art means getting caught by the game it represents. In this game-like instance, we are not conductors but captives, as we get carried away by the rhythm of music, the beauty of a poem, or the magnificence of a cathedral. The game is not subjective at all: understanding an artwork means getting caught by it. In addition to captivating us, the work of art discovers something essential that refers to itself and ourselves.

A work of art refers to itself because it is a *surplus* of reality, a more revealing reality. To exemplify this, I chose *The Calumny of Apelles* by the Italian artist Sandro Botticelli. In this picture, the observer can see the image of a naked woman looking up to the sky: the allegory of truth. It represents a transcendent ideal of virtue which refers to the religious spirit still present at the beginning of the renaissance when the secularization process began. In turn, the *surplus* of reality conveyed by that image also challenges the observers, making them reflect upon the complex concept of truth.

Summing up, I assert that Gadamer's principles transcend the nineteenth century methodological monism and examine the artistic experience from the perspective of finitude. Taking it into account, present-day thinkers could implement the same approach to inquiry about the nature of religion, politics, or law, that is, the 'sciences of the spirit' in any of its forms. By doing so, they will realize that the question put at the artistic experience proves that art is knowledge, and as such, an indisputable path to truth.

Conclusion

In this text, I have briefly explained the philosophical foundations that legitimize the genealogical relationship between literature and social sciences and, more widely, the relationship between art and science. To achieve this purpose, I resorted to Georg Gadamer's philosophical guidelines, which validate the truth of the aesthetic experience and other manifestations of the social sciences such as politics, religion, and law. I began my paper with Hardy's inquiry: "what would become of science without metaphors?" After all the considerations presented here, I would reformulate this question, asking what would become of us without science and without metaphors.

Core Messages

- The assumptions of methodological positivism have long hampered the legitimization of other forms of knowledge, such as art.
- Overlooking the validity of other forms of truth ignores the need for knowledge that every human being holds by nature.

- While specialization has brought about significant progress, excessive atomization of knowledge led to disregarding other realities, such as art or religion.
- The worldview of leading scientists exceeded science fragmentation and admitted other forms of truth besides science.

Acknowledgements The author would like to thank Inés Álvarez for assistance with the process of translating the chapter

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27 How Rational Thought is Conceived in Christian Doctrine: The Case of Saint Thomas Aquinas

Rogelio Jiménez Marce

"*Although the truth of the Christian faith exceeds the capacity of human reason, nevertheless the truths of which it knows do not oppose those of the faith.*"

Thomas Aquinas

Summary

The objective of this research is to analyze the way in which Saint Thomas Aquinas conceived the rational processes in the human being. Although the work of this medieval thinker had a theological character, it is of great interest to analyze the way in which he reflected on human rationality understood as a mechanism to access the understanding of reality. Thomas Aquinas' thought evidenced the importance of reason for the human being since it not only constituted the quality that allowed him to differentiate himself from the rest of earthly creatures but also allowed him to approach spiritual ones, although without reaching the levels of understanding which they enjoyed. This was explained by the way in which knowledge of reality was produced since access to it was achieved through the body that became the means to approach the sensitive experience, but the processing of information was not associated with the material but was produced in the intellectual soul that was not located in any specific organ. According to the theologian, reason was indispensable to achieve the knowledge of the faith.

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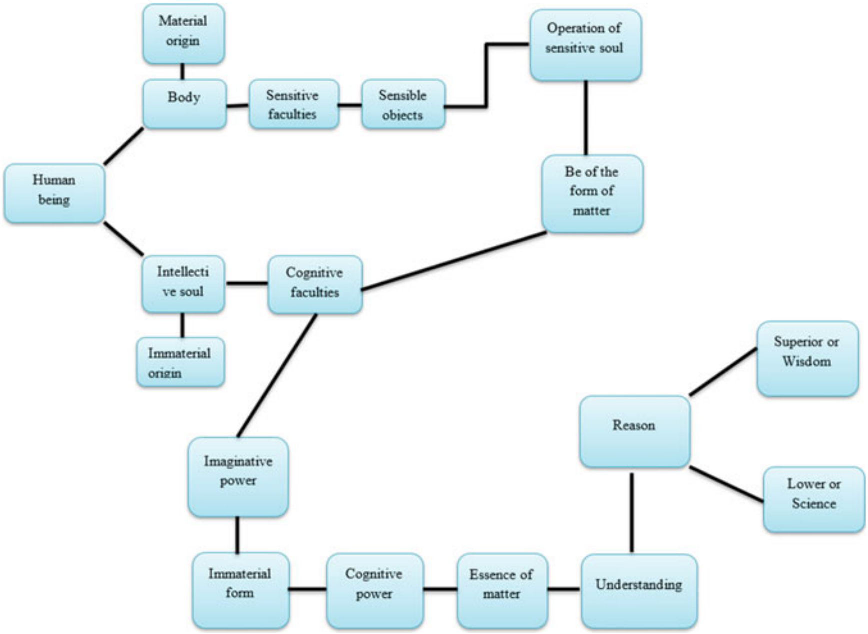
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_27



The rational process, according to Saint Thomas Aquinas.

Keywords

Cognitive faculties · Language · Rational thought · Saint Thomas Aquinas · Science · Sensitive faculties · Understanding · Wisdom

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

The beginning quote evidences one of the main concerns that encouraged Thomas Aquinas's thought: seek harmony between faith and reason because it was indispensable to achieve the knowledge of the faith, which was possible by the fact that reason was an image and a reflection of divine wisdom. Through the understanding of how the world works, you could understand God; according to the theologian, it was the desired objective to achieve, although he warned that the reason had certain limits that prevented him from achieving a true understanding of divinity at the same time, he should not try to assimilate what exceeded his capacity. To analyze the meaning of reason in Catholic doctrinal thought starts in Aquinas' work which has been considered one of the "culminating moments of medieval thought" [1], due to he managed to integrate philosophical ideas and the Christian conception of the universe in a great system of explanation of the natural and supernatural world [2]. Thomas not only presented faith as the formal principle of theological construction but also made it a source of rational knowledge. In this case, the theologian warned that without reason, it was impossible to conduct intelligence to the knowledge of the truth taught by faith [3, 4]. With this position, Thomas renounced the vision of the medieval Christian conscience that considered that the truth of things found in the eternal thought of God and the perfection of intelligence was acquired thanks to divine illumination [1, 5–7]. Most studies about Aquinas' work focus his interest on the theological aspects, but rare attention has been paid to his views on the way in which intellectual activity was generated, an aspect that was fundamental in its thought, then, as Carlos González [2] indicates, if the human being did not know himself, he could not come to understand God.

The objective of this research is to analyze the way in which the saint conceived rationality, where it originated, what were its characteristics, what was the relationship that existed between the sensible and the cognitive, how the understanding of the world was generated naturally, how rational thought was concretized through language, what were the scope and limits of human knowledge, and what was the difference between science and wisdom. The work is divided into three sections:

i. the first one explores, so succinctly, the intellectual context of Aquinas and its approach to the work of Aristotle;
ii. at second, the place that the human being occupied within creation and the motive are presented by which the use of reason was granted; and
iii. in the third, the elements that shaped the understanding of its characteristics and the way in which they reached an understanding of the natural and of divine knowledge are discussed.

The Parisian Intellectual Environment

Saint Thomas was born in Naples in 1225 into a noble family. Despite the opposition from his family, he entered the Dominican order at 18 years old. He studied in Paris and in Cologne. His stay in Paris, first as a student and later as a teacher, would be fundamental for the development of his theological ideas because, during the thirteenth century, there was the concentration of university schools, which favored exchange and confrontation of ideas between the faculties, in which a broad scientific and philosophical literature of Greek, Jewish, and Arab origin, a situation that, among others things, it allowed to know the Aristotelian philosophy that, according to some scholars, constituted a key element to understand theological work in the Middle Ages [8–10]. Although an attempt was made to prohibit the writings of Aristotle for believing that his approaches threatened the transcendence of the truth divine, the truth is that his ideas found important defenders among which Albertus Magnus stood out, who would be Thomas' teacher. Aristotelian thought caused a "radical reformulation" in science, philosophy, and theology. In the case of the last, it was stated that it was not enough to delve into the meaning of the words of the Bible or gloss the truth taught, but the right of reason to analyze the sacra was a recognized page from science. In this sense, William of Auxerre affirmed that the theologian had to propose a faith based on reason. During his second stage as a teacher in Paris, Thomas gave himself to the task of refuting approaches with which he did not agree like the Averroistic monopsychism that placed the individual in an indeterminate intellectual activity, which alienated his personal conscience and compromised his ability to free initiative, that is, it eliminated individual eschatology. With the baggage of philosophy Aristotelian, the theologian warned that understanding reality was possible if its principles were sought in itself, a conception that allowed rationally analyzing all earthly manifestations [6, 7, 11–13].

Why Was the Human Being Able to Reason?

To answer this question, it must be taken into account that Aquinas considered that the human being was part of a divine plan embodied in a shaped universe by a plurality of creatures, which were characterized by their inequality derived from a hierarchical vision of material reality. This constituted the first principle of divine wisdom. Each of the creatures was ordered to its own act; because of that way, they reached their goal, which was to achieve the perfection of the universe. The human being constituted a part of the whole that, thanks to reason, could order its ends to God through works, knowledge, and love. As one of the central ideas of Aquinas's thought is that the imperfect tends to the perfect; the human being constituted the perfect within the realm of the animal, but he was an imperfect being with respect to angelic beings. This circumstance placed the human being between corruptible and incorruptible beings. To understand human perfection in the natural environment, it must be kept in mind that Thomas considered two aspects: movement and rationality. With respect to the first point warned that the more perfect the movement itself, the more perfect the life would be. There were three types of movements: that of plants that only sought their development, that of animals that were guided by the senses, and that of humans whose actions were directed to an end determined by reason, which was explained by the fact that the intellective faculty moved the sensory powers and these, to the organs that executed the movement. As for the rational, beings without knowledge obeyed their natural impulses, due to in them the sensitive soul predominated that only sought to satisfy their material needs [14].

The opposite happened with the human being whose intellectual soul, which was considered as their substantial form, tended to seek knowledge. However, at this point, the saint indicated that it should not be forgotten that the human being was part of the animal genus since his body was animated by sensitive and nourishing souls; that is, it contained in itself the elements that formed the substance of inferior beings (being, living, and feeling) which made it imperfect, but the presence of the intellectual soul allowed it to dominate its rational nature whose essence was understanding. The union of the four elements (being, living, feeling, and understanding) not only allowed him to achieve perfection, despite his unity with the matter but also served to grant him the category of person because he was conceived as the individual substance of a rational nature. Thus, within the natural order, and on the principle that animate beings were perfect more than inanimate ones, plants were placed on the lower scale, animals on the middle part, and the human being on the upper scale as the most perfect of living beings, thanks to the fact that his intellectual soul granted him a certain similarity with divinity. This fact gave him the power to govern the rest of the species since the inferiors had to be ruled by their superiors. However, the theologian warned, in a clear allusion to the Averroist monopsychism, that there were differences in the species and the forms that were distinguished from each other by their greater or lesser perfection, that is, there was, for example, no rational human nature that was the same for everyone. Although the intellective soul was superior in the natural order, it was inferior in what referred to angelic intellectual substances because the innate knowledge of the truth, as it happened with the angels, was not innate to it, the reason why it needed to reach it by the middle of the senses [14].

To explain this fact, Thomas said that human nature requires a sensitive soul to reach the intellective. How feeling could only be carried out by means of a bodily organ, the intellective soul needed to unite with a constituted body that served as an instrument for the senses, which used touch to reach the perfection of their sensible capacity [15]. The union of the intellectual with the sensitive could only be carried out in the human body for two reasons: for having a balanced complexion and for possessing the organ of the organs, that is, the hand in which the sense was lodged superior touch. In fact, the theologian claimed that human beings with the best touch reached the highest levels of understanding. Although the intellectual soul did not require the body to carry out its intellectual operations, it required the sensitive part that needed an organ of adequate complexion. In this sense, it was not the body that joined the intellectual soul, but it used its constituent parts to carry out its operations, such as seeing through the eye or listening through the ear. Thus, meaning existed on account of understanding. Although the intellective soul could understand the universal and the infinite, it limited its understanding as a consequence of its dependence on the bodily. However, Thomas warned that certain operations of the soul, such as the understanding and the will, were carried out without the intervention of a bodily organ [14]. It is interesting that the theologian did not associate reason with any specific organ, which showed that he was disassociated from the debate that existed regarding the place where mental functions took place. A posture, called cardio-centric, would be proposed by Aristotle, who thought that the brain was a "useless organ" that played a secondary role, so he established that the mental function was in the heart because of the central place it occupied in the body. This conception would remain valid until the seventeenth century.

In fact, in the Middle Ages, it was considered that the heart produced not only thoughts but also feelings. The primacy given to the heart was derived from the fact that it was the origin of the veins that distributed blood in the body, so it was of greater importance than the head, which, although it housed the soul, was not the repository of "vital forces." Cardio centrism was opposed by encephalocentrism, a position defended first by Hippocrates and later by Galen, who argued that mental activity originated in the brain. This stance had no major impact [16–18]. Given the above, one wonders why the Aquinate did not place reason in any organ. In order to explain this matter, Thomas warned,

i. first of all, that the "thinkers of antiquity" were unaware of the existence of intellectual capacity, a situation that caused them not to distinguish understanding from meaning. Therefore they considered that the world only existed by perceptions generated by sense and imagination. This position was erroneous based on the fact that the sensitive part corresponded to the exterior of the human being while the intellectual part was located within it;
ii. secondly, the theologian indicated that since the intellectual substance did not have any kind of matter and since the operation of any being was carried out according to the mode of its substance, the act of understanding constituted a totally immaterial operation, which could be corroborated by examining your object. Anything could be understood as soon as it was abstracted from matter since the forms were individual and could not be perceived by the understanding. This allowed us to conclude that all intellectual substance was immaterial. However, he warned that the intellect could only apprehend material things according to each individual's own capacity, which was not the case with angelic substances that could not understand how they were in themselves, but only in their way of being composed; and
iii. thirdly, the theologian affirmed that the intellectual principle was a power of the soul granted by the divinity to the human being, so that he recognized himself differently from the rest of the animals, thanks to his intelligence since they were not masters of their acts if not that acted on the impulses. Thus, in

intellectual creatures, understanding became a power of the one who understood the material. The union of the corporal with the intellect limited the possibilities of understanding, unlike angelic beings who understood the immaterial because they integrated the intellect and the will in themselves, a situation that included even the divinity itself. However, the Aquinate mentioned that there were some divine truths that could be accessible to human reason, a fact that can be explained by the existence of beings with a higher level of understanding derived from the various degrees of rational substances. The opposite happened with those whose understanding was weak, for they doubted the truths of the faith because of their incapacity. Thomas explained that diversity in the degrees of rational substances was indispensable to achieve perfection since uniformity and equality were manifestations of imperfection. Thus, plurality and inequality constituted a means for creatures to work for one purpose: resemblance to divinity. Diversity and inequality were not the consequence of the plurality of matter or the intervention of certain causes or merits but were the result of the divine will that gave each creature the perfection that it was possible to have;

iv. fourth, he mentioned that intellectual creatures occupied the highest point of the perfection of things, but an effect of perfection was the return to its principle, which in this case was divine understanding. With that, the created universe would achieve its ultimate perfection [14, 19, 20].

The intellect could not be assigned a specific place in the body since the faculty of understanding came from God, who considered himself the first intelligent because he was immaterial. This faculty was conceived as the root of understanding. The intelligible reasons coming from the divinity (first cause) allowed the intellectual operation to be carried out (second cause). This assertion was also verified in the case of angels that did not require a body. Since all angelic beings were perfect intellectual substances, they did not need sensible things to acquire knowledge. In this sense, Thomas warned that both the intellectual soul and the intellectual substance lacked the matter-form composition. In fact, in the intellectual substances was found the act-potency composition, not from the matter but from the form (what is) and from being participated (what it is). Now, it must be borne in mind that since the intellective soul was considered a divine gift, it could not be dependent on the corporal because it would mean its imperfection, but, through substantial union, the last was ordered to the first, and thus the imperfect reached its perfection as a being. If a deeper knowledge was achieved, it was because the natural light of understanding was strengthened with the light of grace that allowed abstracting the concepts of the sensible. Although the human being was distinguished from the rest of the animals by intelligence, he was not separated from them by his bodily nature that allowed the understanding of his material reality since the intellectual appetite moved through the sensitive appetite. As what characterized the human being was the intellective principle, it became its substantial form of the body. The higher the category of a form, the more mastered body matter was and the less it was immersed in it, so there was a greater impulse in its intellectual operation and in its ability to understand [14].

The understanding varied depending on the multiplicity of the matter, which explained that only some reached wisdom. He warned that the more sublime a being was, the more knowledge he could extend to a wide number of subjects. Although the intellective soul was united to the body as form, the truth is that it retained its being. The only way in which the intellective soul could do with the body was for it to receive intelligible species through other influences. It is important to mention that Thomas adhered to the Aristotelian vision of the brain that considered it a wet organ that tempered the intense heat of the heart and in which the operations of the internal sensory powers took place due to the vertical character of the body, which allowed greater freedom in its operation. He also noted that the human brain was larger than that of other animals and that those with less moisture in that organ were smarter. According to the saint, women and children had a lower intellectual capacity due to the remarkable humidity of their brains, a situation that justified the control that men exercised over them. The Aquinate also clarified that not all men were intelligent since that quality was determined by the moisture they had in their brains [14].

The Sensitive as the Basis of Understanding

Thomas started from the principle that the human being knew all the genres of being through his sensitive and cognitive faculties. Through the first, he knew the singular and material, while he reached the universal and immaterial by the latter. To reach the understanding, considered the highest of the powers of the soul, the intellectual substances of the human being required to approach sensible things through the bodily senses, a state that he called the operation of the sensitive soul. The sense was a passive power whose alterations were produced by the external sensible objects in two ways: a physical one that manifested itself in the form of the natural being and a spiritual one that presented itself in the form of its spiritual being. The second was necessary for the operation of meaning to take place since it established an intentional representation of the sensible form in the organ. The opposite would happen if the first one dominated because the sense would manifest itself in the whole body. As sight was the only sense in which spiritual alteration occurred, it was considered the most perfect and universal of the senses. In the others, the spiritual and physical alterations that could be an object (in the ear and smell) or organ (touch and taste) were combined. Because of the diversity of objects that were perceived by the senses, there were four inner sensory powers (common sense, fantasy or imagination, estimation, and memory) that achieved the perfection of the animal being, as they helped to perceive the sensible reality, both present and absent, and with this, the achievement of a superior-good was sought. Each of the powers had a specific function: common sense perceived sensible forms, fantasy or imagination served to retain and preserve them, the estimate knew intentions that were not received by the senses, which were stored in the memory that allowed remember the good and the bad [14, 19].

Imagination was the only one of the powers to be found in every way, allowing material forms to pass into an intelligible state. The form of the imagination lacked matter but was subject to material conditions in such a way that it became the intermediate point between the being of the form of matter and the form it acquired in the understanding when it was abstracted from matter. The sensible objects were not the only ones that altered the imaginative power, but through composition and division, images could be formed without the intervention of the senses. Thomas noted that the perceptions of the sensible forms of the external sensible objects were similar in the human beings and the animals, but there were differences regarding the intentions. Irrational animals received them by a natural instinct (natural estimative faculty), while humans distinguished them by comparison of particular intentions (cognitive faculty or, in particular, reason). This last function was in the middle of the head and used memory to analyze them. According to the theologian, common sense was the root and the principle of the external senses because he had the judgment of discernment that brought together the apprehensions of the senses and their intentions, so he resorted to the imagination and memory, known as the passions of the sensory root, to give meaning to what is perceived. This situation distinguished him from his own sense, which only knew the form of the sensible that altered him. All of the above constituted the alteration operation, but there was a second one called formative that occurred when the imaginative power conceived the image of some absent or never observed object. This double operation was generated in the understanding. Common sense was the most sublime of the proper senses, and although it was a power, it could know everything manifested in the five external senses and perceived some things to which they had no access [14, 19].

However, the participation of all powers was required to reach an understanding. Thomas clarified that although the action of the understanding originated in the senses, the latter knew certain things that they could not perceive, the same situation in which the estimative, cognitive, and memorable power found themselves, which was explained by the proximity they had with the universal reason. The understanding knew some things naturally, such as the first principles of the intelligible, which allowed it to reach certain conclusions, but there were also some intelligible realities, such as contingent propositions, which it did not necessarily admit because it had no connection with the first principles. The opposite happened with demonstrable conclusions that were closely related to them and whose denial led to ignorance of the first principles, which could be recognized after they were deductively demonstrated. From the first principles, which were considered self-evident truths of nature, it was possible to obtain certain knowledge that was not supported by rational research but which could be reached by means of the infused speculative principle or understanding of the principles and of the infused practical principle or synderesis. This first knowledge induced to seek understanding since the speculative tended to order the perceived to the consideration of the truth, while the practical sought action or the operative. Since the understanding required the senses to know the external reality, it was considered an imperfection of its intellectual nature because it needed a mediation to apprehend things on the outside and from there, to be able to reach its knowledge inside, that is, move from its being to its essence [14].

The theologian clarified that while the understanding was attached to a body, he had to resort to images to understand in action not only when he first acquired knowledge but also in its subsequent use, for which it also required imagination and the other faculties. This was explained by the fact that material things could not know with the intellectual vision but required the sensible that perceived things and the imaginary that found their similarities. Thus, the proper and proportionate object of understanding was the nature of the sensible, which became a principle of knowledge. If an organ was injured, the human being could not understand in act even those things that the understanding had acquired. When one sought to understand a thing, certain images were formed in which one could contemplate what one intended to understand. This process was explained by the fact that the cognitive power was in proportion to the knowable. Although it was true that meaning provided the image of the object, the agent was the one that gave it the representation of the understood or intelligible species. The proper object of understanding was the essence or nature existing in the bodily matter, and through the nature of the visible, to be able to reach the knowledge of the invisible. In order to know the nature of any material object, one must have certainty of its existence in a concrete way, which could only be perceived by the senses; that is, recognizing being becomes a condition for accessing the essence. At this point, the imagination acquired a role of intermediary between the sensitive and the understanding in action because, through the images, the universal nature that was present in a particular object could be discovered. Since a similarity of concrete reality could be found in the image, the imagination did not need to resort to a new particular representation, but it did when it was about the incorporeal realities whose images it did not know [14].

As the image was related to the understanding, it became subsistent and could know the nature of all things because the understanding had a double condition: to know being and universal truth, but it was also a particular power that was ordered to a certain act. Thomas did not agree with the Averroist idea that there was a single understanding for all human beings, nor did he accept the Aristotelian approach that the understanding is considered a power of the soul because he said that it should be taken into account that understanding as an action proper to the understanding, it was the fruit of the individuation of the being that understood and the individuation of the species by which it understood, which did not mean that it was not possible to have a knowledge of the universals, that is, the representation of a thing without that which distinguished and multiplied it. In this sense, it did not matter if one or many understandings existed, but the understanding and the species by which it was understood were required to be something concrete, that is, although the understanding was one or multiple, what was understood would always be one and would be found in whom he understood through representation. Thomas indicated that what was understood constituted a perfection of the one who understood by virtue of the intelligible species that he had in his understanding, which allowed him to apprehend the essence of material things that became intelligible by abstraction. Thus, the object of understanding was that which something is. What was understood was potential when the species of the object were in the cognitive faculty, but it happened when the cognitive power received the species. This situation showed that being moved by the object did not it was essential to understand, but insofar as it was possible to understand. The understood in act showed that the representation of the understood was the form of the understanding, in the same way, that the image of the sensible object was the form of the sense in act.

The understood in act implied both the understood and the act of understanding, which caused, in a secondary way, the intelligible species to become the understood because it was representative in the understanding. To exemplify this point, he said that what was understood was not the image of a stone (essence) but the stone itself (being). If one did not proceed this way, science would not deal with things but with intelligible species. As knowledge was realized through the assimilation of the knowledge to the known, the same thing could be known by different beings because they all understood their common nature, a process that they called abstracted universal because their principles of individuation were excluded. The theologian warned that the senses conceived of nature individually, but through understanding, conceptual abstraction, intellection, and universalization were reached [14].

Understanding as a Means of Knowing Reality

Thomas mentioned that the understanding was an action of the concrete human being because the one who understood experienced that he was the one who understood. Since the object of the understanding was to know the essence of things, it began to do so by means of the meaning of which the proper object was external and singular accidents, but the form of the known was received in the understanding in an immaterial and universal way. The power by which the understanding knew what was necessary was not different from that by which the contingent was known since the two fell under the same objective consideration as to being and the true. The understanding knew the necessary but not the contingent. Although the two agreed on the common notion of being, which was the proper object of the understanding, they differed in that the contingent, by its particular character, was known directly by the senses, while the understanding was concerned with what is necessary to contain universal notions. If the universal reasons of the knowable were considered, all the sciences would have as their object what was necessary, but if things were considered in themselves, then sciences such as the moral and the natural would deal with the contingent and the rest with the necessary. The understanding went from ignorance to knowing because it was potentially towards the intelligible species, which became knowable when the understanding was in action. When the power was passed to the act, an indeterminate and confused knowledge was generated, which became understandable and determining when the perfect act was reached. In cognitive beings, the intellectual appetite induced the desire to obtain immaterial goods such as science or virtue because they sought to apprehend being absolutely. In contrast, sentient beings knew about being subjected to the here and now [14].

From the theologian's perspective, the understanding was made up of two potential understandings (agent and possible) and two acting understandings (habitual and accomplished). A potential understanding was what allowed understanding, and acting understanding provided knowledge of reality. There are two other acts of understanding that dealt with the contingent: the opinion that sought the true from the contradiction and the judgment by which certain principles were applied to the analysis of questions, in such a way that to understand was to approve what was judged. By means of the agent's understanding, the intelligible species were abstracted from the images that, as current representations of certain natures, were potentially immaterial. As the soul knew the intelligible species, it was perfected in potentiality, and its intellectual part became immaterial in act. The agent understanding provided the light to understand, which was explained by the fact that it was part of the soul. To demonstrate this point, Thomas warned that above the intellective soul was a higher understanding from which it received the faculty of understanding. However, it clarified that the intellective soul came to the knowledge of the truth through the argumentation that materialized in the discourse and in the movement. The discourse was made up of propositions that allowed access to the way the understanding judged external realities. In the agent understanding, the intellectual operation began, since it managed to abstract the universal forms from their particular conditions, but it constituted an imperfect intelligence insofar as it did not come to understand everything, and therefore, it required the angelic light to facilitate the understanding of everything that naturally you could know. Aquinas warned that the agent understanding allowed to know the first intelligible concepts, which constituted a consequent action of the human species that demonstrated the unity of the understanding, but not the unity of the agent understanding insofar as each soul had an understanding [14].

While the agent understanding helped to make everything intelligible, the possible understanding functioned as a receptive faculty of these species in such a way that the first was an active power while the second was a passive power. This differentiation was explained by reason of the object since the principle that constituted the active power by which the object was in act had to be different from the principle of the passive power that was moved by the object that was already in act. In receiving the intelligible species, the body joined the possible understanding to act as it wished, that is to say, it was in power, but as it required the agent understanding to turn intelligible into act, sensible knowledge could not be considered the total cause and perfect of intellectual knowledge, but was the subject matter of the cause. Through the agent's understanding, the immutable truth could be known, the objective reality and its image could be discerned, and it helped the possible understanding pass from potency to act. Thomas indicated that when the intelligible species was in an intermediate state, that is, between the act and the power, it belonged to the habitual understanding whose function was to preserve the species of things that were not perceived in act, which was also known as reason of memory that, together with intelligence and will, formed the mind. When the memory referred to the past as such, it was located in the sensitive part because it alluded to a particular condition. If the condition of the past was applied to the known and to the act of knowing, then it was part of the intellectual soul because mention was made of what was understood because it had been previously understood. The consummate understanding referred to the action of the understanding that came from the same understanding in which it was carried out, which was also called the movement of the understanding whose principle was twofold: as an intellectual virtue that was in power to understand and the understanding in act that was the species of the known [14, 19].

As the last perfection of the understanding was its operation, it remained in the one who acted as his own act because the first thing the understanding knew of itself was its own understanding, a situation that explained the diversification of the understanding in the human being. Thomas warned that understanding was also called intelligence since it was an act of understanding consisting in understanding and was different from the act of reason by virtue of its hierarchy. The intellectual act began with the apprehension of something (intelligence), and later, it was oriented towards the knowledge or action of something else (intention). This action was called thought while persisting in the investigation of what was proposed and knowing or knowing (phronesis or wisdom) when what was thought was examined and related to certain notions. After you were certain that something was true (internal language), you sought to communicate it to others (external spoken language) through language that was a sign of thought [15]. Both language and understanding required composition and division, a process that, in the case of the second, allowed him to think and reason, or otherwise, he would only contemplate what something was. However, the theologian warned that the understanding could be imperfect for three reasons: by its knowable object (to know things in their own nature), by their means of knowledge (to reach a conclusion by probable means), and by the subject (when an opinion was accepted). The understanding, as the first engine of the universe, sought its ultimate end in the good of the understanding that materialized in reason. Thomas warned that reason and understanding were not two distinct powers but were differentiated by virtue of the fact that the former passed from one concept to another to know the intelligible truth, while the latter carried it out simply by apprehending the intelligible truth. In order for reasoning to carry out the process of investigation, or invention, it had to start from certain truths understood directly, that is, the first principles, and then return, through a trial, to check the adequacy of what was found in those truths [14].

Reason knew universals in the same way that understanding did because the two shared the same cognitive power, and although it belonged to the same gender as that of the angels, it could not know the intelligible truth in a perfect way. From these universal principles, reason deduced particular conclusions that, by means of particular or cognitive reason, could be compared with each other. The saint mentioned that reason was divided into two: the lower one dealing with the earthly and the upper one examining the eternal. The two were powers that were differentiated by their functions. He said that the temporal and the eternal, with respect to reason, implied subordinate realities among themselves because by the earthly, it became the means to know the heavenly, and with it, a double order was generated in the truth that was essential because the natural truths led to supernatural ones. To achieve this, the two reasons were assimilated to the cognitive faculty that was in charge of rationally analyzing that which should be sought. The fruit of the lower reason was science that dealt with the conclusions drawn from the necessary notions, while the higher generated the wisdom that focused its attention on unprovable first principles. Both science and wisdom, understood as speculative intellectual virtues, were perfections of the mind that provided it for the knowledge of divine and human things. Science devoted itself to the understanding of the nature of the material and then came to the understanding of its essence, from which the infallibility of the truth of its conclusions could be deduced. To arrive at the truth, science was required to orient reason to its object through the vision and understanding of the first principles, which in turn led to conclusions [14, 19, 20].

The reason would always be true when he understood the essence of what something was and became a principle of sufficient knowledge by which reality could be known. However, he warned that the apprehension of the truth was differentiated by virtue of the type of reasoning by which it was arrived at. If it was the speculative reason, which was perfected by the understanding, the truth was the same for everyone, but it was not known in the same way in its conclusions; while the practical reason, which was based on the advice, was not the same for all nor could it be known. To be judged correctly, practical reason required science and speculative reason wisdom. The latter, from the perception of Thomas, was understood as the habit that perfected the knowledge of divine things. Because it was a gift of the Holy Spirit, it had its own principles, derived from divine science, with which it judged the knowledge of other sciences, not with the intention of testing its foundations but to show that they were not incompatible with its own truth, For this reason, it was known as the head of the sciences, but it was also called light because it was a pure act of knowledge. There were two types of wisdom: the created that was proper to creatures and the begotten that was attributed to angelic beings. This division realized that the created was perfected by receiving the nature of the one who begets. Wisdom could be achieved through the study of sacred doctrine, which was possible because the divine understanding was manifested in the minds of human beings.

Although not everyone could come to the knowledge of supernatural truth through natural reason, the theologian said that certain principles could be accessed if God was studied in the same way as he was done with creatures; that is, he should be examined the object absolutely in what it is a certain being, analyze it as it is one, understand if it had the capacity to act or cause, and the relationship it had with what was caused. With this, it would be possible to reach the intellectual virtue that was the perfection of reason. When wisdom was conceived by the understanding, it was considered a manifestation of the intelligent being, but when it managed to access certain divine truths, it was called bliss because it achieved, in a certain way, the perfect good of the intellectual nature that was the act of the understanding, the which brought the human being closer to the lower angelic beings [14, 19, 20].

Conclusion

Although the objective of Thomas' work was theological, it is of great interest to analyze the way in which he reflected on human rationality understood as a mechanism to access the understanding of reality. Thomas Aquinas' thought evidenced the importance of reason for the human being since it not only constituted the quality that allowed him to differentiate himself from the rest of earthly creatures but also allowed him to approach spiritual ones, although without reaching the levels of understanding which they enjoyed. Thus, the human being found himself in an intermediate situation: he was superior in the environment of natural beings but inferior among supernatural beings whose knowledge did not depend on the sensitive. This was explained by the way in which knowledge of reality was produced since access to it was achieved through the body that became the means to approach the sensitive experience, but the processing of information was not associated with the material but was produced in the intellectual soul that was not located in any specific organ. This approach differentiated Aquinas from the rest of his contemporaries, who believed that intellectual processes occurred in the heart. Denying any type of connection of reason with the corporal was explained for two reasons: the lack of knowledge about the physiological processes that gave rise to thought and the purpose that guided its theological approaches, as it sought to show the relationship that existed between reason human and faith. The perfect reason was found in God, who, by an act of love, poured it out on spiritual beings and natural beings, who appropriated it according to the degree of their perfection. Thus, in divinity, the understanding was a pure act; in angelic beings, it was in act with a certain mixture of potency, and in the human being, it was only in potency and required the intelligible to be able to carry out its operations [14]. Unlike angelic beings, the human understanding was imperfect not only by its own substance but also by the fact that, by his own will, the human being could decide if he sought to advance in the knowledge of the world through science or he only kept what he perceived, but he did not stop to analyze it. Despite the fact that the intellect was a divine gift, its perfection was not reached due to the predominance of the sensitive, which caused that the universal truths that constituted the ultimate goal of the human being were not known. The approach to the work of Thomas allows knowing how an intellectual activity was conceived in medieval Catholic doctrine and, at the same time, asking questions regarding the way in which other religious traditions understood the origin of thought.

Core Messages

- Rational processes were not generated in any organ of the human body.
- The intellectual substances of the human being are required to approach sensible things through the bodily senses.
- The understanding is an action of the human being who understood that he was the one who understood.
- The intellectual appetite induced the desire to obtain immaterial goods because they sought to apprehend being.
- The intellective soul came to the truth through the argumentation that materialized in the discourse.

Acknowledgements I wish to express my gratitude to Eva Berenice.

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The Interest of Religion on Ethical Thought in Science

28

Jude Likori Omukaga

> *"That which has happened is a warning. To forget it is guilt… and it remains possible for it to happen again… Only in knowledge can it be prevented." [1]*

Summary

Suspicion between religion and science facilitates attitudes of conflicts that can hold back progress. Some policies ignore religion as inconsequential in preference to the definitive prescriptions of science. Nevertheless, the destructive potential of the evil of religious fundamentalism, radicalization, intolerance, or obstinacyawaken open society to possibilities of religion. This primary question of attitude sometimes even affects the advances of science in critical areas of service to society. As society becomes more conscious of the traits common to human thought processes, experts raise an existential question of interest: What is the value of society's conflicting regard for the realities of religion and science? This chapter considers this debate in two aspects. Firstly, it presents the history of complementarity between the two. This will be the basis of its plea for the irreplaceable interest of religion in the ethical thought of science. Secondly, it entrenches religion as a social science. As such its institutional character can be a foundation for a stable, ethical base for the pursuits of science. It will, therefore, tie the relevance of religion to both its potential for a stable institution and as an instrument of scientific research. While the former anchors the interests of

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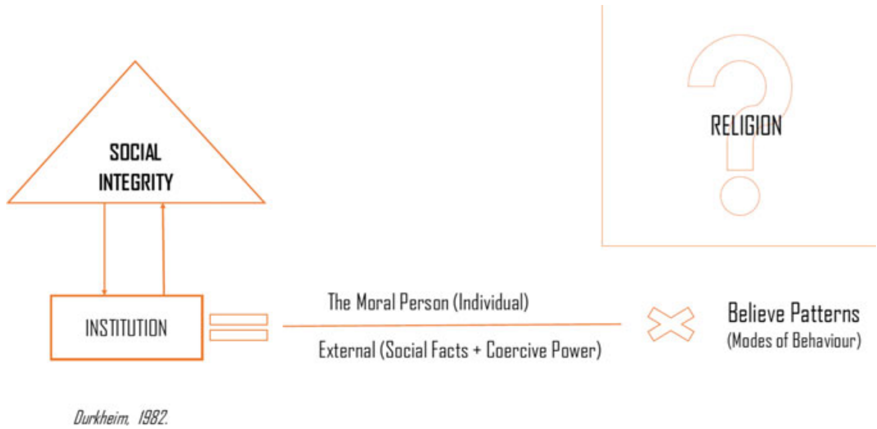
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_28

religion in ethical science, the latter motivates the value of religion as a social science.



Envisioning the role of social science.
(Prepared with data from [20])

Keywords

Building bridges · Integration · Religion · Science · Thinking

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

Science and religion have provided alternative opportunities to the solutions of the problems of society both as institutions and ideologies. In this struggle, these two occupy peoples' minds differently depending on the challenges of the time. While religion exhibits tendencies of authoritarian dogmatism where it often goes unchallenged, its tenets over moral standing or ethical behavior in society remain stable and guarded. Dogmatism arguably shields religion against the uncertainties of temporariness and secures its stability in character formation. Nevertheless, it is at the same time the crucial point where religion parts ways with science. The problem, however, is not that these two approaches radically differ, rather the observation that the outcome of this difference is perhaps more dangerous to society than the solutions each purports to offer. The common grounds for blame on the side of religion include, for example, fundamentalism, fanaticism, and radicalization. They articulate exaggerations and precipitate conflicts. They are often seen as the outcome of the imperatives of dogma in religion. On the side of science, manifest failure to embrace ethics respectful of the dignity of people not only generates mistrust but also causes irreparable harm to health, the environment, and global business.

Arguably, these differences arise on the institutional level of either side. Institutional religion is an existential cultural unit bound by common interests and guarded by specific regulations that safeguard the set goals. On the other hand, the institutional face of science manifests in specified pursuits targeting specific interests such as medicine, agriculture, and engineering. At this level, interests are specific and concerns are narrow; therefore, conflicts abound. However, emerging challenges of society imply a comprehensive multidimensional search for actionable solutions. Although this chapter looks at religion more as social science, the discussion will draw from its institutional advantage to argue for its special contribution to stable, ethical thought in science. Beyond the basic shortcomings of the institution, such as religious fundamentalism or so-called unethical scientific innovations, society faces complex challenges that demand attention. These include, for example, environmental degradation, armed conflicts, and social inequality. When these challenges involve people's behavior, character, attitudes, or values, religion is an unavoidable partner. Religion, both as a cultural value and social science, can be engaged in conflict resolution, advocacy for social justice, environmental integrity, and human dignity. However, times have changed, and the method of approach is of the essence. At the level of science, engagement of religion must embrace research methodology but not without strict adherence to stable, ethical protocols. Therefore, the work presented in this chapter maneuvers the counterpoint concerns of religion in a scientific milieu as it forges its way as a relevant partner. While its departure from a sound institutional background guarantees a stable, ethical disposition, its embrace for method entrenches it as a reliable social science.

Religion and Science in Context

Context Designation of Religion

The conception of religion often assumes a dominant perspective of a transformative, individual experience of the self and the distant divine. In this framework, it is considered a psychological phenomenon residing within the individual either as feelings or acts or experiences lived in solitude. It can also be a "state of being" with a transformative import pointing at ultimate transformation and orientation [2]. Other experts concentrated or represented realities higher than the individual and emphasized the "symbolic transformation of experience" without attention to the individual behind the experience [3]. Social science leans towards a cultural framework. Experts in this school look at "religion as a system of beliefs and practices" by which people orient themselves towards a moral community relative to both ordinary and extraordinary experiences [4]. As such, the appropriate context conception of religion recognizes the place of the individual in specific cultures while projecting the individual and society towards realities beyond the existential realm. The emphasis here is that religion soundly endorses culture and a 'me' within which its meaning unfolds [5].

This indeed is the attention religion must have in order to receive just consideration both as an institution of faith and an instrument of social/cultural progress. It sets limits against what experts would call 'extravagant' exclusivity or inclusivity, which are often known to attract thoughtless biases for or against even the mere mention of the word. On the contrary, proper regard for 'religion,' as captured in this definition, distinguishes as much as it harmonizes mutuality between the 'institution' and the 'science.' This holistic conceptualization also bears significant implication on how we theorize, design our projects, and make knowledge claims on matters of religion. Thus, well suited to scientific pursuits of research on social issues. It places the research outside 'religion' and disposes research work to objective criticism. Thus, the proper conceptualization of 'religion,' according to experts, inspires active and creative engagement over aspects of research. To this extent, the research design in religion follows the pattern of research in all other social sciences: the questions, the objectives, the method, and the procedure remain largely a social science venture. Unlike theology, religion as the object of research is a social science.

Important Origins of Religion and Science

In its prehistoric significance, religion evolved basically as an institution. Its visibility was an effect of a reciprocal significance in which it facilitated the experience of communitarianism, which, in turn, developed and sustained it. Socio-economic experts use the Tribal band, chiefdom, empire, and City-State stages to articulate the extraordinary abilities of humans that appeared in the late stone age or so-called the Neolithic age, estimated to occur roughly between 50,000 and 13,000 BC. According to this categorization, human character developed in complexity towards cohesion as members of smaller simple communities in tribal bands towards complex societies organized in States. The Neolithic age assembled the earliest visible vestige of the instrumentality of religion on the civilization of technology that summarises its progress from hunter-gatherer small nomadic groups through domestic life of agriculture and livestock to complex organized city life [6]. Archaeological excavations reveal the presence of spiritual shrines exhibiting carvings, statues of both male and female deities with spiritual inscriptions that marked very orderly religious practice. The Neolithic revolution saw the expansion of the tribal bands to villages with elaborate social, economic, and political structures. Experts trace the emergence of organized religion to this stage [7] (Fig. 28.1).

Religion captured the community's awesome wonder generated by the experience of exact patterns in weather conditions, great winds, and measured rainfalls that ensured good agricultural yields. In such an experience of success, religion led the community's appreciation through worship of fertility gods and goddesses, made offerings of communion with the deities, and pledged loyalty to the forces of such benevolence [9]. The desire to represent people's reaction to the benevolence of nature in the tribal band stage exposed individual talents of a sculptor, carving, and molding better articulated in religious statues, shrines, or instruments. Thus, human art was facilitated by and first served religious interest. Religion, in its turn, expressed what safeguarded the central community interests. Even though these skills were advanced and technical, they did not just serve the individual's interest alone but were more directed to the service of the community.

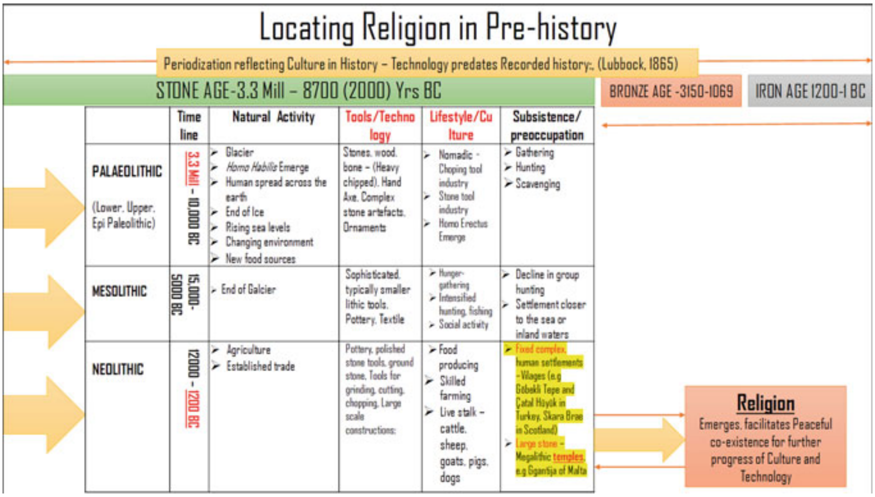


Fig. 28.1 Locating religion in prehistory *(Prepared with data from* [8]*)*

These early aspects of religion developed gradually through the other stages: chiefdom, empire, and state. The Agrarian lifestyle defined the consequent stages of development. Human living not only exhibited strong tendencies towards community life but also gradually experienced the imperatives of peaceful coexistence. This gravitated around the figure of a chief, a king, or its equivalent. Strong and responsive leadership was the immediate manifestation of the assurance of the deity's protection. Religion did not only enrich the community with narratives of the legends, heroes, and demigods but gradually conceived and nurtured the fragile importance of peaceful coexistence in the community. As the communities grew larger, the leaders needed rules, laws, regulations, and, ultimately, strict and higher ethical standards to sustain harmony. Religion preserved the norms set and inspired voluntary obedience to these norms by members of the community. Ultimately, The City-State stage emerged with what the historians observe as the most 'civilized' level of religion expressed in ethical monotheism [10]. Society at this complex level needed moral guidance, peace, and order. Religion defined the highest security available, most visible in the Abrahamic religions of Judaism, Christianity, and Islam. The higher monotheism found in these religions was anchored and facilitated by the hierarchical structures of "authoritarian god-like absolute ruler at the top" [11].

Separation of Science and Religion: The Catalysts

Institutional Dogmatism

The consolidation of doctrinal monotheism in the Abrahamic religions and the appearance of elaborate ethical codes in other present-day world religions in the Middle Ages did not deliver its anticipated climax. Instead of flowering the growing quality of science and art to maturity, the period triggered endless disagreements, conflicts, and superiority struggles that ceaselessly pitted the established faith groups against each other. Institutional Churches emerged, constituting Christianization in the Western World and the spread and consolidation of Islam and Buddhism in the East and the Far East. Advanced literary thought, competing ethical doctrines, and uncompromising deism fomented cracks that began to tear society into independent conclaves.

The conflicts that characterized the Middle Ages hardened respective faith groups in their resolve, often guarded against interference by the 'heathen' others. Religion evolved into a coded package of givens administered by the faith groups. Faith institutions grew more towards the vertical dimension rather than unilaterally concentrating on the god figure. The horizontal dimension remained limited to the scope of specific faith interests and adherents. Literary instruments, philosophy, and theology were employed to defend the group's identity and advance dogmatism, absolutism, and apologetics against interference from perceived enemies. This difference was also variously rendered in the distinctions between the divine and the worldly, the religious and the secular, and the sacred and the profane. Henceforth, religion looked suspiciously at science as a heathen, secular, and profane body of knowledge not befitting in the pursuit of the divine plan of saving the world. Religion enjoyed superior opinion over society [5].

Enlightenment

The extremes of enlightenment served two purposes to be reckoned here:

i. Firstly, society rebelled against the religious dominance of knowledge and prescribed a radically different methodology of pursuit against society's problems. The search for alternatives began with splinter movements within the hitherto solid world religions;
ii. Secondly, enlightenment rejected religion and ushered in consistent secularism that championed social pursuits independent of religion. It rediscovered the independent value of fine art, social science, business and commerce, law, and linguistics [12]. Through the pursuit of these disciplines, science employed methods that sought precise and definite answers to the problems of the time.

Emergent modern philosophy of science advocated a new theory of knowledge and experimental methodology. Contrary to the religious theory of faith, intuition, innate ideas, or tradition, modern science advanced empirical evidence discovered in experiments. As natural science maintained its empirical, experimental bases, the philosophy of science pursued the defense of the new method through skepticism, empiricism, and rationalism. Hypotheses and theories had to stand the test of the rigor of natural science [13]. Capturing the common mindset of natural science philosophers against religion, Thomas Hobbes is quoted to remark, “people should accept revelation and its interpretations for the reason that they should accept the commands of their sovereign, in order to avoid war” [14, p. 146].

Postmodernism

The postmodern era ushered paradigms more akin to a break from both perceived and real ideological bondage of the past, even when it did not offer better alternatives. It did not only generate passionate distaste of religious dogma, nor did it just oppose the dominant brilliant methodology of natural science; it went further to antagonize history and its sources [15]. In the postmodern era, society rejected institutional dogmatism, consistency, and method. Never prescribes absolute versions of reality or truth. The era rejected universal religious truths or laws as it remained uncomfortable with scientific methods prescribing the same answers to all situations. It approached any of these hitherto trusted approaches with absolute skepticism. As society weakened regard for institutions and any tendency towards objective reality, it strengthened the perspective of the individual worldview, subjecting religion to individual freedom and taste. Postmodern religion downplayed dogmatism and freely varied the sources of its practices to suit the convenience of the time. It embraced levels of syncretism, shifting, and changing realities to advance its progress [16, P. 94].

The Fruits of the Separation

Gains in Natural Science

Natural science enjoyed a substantial period of independent pursuit of social progress facilitated by noble discoveries, especially concerning medical healthcare, technology, and biotechnology. Cures of complicated diseases were discovered. Important medicine like penicillin, quinine, and procaine was discovered, generated in exact experimental protocols, and administered in precise and measurable doses for factual healing. They were put into commercial use to cure hitherto chronic diseases like syphilis, gonorrhea, and malaria. The management of therapeutic operations like surgery uncovered the value of anesthesia. The use of psychiatry and psychoanalysis to manage strange psychosomatic nightmares such as hysteria and general psychopathology became unquestionable alternatives to vague religious mysticism [17]. Most excitingly, the science of eugenics pioneered molecular science's possible transfer of organs with the possibility of modifying, replacing or fabricating parts of human bodies for use in extraordinary situations of need.

Further exploration of molecular science in biotechnology exposed a wider range of scientific processes and procedures targeted particularly at innovative cultivation of food plants and domestication of 'improved' livestock through breeding programs and agrochemicals for weed and pest control. It employed enhanced artificial interventions and specialized natural hybridization for improved human subsistence and welfare [18]. The manufacturing of food from both agricultural and livestock products was not only a primary issue of subsistence; it provided a veritable springboard to agribusiness that introduced a very new face to world commerce and trade [19]. Later, stem cell engineering gave hopes for the treatment of terminal diseases such as cancers. Genetic manipulation gave hope to immunization and exposed the pharmaceutical industry to competitive innovation in medicine. Successful animal cloning provided further hope for reconstructing functional deoxyribonucleic acid (DNA) from some cells of the extinct species to clone and preserve select species of value feared to be disappearing in creation.

The area of technology articulated further gains. The inventions of fire-steam engines and the consequent manipulation of locomotives, flight engineering, and explorative water vessels in the navigation of deep waters opened space in the world not only for habitation and exploitation; it widened the horizons of peoples' understanding and use of nature to improve quality of human life. Electricity, running water technology, and rapid adaptation of human settlements in complex plans and designs of growing towns and cities did not only define the high quality of life of society, but it also accelerated the rapid transformation of backward rural settings into modernistic urban centers with modern security, and social amenities adapted to higher standards of living. These areas did not only provide excitement for the real gains of science for practical relevance at the time; they defined the path of innovation for inexhaustible future breakthroughs for real progress in science.

The Emergence of Social Science

Despite the sterling performance of natural sciences, some philosophers of religion remained skeptical. In the existentialist worldview of Karl Jaspers, for example, though human freedom enjoyed preference over and above religious dogmatism, he still wrote intuitively against the threats to this freedom posed by modern science. An attempt of balance, too, was visible in his thought. His holistic view of reality comprised coming to terms with philosophical transcendence in which he envisioned borders of reality beyond which science alone cannot go without a religious commitment of faith [20]. Other philosophers of religion remained critical of both science and religion while others made an effort to develop a balance. Thus, rejection of religion did not always mean enthusiastic acceptance of science; sometimes, it meant rejecting both. However, good debates often led to a reasonable balance.

Auguste Comte's positivist philosophy gradually shifted the formularies of empirical evidence towards the concerns of order in society to open a critical platform of reciprocal relevance of science to religion. A refined relationship between these two realms of reality not only defined the consequent input of experts but also marked out the trajectory of the future potential of science in the progress of society. Émile Durkheim structured social science around the perception that society is made up of institutions, beliefs, and modes of behavior it collectively institutes. Accordingly, institutions must aim to discover structural social facts. Durkheim envisaged social facts to "consist of manners of acting, thinking and feeling external to the individual" and a form of coercive power by which these facts exercise control over the individual to preserve the integrity of society [21]. The consequent image envisioning the role of social science is captured in Graphical Abstract.

From this background, Durkheim's push for sociology as a definitive academic discipline in the university targeted a two-fold role:

- "to analyze how societies could maintain their integrity and coherence" in new social institutions where shared religion and ethnic background no longer count;
- to establish the practical implications of scientific knowledge in society [22].

To this extent, he built his theory around the premise that sociology is the science of institutions, i.e., a social science. As such, it should organize empirical facts in relationships that can generate scientific laws and methods that avoid philosophical speculation. Ultimately, the mission of social science is social integration.

In order to pursue the interests of society effectively in this mindset, Durkheim was influenced by Auguste Comte's *Social Positivism*, "to extend and apply the scientific method found in natural sciences to social science." He employed epistemological realism and a hypothetico-deductive model of reasoning to review Comte's positivism premised on a firm belief in the reality of the nature of knowledge [23]. Consequently, knowledge was pursued as a reality that exists independently of our conceptual scheme, while the scientific inquiry of the unknown subject relied on hypotheses that stood the test of observable data [24, p. 174].

The new social science prescribed five approaches through which the progress of society can be advanced:

i. firstly, the route of social research worked with large statistical surveys, the analysis of which pointed at a direction of need or progress. In this regard, social research is pursued following a systematic plan facilitated by quantitative or qualitative methodologies. While the former utilized statistical analysis to create reliable claims of quantity, the latter employed direct observation, interrogation of participants, or analysis of text, to expose contextual subjective accuracy over quality [25];
ii. the second route undertakes the study of 'social facts,' proposition of social theory, and formulation of meta-theoretical ideas [26];
iii. the third avenue arises from the methodological dichotomy implied in investigating the influence of individual and external social occurrences on one's behavior and opinion;
iv. the fourth route advanced economic knowledge as a natural hard science;
v. the fifth approach concerned the correlation of knowledge and social values [27].

The above concerns were initially pursued from positivistic perspectives but soon overtaken by interpretivists who preferred symbolic interpretation to empirically falsifiable theories. Stephen Kalberg, for example, rejected the use of a scientific method for the study of the social realm. He insisted on a specific epistemology that captures and shapes proportionate social worldview immediately under investigation [28].

Religion as a Social Science

Research-oriented thoughts of social theorists at enlightenment influenced the German protestant theologians towards founding a special school for the history of religion. This school, *Religionsgeschichtliche Schule,* used criticism methodologies to investigate the origins of ancient texts to understand "the world behind the text" [29, p. 48]. Leaning more on Max Webbers' multicausal investigative approach espoused in methodological anti-positivism, the Göttingen theologians formulated theses that regarded Christianity as one religion among others, particularly challenging its claims to absolute truth. Through the historical–critical methodology, they demonstrated that indeed Christianity shares important characteristics with other religions [5]. The insights of their historical criticism exposed the varied influence of these religions on Christianity. It became clearer that the roots of Christianity spread wider than just the Old Testament. Though the study focused on written records as it developed the formal religion image, it highlighted religious beliefs long before written records. Where written records were lacking, prehistory was accessed through advanced archaeological records. In the advent of historical-critical methodology, other indirect parallel sources helped formulate hypotheses and support suppositions that facilitated research and continued debate among prospective experts [4].

The study of the history of religion opened religion to the methodological appreciation of its role in society. With Aguste Comte's positivistic assertions that considered the visible regularities in society as subject to empirical study, religion assumed a social scientific study pattern [30]. It competed for scientific research methods and, like all social science, adopted the principles of natural science for the study of society. As a science, therefore, religion engaged theory, developed hypotheses, and employed derived empirical generalizations in further refining theory [31]. It had to demonstrate a capacity to resolve the basic dilemmas that characterize research pursuits in formulating research questions, goals, actionable objectives, target unit of analysis, quantity and quality of target data, observation methods, and the time frame.

The Crusade for Human Rights

Though human rights can be traced to elaborate justice theories of the Middle Ages, the earliest formal narrative in this age springs out of the debate on Natural Law doctrine. The classical natural law tenets envisage an interplay between the human faculties of reason and free will to deduce the primary principle of human behavior that commands an imperative to "do good and avoid evil" [32]. The doctrine expounds that good and evil not only derive from the rational nature of a person but that both apply to all people at all times everywhere. The immediate moral implication is that "standards of morality are in some sense derived from, or entailed by, the nature of the world and the nature of human beings" [33]. In fact, the nature of human beings is what actually defines natural law. Thomas Aquinas expounded on this common view that "since human beings are by nature rational beings, it is morally appropriate that they should behave in a way that conforms to their rational nature" [34]. The ultimate general regard for the natural law doctrine was that the knowledge design of God, the powerful creator of the universe, safely guided His creation to its intended end [34].

However, with time unfolding events of history, it led to doubts on the ability of natural law in its religious version to guide the practical life of society objectively

[35]. In the spirit of enlightenment, with emerging nation-states, 'Reasons of State' were believed to override ordinary moral considerations [36]. The weakening of church authorities and the challenges of rationalism pushed political philosophers to argue for new bases of natural rights. Thomas Hobbes, for example, described a 'State of Nature' (war of all against all) in which the divine basis of natural right did not seem relevant [37, p. 36]. Ultimately, Stephen Buckle traces change to Hugo Grotius, a Dutch lawyer, who advanced a new argument based on an earlier perceived distinction between natural and eternal law [38]. As eternal law underlined the religious purpose, natural law espoused the right reason capable of functions that remain independent of the religious implications. This capacity conferred a moral authority to guide the individual to quality life decisions considered in law as 'moral' [38]. The legal philosophy of the time considered this law more binding than the struggle to know its source. Inevitably, positive law became the practical expression of human rights formalized in the Universal Declaration of Human Rights in 1948 [39].

As an international law, this popular version today relies more on the capacity of right reason than on any explicit religious, moral content. Although this shift profoundly changed the understanding of morality, "with the further implication of the moral significance of the separateness of persons" [38], experts remained more focused on founding an independent modern theory of human rights. From this foundation, the human rights narrative carried forward the condition of humankind in its multiple aspects: political, social, economic, and cultural. As it fostered coexistence and progress, so did it attract protection by popular consensus.

The Cost of the Separation

The Excesses of Science Without Ethics

The enlightenment and the postmodern ages posed unique challenges to human welfare, particularly in natural science. Two isolated case studies of high-stake research trials on complex medical situations stand out conspicuously: The "Tuskegee Study of Untreated Syphilis in the Negro Male," in the United States; and the case of vesicovaginal fistula featuring the famous physician James Marion Sims, "father of modern gynecology." Regarding the first case, the interest to pursue the cure of syphilis turned out to be the worst massacre of innocent participants in a research study driven by self-serving interests rather than by the people's dignity and welfare [40]. The second case was the complication of childbirth among the female victims [41]. James Marion Sims' first intervention is today remembered perhaps more for its cruelty against the dignity of women than as an achievement in medical health [42].

Perhaps the climax of the examples of the failure of science to uphold the dignity of man it set out to redeem is the massive failure of experimentations on eugenics in Nazi Germany. This experience did not only raise grave ethical issues on general misuse of the potential of science; rather, it exposed the instrumentality of science in the hands of bad ideology [43]. Apart from the structured social issues such as segregation, healthcare, class bias, and racism, the experience raises very grave ethical issues at the center of which is the dignity of persons in healthcare [43]. To modern bioethics experts, the experience did not only contravene the known principles of ethical practice in research or medical care: autonomy, justice, beneficence, and confidentiality; it exposed maximum void in the personal character of the doctors and researchers [44].

Beyond its social ramifications, the impact of unethical practice of science invaded the microbiological technologies in plant genetic engineering, cloning, and subsidiary farm technologies in biochemical products to target fertilizers and pest and weed control. The Monsanto chain of companies, a pioneer in commercializing biotechnology in agricultural and agrochemical products, faced problem after problem with business law, environment, and social responsibility. On cloning, the proliferation of DNA profiling and the use of stem cell nuclear transfer (SCNT) technology to harvest stem cells continues to raise grave ethical issues. In 'therapeutic cloning,' for example, these two are not only wasteful of living tissue, but they also generate complex processes that remain expensive to sustain [45]. Ethical questions became graver with 'organism cloning' technology targeting genetically identical organisms without fertilization or inter-gamete contact [46, p. 53].

'Religion' Without Method

Consolidation of religion into faith groups in the Medieval Ages concentrated on the psychologically transformative model that focused attention on the monolithic institutions and the spiritual-moral progress of the individual. Community convents, monasteries, seminaries, or catechetical classes in parishes became stronger. Meanwhile, the curriculum of the cathedral and monastic schools trained individuals in religion alongside the famous 'Seven Liberal Arts' [47]. The goal was largely the vertical progress of the individual or the community towards the divine [48].

Although the schools soon grew into Medieval Universities, the ordinary university curriculum consisting of the preparatory *trivium* advanced to the famous *Quadrivium* did not factor the study of religion in any significant content. Even the study of the prestigious Master of Arts degree pursued after a successful pass of these two stages could only deliver a student to philosophical classics in physics, metaphysics, and ethics but would carefully ignore religion as an academic discipline [49]. According to the experts, a good pass at the Master's level earned brighter students a prestigious place of further studies in three important disciplines: law, medicine, or theology. At this level, the study of theology was universally considered the most prestigious; students of ability would then pursue religion. Unfortunately, the studies in theology were strictly controlled by the bishops, and only a few Universities had faculties of theology [50]. Those accepted to the program had to bear with the rigors of scholasticism, which involved more of "conceptual analysis and the careful drawing of distinctions." It emphasized dialectic "reasoning to extend knowledge by inference and to resolve contradictions" more than it ever suggests a learning methodology for innovative pursuits in philosophy or theology. Thus, lack of methodological pursuits and attention and its relegation to near insignificance left religion more like a private spiritual endeavor than a competitive methodical academic discipline [51].

The resultant Medieval University education pattern, rooted in the ancient Greek and Roman systems, was conceptualized as the art of: "raising or educating a person" or "strengthening or bringing up men." Liberal art trained adults in all-around knowledge and skills to become leaders in any area of need [52]. Religion had no significant role and place in the public sphere for the entire system for a long time globally. It was confined to the private life of individuals and strictly guarded for a determined purpose [50].

From Relevant Institution Towards Stable Ethical Science

The study of the history of religion in the civilization of societies cannot ignore its steadfast focus to sustain stable moral institutions in society, private or public. The relevance of religion for contemporary society going forward will, likewise, depend on how society finds it necessary in its key institutions. On the other hand, the role of natural science in society is clearer and, in fact, dominates the progress of society. The grievous weakness in the pursuits of natural science emerges to be its unsteady regard for ethical integrity. Therefore, the phenomenology of religion as a social-cultural value compels its interests in the ethical thinking of science. In the final analysis, religion and science share both the source and destination of the progress of society. Two important factors expose ethical thinking as a concern of interest emerging from the foregoing discussion: the twin role of history in exposing ethical monotheism as the climax of the pursuits of religion for human civilization and religion as a veritable social science; and the acclamation of research as a common concern of religion and natural science.

The significance of history in the study of religion emerges in the archeologically backed involvement of religion in bringing harmony between the progress in the use of technology and in the growing complexity of society. When human society grew to the stage of City-State, religion contributed to facilitating ethical monotheism for the required peaceful coexistence. However, the link between history and prehistory is the institution and its cultural relevance to the progress of humanity across the ages. Furthermore, the pursuit of the history of religion opened its potential as a science.

The gains of natural science emerge strongly in varied research experimentations and discoveries. The absence of religion at higher academic training coincided with the many challenges encountered in natural science. Thus, the importance of religion as a cultural value in the education system targeted at decent respect for human dignity is not only the logical finding of this presentation; it is indeed the trend of higher learning which places research innovation and extension at its center. Institutions of higher learning today target measurable impact with the concern of scholarship being shifted more and more towards the service of the needs of society.

Recent development in the structuring of university education emphasizes a research-oriented model globally. A comparison of university education between Europe and Kenya [53], for example, highlights the common thrust in a threefold matrix, namely: quality teaching, research, and extensions, with emphasis on extension programs for community service. Therefore, it is possible to argue for the crucial role of religion in the progress of humanity today through its instrumentality as the agent of research science across the platforms of both natural and social science. This discussion identifies this role as the ethical component of religion by which culture advances the relevance of any science across generations. Though science is an instrument of progress in society, it requires stable attention to ethical issues better safeguarded by the institutional structures of religion handed down from history.

Conclusion

This discussion has profiled the different images of the relationship between religion and science in human history, its role in society's civilization, and peoples' regard for the two in different circumstances. In our times, the concerns of social science in the progress of society view religion as a cultural system is oriented towards a moral community relevant to both ordinary and extraordinary experiences of the here and hereafter. Most importantly, the discussion highlighted both the positive and negative scenarios of separating religion from science. Negatively, the separation highlights the potential of the two to inflict suffering on humanity. A positive scenario allows us a glimpse into the huge potential of science to uplift the quality of human life. Drawing from the synergistic relationship of the two, this discussion underlined the social-cultural signification of religion which not only exposes the unavoidable relevance of religion as a social science but also confirms its institutional potential to build a stable, ethical base for general pursuits of science. Just as religion delivered society to ethical monotheism and facilitated peace in governance to build prehistoric communities, its involvement can contribute to honorable ethical practice in research initiatives of building contemporary society; so, for knowledge in the failures of the past is a securer path to the gains of the future.

Core Messages

- Religion facilitated the formation of crucial social institutions in human civilization.
- Social institutions hold the key to social integrity, the subject of social science.
- The gains of natural science overshadowed religion at enlightenment and sacrificed the institution, opening room for abuse of science.
- The entrenchment of religion as an institution and social science is necessary for ethically stable pursuits of science.

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29 Thinking, Politics, and the Evolutionary Process of Societies

Mauro Scalercio

> "*All intelligent thoughts have already been thought; what is necessary is only to try to think them again*".
>
> J. W. Goethe

Summary

This chapter shows that presenting Vico's idea of history and combining it with recent studies on prehistorical humanity and the development of the symbolic mind may lead to a conception of history that is original and capable of dialogue with critical theories and natural sciences. In particular, Deacon's idea that the very use of words provokes the change within the human mind that makes the symbolic thought possible is very close to Vico's idea that the process of "education" of humanity through words changes the human body itself. Here Vico may be an important reference that allows for a fruitful dialogue between philosophy, social science, and natural sciences, as some of the more recent works on Vico acknowledge. The kernel of the evolutionary process of societies, according to this chapter, clearly emerges. It begins with a poetic act that, in modern terms, corresponds to the development of symbolic intelligence. From this moment on, human beings invent new symbols, new meanings, and of course, new technical artifacts that constantly change the natural, cultural, and political environment in a way that affects their very mind.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_29

Magritte: The Mystery of the Ordinary, 1926–1938. It is an oil painting on canvas by René Magritte. La Clairvoyance (Clairvoyance). Brussels, 1936. Adapted from https://www.moma.org/audio/playlist/180/2391.

Keywords

Co-evolution · History of humanity · Humanization · Modification of mind · Symbolic intelligence · Vico

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

The subject of this chapter is the history of humanity. It may seem a very ambitious subject, and of course, it is. Moreover, the very idea of a "history of humanity" has been radically questioned by a wide range of critical theories: postcolonial studies, gender studies, decolonial theory, and many more. Even worse, the title's expression "evolutionary process" shows dangerous traces of social Darwinism. The author is fully aware of the danger of the enterprise that he is about to present. Of course, this brief chapter is only a first sketch of such a project and presents a specific perspective. This essay shows that the ideas about history expressed by the Italian philosopher Giambattista Vico (1668–1744) in his masterpiece *The New Science* (1744) may be fruitfully connected to some of the more recent discoveries in the fields of evolutionary biology, anthropology, paleontology, and archaeology. I will argue that the traditional idea that Vico is the father of modern historical science still holds true. It constitutes a philosophical framework to interpret the evidence produced by science in the last century. This essay describes an idea of history as compatible with critical theory's criticism of unilinearity, universality, and necessity of modern philosophy of history. In other words, such an evolutionary idea of history is not only not against postcolonial and feminist critiques but may constitute another important source of critical theories. Finally, the author will discuss that presenting Vico's idea of history and combining it with recent studies on prehistorical humanity and the development of the symbolic mind may lead to a conception of history that is original and capable of dialogue with critical theories and natural sciences.

Beginnings and Process

Vico is widely regarded, rightly, as one of the fathers of modern social science and modern history study [1, p. 296]. Moreover, he is often referred to as the theorist of a circular history, as opposed to the idea of linear history. This view fails to capture the complexity of his *New Science.*

Before illustrating Vico's argument, a brief warning is needed. Vico's thinking is very complicated both linguistically and conceptually. He intends to re-read the biblical chronology, anthropological evidence from archaeology, ethnology, history, and the deductive method. Therefore, any interpretation of his *New Science* implies a partial and simplified reading, and the one presented here is no exception.

To reconcile the biblical account with his ideas, Vico begins from the Flood and theorizes that after the Flood, almost-human beings were wandering around the globe, living like animals, without any kind of society. Humanity is born from this almost-human life form that Vico calls *bestioni* (beasts) [2, par. 374]. What is relevant here is how the "human world" begins. This is relevant because it allows for a dialogue with anthropology and paleontology, which aim to show when and how something called *Homo sapiens* appears.

"The first founders of gentle humanity," Vico said, "when at last the sky fearfully rolled with thunder and flashed with lightening (…) [they] were frightened and astonished (…) they pictured the sky to themselves as a great animated body, which in that aspect they called Jove, the first God" [2, par. 377]. This passage is crucial to understanding the beginning of humanity's evolutionary process. What is the difference between the "beast" and the "first human beings"? The answer is not entirely obvious. On the one hand, there is no big difference: both are more animal than human, far removed from any culture we may acknowledge as human. On the other hand, this being, partly beast partly human, enters what Vico sees as true human history. The difference is not physical but rather a matter of the *mind*, its use, and configuration. This is very close to paleontology and anthropology ideas in that it was not a mere physical change that led to humanity but a sort of reorganization of mental functions [3, pp. 321–322], [4, p. 14]. Here Vico introduces a crucial concept: the "modification of the mind" [2, par. 374]. As is common in Vico's philosophy, the concept of "modification of the human mind" is polysemic. It deals with the modification of the individual mind as well as the modification of the common sense of each social group. In fact, as the author will show later, the two are strictly interrelated.

For some reason, Providence, according to Vico, part of that beast had a sort of poetic vision that connects the thunder and the bolt not to a simple, natural, atmospheric condition but something else. Therefore, the thunder and bolt became *symbols*. The symbolic relation here is not derived from the representative relation thunder = God, but from the transfer to the sky of the qualification of God. The thunder allows human beings to develop an implicit inferential capacity, borrowing Deacon words [3, p. 78]. In other words, thunder is not God, but *the word* of God: "The first men, who spoke by signs, naturally believed that lightning bolts and thunder claps were signs made to them by Jove […]. They believed that Jove commanded by signs, that such signs were real words, and that nature was the language of Jove" [2, par. 379]. This introduces another critical element in Vico's philosophy: language. It is crucial because, in Vico's philosophy, both the modification of mind and the modification of social form are unthinkable without it. It is why some associate Vico with the first modern "linguistic turn" [5, p. 173].

Vico's theory of language moves away from the traditional representative conception. Reality is not simply "out there," but it must be linguistically elaborated. This does not mean that Vico embraces a skeptic conception of reality or a precursor of "postmodernism." On the contrary, Vico's epistemological principle *verum ipsum factum*, which implies the possibility of knowing only what is made, means that it is possible to understand reality only insofar as the rules and constraints of the action of the maker are known [6]. Accordingly, knowledge is only possible by answering some crucial questions: How does language work? With which constraint does it develop? Which function does it permit? What rules and constraints shape its use? The invention of symbolic language is a creative act, but this does not imply the creator's total freedom. When the giant interprets the thunder as a sign of something else, he must, because of the constraint of the form of his own mind, imagine it as a *body* [2, par. 377]. Abstraction is not possible at this moment. The whole history of humanity displays a productive tension between constraints and creation. The paradoxical nature of Vico's philosophy lies here in its attempt to show that evolution is only possible with the tools that the concrete situation offers.

Therefore, language is both the creation of humanity and the creator of language, a sort of self-creation. This self-creation logic is possible because of the peculiar position of language: "A man is properly only mind, body and speech, and speech stands as it were midway between mind and body" [2, par. 1045]. Language is partly body, partly mind; as we saw earlier, the first words have their own materiality, but since the invention of the first symbolic reference, it is also mind. In this sense, we can say that the evolution of the body is conditioned by the mind. Vico means that in a very literal way. The first men were giants, beasts who perceived the world by pure sense, whose main characteristic was their huge bodies. When the process of humanization begins, men and women start to become smaller and smaller [2, par. 369–372]. Of course, if we take this account literally, it is simply not viable. However, it is necessary to grasp the core of Vico's idea that the evolution of the human mind influences the body's evolution. This view is close to Deacon's idea that the first use of symbolic reference changes evolution [3, pp. 321–322]. According to Deacon, the very use of words provokes the change within the human mind that makes symbolic thought possible. This view is very close to Vico's idea that the process of "education" of humanity through words changes the human body itself since, as illustrated earlier, the word is between body and mind. Here Vico may be an important reference that allows for a fruitful dialogue between philosophy, social science, and natural sciences, as some of the more recent works on Vico acknowledge [7, p. 97].

The relevance of Vico's ideas is to focus not on the study of "human nature" but the process of humanization. This is a crucial point, both from a philosophical standpoint and from a scientific perspective. The idea that it is possible to determine exactly what "being human" means has been one of the founding ideas of modern western thought. The philosophies of Descartes, Hobbes, and Locke, the founders of modernity, presuppose the invariability and uniformity, the unhistoricity of the human mind. Herein lie the roots of the philosophy of history that justifies imperialism and colonialism [8, pp. 11–41]. As the author will show later, modern philosophy of history is the object of the sharpest critic from postcolonial studies.

From the perspective of science, since Darwin's theory of evolution is a key point, nature, or at least life, has a history. From an evolutionary point of view, nature is not a dogmatic set of rules but the source of different possibilities.

Family: The Co-evolution of Mind and Society

Since the invention of symbolic intelligence or, to use Vichian terminology, "poetic logic" [2, par. 114], humanity is embedded in a web of signifiers that they themselves produce but over which they do not have total control. In other words, humanity creates new constraints in addition to the purely natural ones. In this sense, language is both a constraint and what exponentially expands the limits of human potential. But what are we speaking about when we speak of *human*? How can the individual vision of the first giants who created divinity humanity be found? How can individual modification lead to the creation of societies?

The process of humanization, indeed, does not cease with the first symbolic thought. Humanization is not an individual process; rather, there is a strong relation between humanization and socialization. Deacon is fully aware of this relation: intelligence depends on social behavior [3, pp. 409–410]. Similarly, in Vico's theory, humanization is a process that depends on the social changes introduced by humanity itself. To investigate humanization and socialization processes, it is helpful to study these mechanisms by bringing Vico's and Deacon's perspectives together.

Following Deacon's text, it is possible to speculate that crossing the symbolic threshold may give an evolutionary advantage to human beings. The author argues that the reciprocal influence between the social factor and individual-bodily factor is crucial in both Deacon's and Vico's accounts of the process of socialization. To demonstrate the point, we will focus on Vico's and Deacon's analysis of marriage. The core of Deacon's argument is that marriage, an outcome of symbolical thought, may survive in the long term because it led to the organization of a more efficient social order, in terms of a more efficient division of roles between man and woman. In a nutshell, his idea about the relationship between sociality and symbolic intelligence is that the need for cooperation for a better organization of the hunt requires a separation of roles between men and women. In order to guarantee both the equity of nutrition and of the transmission of genes, regulation of the reproductive process is required. In this sense, the most important hurdle to cooperation is the uncertainty of paternity. To overcome this problem, it is necessary to pass from simple copulation to marriage [3, pp. 384–389]. The most important idea is that this problem can be solved only symbolically [3, p. 397].

Stressing the importance of marriage is, of course, not new to anthropology. Many authors note that marriage is an almost universal ritual in human cultures. Noteworthy, however, is that both Vico and Deacon attach crucial importance to marriage in the passage to a symbolic culture or, in Vico's terms, to a poetic logic. In this sense, marriage is, according to Deacon, the regulation of sexual reproductive relations by symbolic means. The core of this argument is already found in *New Science:* "They first defined Chaos as confusion of human seeds in the period of the abominable sharing of women (…). [The poetic Chaos] was confused because there was no order of humanity in it, and obscure because it lacked the civil light (…) in this infamous community did not have the proper form of men, and were swallowed up by the void because through the uncertainty of offspring they left nothing of themselves" [2, par. 688]. It is pretty apparent to note the similarity between Deacon's idea of "paternity uncertainty" [3, p. 382] and Vichian's idea of "uncertainty of offspring." Therefore, the social problem to be solved is ensuring genetic transmission or, more broadly, the stability of identity through time. Symbolic culture could provide a solution to a reproductive problem that may be solved only symbolically: "the imperative of representing a social contract" [3, p. 401].

The importance of "marriage" in Vico's thought has not gone unobserved. Peter Winch, for example, from a point only partially diverging from the one here presented, maintains that in Vico, the possibility to understand human history rests upon three elements: life, death, and sexual relations [9, p. 322]. We argue that following Vico and Deacon, what matters are not sexual relations, but their ritual and symbolic elaboration. The point that we are proposing may seem merely analogical. Actually, it is an analogy; nevertheless, it is an analogy that sheds light on a key point shared by Deacon and Vico: an important obstacle to cooperation, specifically the uncertainty about paternity, may be overcome by a symbolic invention.

The key point is that Vico sees clearly that the process of "becoming social" is a complex intertwining of the natural and cultural elements and that symbolic imagination leads to overcoming natural constraints. This complex relationship between natural constraints and symbolic capacity is the very core of Vico's philosophy.

Even more important is the general principle Vico states that poetical logic, or symbolic thought, paves the way for sociality. Vico's study of history is founded on the "modification of the human mind," i.e., modifying social forms and studying the relationships between them. In other words, the evolutionary process of societies is nothing but the history of the intertwining of the human mind's modifications on one side and the social form on the other side. As Viana observed, the mind is made in history; it is not static [7, p. 7].

At this point, it is fundamental to speak about one of the cornerstones of Vico's thought: religion. This is a very complicated issue because here, we find in its purest form a very common feature in Vico's text: to affirm something strongly, let the argumentation go in quite a different direction. His relentless affirmation of Catholic orthodoxy is contrary to his argumentation, to the point that the Inquisition considered taking to trial the *New Science* [10]. It is difficult to establish firmly whether Vico's (apparent?) contradictions are derived from a confused philosophical system, from metaphorical reasoning, or from a deliberate attempt to hide his more dangerous ideas. Given the impossibility of dealing with such a complex subject, here we will focus only on a precise level of interpretation of religion, i.e., the functional one. As mentioned earlier, the idea of a superior being was the first symbolic thought of humanity, and as such, according to Vico, the first principle of humanity [2, 333–334]. The idea of a superior being is strictly related to ritual. The presence of the superior being is what guarantees the legitimacy of ritual through priests' presence able to interpret its will. In this sense, the legitimacy of priests is also the legitimacy of interpretation, guaranteed by God. The idea that ritual and religion are the basis of civilization is quite a recent discovery. Until the last part of the twentieth century, the idea was that temples and complex rituals were developed successively to the sedentarization of humanity to organize the huge population. Particularly important in order to change this idea was the discovery of the Göbekli Tepe archaeological site in Turkey. The Turkish site is the "oldest man-made place of worship yet discovered" [11]. What matters here is that it is a place of worship without a city. It appears that the creators of Gobekli Tepe were hunter-gatherers who periodically made a pilgrimage to this site. Two points are relevant here: i, first that a very complex structure can be built by many small groups of hunter-gatherers who come together for ritual reasons; and ii, second that religion with complex rituals developed before cities. Klaus Schmidt, the archaeologist who discovered the site and wrote extensively about it, put it very clearly in his book *Sie bauten die ersten Tempel* where he maintains that the temple's construction preceded the foundation of cities [12].

The importance of symbolic thought and its cultural expression, religion, is the cornerstone of Jacques Cauvin. The French archaeologist maintains that the diffusion of the Neolithic is a long-duration phenomenon of several millennia, "whose amazing diversity only appears coherent by reference to the 'symbolic system' which governs it. (…) It seems that 'religion' far from being purely irrational first developed a sort of 'transcendental logic' at a non-utilitarian level, a logic that was then applied to the real world, imprinting on it new significance in a novel and different system of relations" [13, pp. 208–209]. This "transcendental logic" is very close to Vico's "poetic logic," sharing the function to give meaning to the physical world and "the ability to regulate certain aspects of human behaviour" [13, p. 209]. According to Vico and coherent with Cauvin's ideas, religion is not simply the metaphysical belief of a population, but the articulation of the newly discovered symbolic intelligence of "first humanity" with social behaviors. This idea is clearly Vichian. His idea is that "the modification of the human mind" is the basis of social change that, in turn, pushes the mind to adapt to new situations, something very similar to the concept of co-evolution proposed by Terrence Deacon. Religion is the consequence of the symbolic modification of the human mind, but also what allows for a new development of the human mind.

A key element of Vico's philosophy is still missing: power. Vico's emphasis on language does not mean that it is a means to neutralize conflict. On the contrary, language is both an instrument of conflict and the real issue at stake. Language (or symbols), power, and interpretation constitute the triad of Vico's political philosophy; that is, essentially a philosophy of conflicts, more than its neutralization, as in natural rights philosophy such as Hobbes' or Locke's. In this sense, Vico is clearly part of an Italian tradition derived from Machiavelli [14].

Power is strictly related, according to Vico, to thought and symbols. Symbols do not speak for themselves. They imply an act of interpretation. However, every interpretation requires an interpreter: power is, first and foremost, an act of creative interpretation. Attributing a new sense to something is, per se, an act of power, but this is not the only relevant fact. In Vico's narration, as already emerged, the shock that provoked the beginning of poetical logic is the fear of the thunder the first giant felt. This is not a natural fear but a symbolic fear since they feared the *thunder* as the sign of a superior entity. As the interpreters of the first sign, the giants became the first interpreters of the words of God and its messengers, the ones able to enforce God's word. This is, in a nutshell, Vico's argument about the beginning of religion, the first and foremost principle of the development of nations. The second principle is marriage. It is strictly intertwined with power. The giants that felt the fear of God found their refuge inside caverns, bringing women with them by force [2, par. 1098]. This brutal union had to be ritually sanctioned in order to certify the possession of women. This means that the mutual ritual recognition between the first men led to a society.

Therefore, power is the symbolically and ritually sanctioned use of force. In fact, it is the first symbolic invention, i.e., religion, that constituted the foundation of both society, "nation" in Vico's vocabulary, and power. Therefore, the symbolic invention that shaped the evolution of humanity hides an act of power founded on the supposed words of God that the first men believed to be able to interpret and enforce.

In a nutshell, this is how civilization was born. Here the history of humanity begins. As already noted, Vico does not theorize an "out of the state of nature" by a juridical act such as a social contract to create legitimate authority, but a ritual, poetic creation. Vico rejects this theory, the theory of Hobbes, Locke, and Rousseau, because it presupposes rationality that is simply impossible within the first human groups. Deacon himself also realizes that his theory is different from the "standard" social contract theory. He maintains that it is a theory "of translation of social behaviors in symbolic form" [3, p. 394].

Actually, Vico and natural rights theorists are speaking, so to say, different languages. While within the traditional doctrine of social contracts, the state of nature is just a theoretical device that allows for an analysis of the origins of society. Vico is really trying to discover the beginning of society. Strictly speaking, Vico's thought is not philosophy: he is really trying to found a *New Science* that is partly philosophical-theoretical and partly anthropological-empirical [2, par. 140] (Fig. 29.1). Obviously, many, if not most, of Vico's empirical claims are proved untenable. But its falsifiability is precisely that what allows for a dialogue with natural sciences, a goal also exposed by Amadeu Viana [7].

Fig. 29.1 Frontispiece of *New Science*. "The darkness in the background of the picture is the material of this science, uncertain, unformed, obscure, which is outlined in the Chronological Table and Notes upon it. The ray with which divine Providence lights up the breast of metaphysic represents the Axioms, Definitions, and Postulates that this science takes as elements from which to deduce the Principles on which it is based and the and the method by which it proceeds" [2, par. 41]

Society: The Co-evolution of Mind and Society

The very first nucleus of civilization is strictly familiar, according to Vico. The family founded on religion explicitly excludes other human beings, those that do not fear God, that, according to Vico, remain nomads. Early humanity is hence divided into two groups. This division is the kernel of the entire history of humanity and permits the development of societies where the core of obedience is not the ritual sanction of paternity but the ritual sanction of submission. When nomads come across families, they, stronger and more organized, enslave them. From this moment on, politics become the study of the division between families or heroes on one side and *famuli* or servants on the other [2, par. 264]. Here lies the beginning of the political conflict in Vico's philosophy [15].

The violent encounter between families and nomads, who now became slaves, arouses a repetition of the process leading to symbolic intelligence. With a crucial difference: while the first time, the symbolic intelligence arises from the fear of God felt by the giants, the second time it arises from the fear of heroes from *famuli*. This recurrence shows some crucial differences with the first invention of God. The dyad God-giant implies a sort of "voluntary submission" to an imagined entity, whose will the submitted may interpret. The dyad heroes-famuli is real and ritually sanctioned. *Famuli*'s servitude is voluntary at the beginning but might be questioned, and actually is, since *famuli* realized that the two parts are equal by nature [2, par. 29].

Therefore, the symbolic/poetic logic of humanity's beginnings became the mythological struggle to control the interpretation of meaning. Here again, the co-evolution of society and mind appears. *Famuli*, the engine of history according to Vico, are forced to become integrated into the symbolic thinking of giants. However, this new constraint is what shapes famuli's minds that, in turn, empower them with the possibility of a new, more equal interpretation of myth. Only this interpretation of myth allows us to imagine civil and political equality. The co-evolution between mind and society continues until democracy, i.e., the abstract idea of equality of human beings is reached, letting abstract thinking develop.

At this point, it is hard to escape the feeling that Vico's theory of history is simply one of the many modern philosophies of progress. There is some truth in this idea because Vico shows a clear preference for what he calls the "age of men," the epoch of reason [2, parr. 31, 326]. In this sense, he is frankly an Enlightened philosopher. However, this is only just a facet of his philosophy. Indeed, Vico has been interpreted as an early critic of modern rationalism, even nostalgia of theocracy [16], because of his passionate reconstruction of early humanity's creativity [17]. Is it possible to reconcile these two interpretations, both having good textual evidence? Even if a definitive verdict is not possible and maybe not even desirable, we argue that Vico's thought shows some important clues to solving the puzzle:

i. First, even if the dichotomy of reason and imagination is not completely symmetric, since Vico's preference is for a reason, the mere reason is not sufficient to face the question of justice. Incidentally, we note that the polemical objective of Vico is here, again, the modern theory of natural law and the doctrine of a social contract. Imagination, piety, and empathy are all key elements to *imagining* a just society, and a society founded on instrumental reasoning is very close to becoming a *barbarian* civilization [2, par. 1106]. Therefore, a philosophy of linear progress seems to be absent in *New Science*;
ii. The second element is, of course, Vico's theory of cyclical history. Each nation develops its institution following a triadic scheme, from the early societies founded on religion to rational nations founded on equity, passing through an intermediate phase of aristocratic societies founded on some kind of "natural superiority" of the ruling class. Reaching the third phase, every civilization may degenerate and regress to the first "barbarian" phase, starting a new cycle; and

iii. The third element is much less present in Vico's studies: the interchangeability of monarchy and republic in the last phase of human history. Riccardo Caporali has shed light on this element. Within the last phase of history's development, there is tension between the monarchy and the republic. The monarchy, or the sovereign state, preserves lives and security, while the republic, which is the people's direct government, is inherently more vital [18, p. 285]. This is a very important point. Vico maintains that the modern natural law solution to the problem of politics, i.e., the sovereign state, is not the *only* possible solution, and politics may be thought outside that framework. In other words, Vico says that there is a sort of equivalence of a republican form where "everything had to be reduced to lot or balance" [2, par. 1101] and monarchical where there is a sovereign power. This equivalence allows a crucial "creativity" and liberty that let undetermined and indeterminable the *akmé* of civilization.

Unfortunately, it is impossible to examine Vico's theory of history in-depth here. The process that brings humanity from the first familiar community to a complex society is much more complex than it appears here. However, the kernel of the evolutionary process of societies clearly emerges. It begins with a poetic act that, in modern terms, corresponds to the development of symbolic intelligence. From this moment on, human beings invent new symbols, new meanings, and of course, new technical artifacts that constantly change the natural, cultural, and political environment in a way that affects their very mind. In this sense, the material and immaterial conditions of human beings are always antecedent to the mind and have to adapt to the situation they create. Like Darwinian evolution, this process is not deterministic nor linear. Without a doubt, it is that need for adaptation that enhances the possibility of different social, cultural, and political forms.

Humanity and Temporality

The brief exploration of Vico's theories about "primitive thought" in relation to humanization and socialization processes clearly shows that the temporal and historical dimensions are fundamental in his philosophy. The key to his theory of history is the relationship between anthropology and temporality [19].

As discussed in the previous paragraphs, Vico's anthropology can be suggested to be based on two pillars. The first is what Vico calls "the modification of the human mind," the clear evolutionist pattern that goes from the first symbolic thinking to abstract rationality. The second are the concrete social rituals, norms, and laws that are derived from and re-create the human mind. Vichian temporality, then, may be seen as the co-evolution of these two elements, a co-evolution that is also caused by the political action of *famuli*.

From a philosophical point of view, there is a crucial point to clarify. Is this evolutionary process common to all of humanity? Are there laws that rule the development of humanity? Are these laws valid for all times and places? These questions are crucial because they determine, to a large extent, if and eventually how Vico participates in the modern philosophy of history.

First of all, it is obvious that Vico is interested in defining something common to all of humanity. After all, the complete title of this masterpiece is *Principles of the New Science Concerning the Common Nature of Nations*. But the other of Vico's key interests is to explain the empirical variety of concrete social forms [2, par. 7].

Vico maintains that the fundamental structures of humanity's history are common to all people that elaborate those elements independently from each other. This anti-diffusionism has a specific purpose in *New Science*, that is, to avoid the idea that some nation has a privileged position within the history of humanity. It also implies that a strong tendency within nations exists to share the basic temporal structure.

How can the common transition pattern between the universal evolutionary structure, which Vico calls "ideal eternal history," and particular histories be explained? We argue that some kind of evolutionary mechanism can explain what Vico had in mind. Noteworthy is that this idea is different from the idea that human history may be explained in terms of an unchanging human nature that gives rise to a universal, deterministic, teleological history. Even if Vico does think that the human mind shares a common structure, this is not the element that produces universal evolutionary temporality. We argued, reading Vico in the light of Deacon, that religion and marriage fit this idea perfectly. These anthropological elements are developed due to the co-evolution of the modifications of the human mind and its own products.

In this sense, the anthropological elements proposed by Vico are equivalent to universal linguistic elements as interpreted by Deacon: "They have emerged spontaneously and independently in each evolving language, in response to universal biases in the selection processes affecting language transmission. (…) these structural commonalities present in all languages have each arisen in response to the constraints imposed by a common adaptive context" [3, p. 114]. The analogy between the essential elements of language in Deacon's work and the essential elements of culture in Vico's draws on Vico's very thought. In the XXII Axiom of the *New Science,* Vico maintains that "There must in the nature of human things be a mental language common to all nations, which uniformly grasps the substance of things feasible in human social life, and expresses it with as many diverse modifications as these same things may have diverse aspects" [2, par. 161]. These quotes are dense in the typically Vichian fashion. The core idea is that a common ground exists in every nation that derives from the interior logic of each nation. The author suggests that the inner logic that underpins the beginning and development of religion and marriage evolves, borrowing the word of Deacon once again to adapt to the human nervous system and its pragmatic limitations in language use [3, p. 119].

The logic that underpins the beginnings of sociality through the emergence of religion and marriage as the guiding principle can be extended to the other principle and maybe to other elements of societies. If the logic is universal, the empirical manifestation of the logic is totally particular and unpredictable. In this sense, the similarities between the rituals or social norms in different nations are not due to genetic kinship but rather to the similarity of the mental and natural constraints that every human group has to face. In other words, different structures of different societies are similar, like bats and birds, not like *Homo Sapiens* and *Pan Troglodytes*.

The use of the idea of "evolution" in social sciences and political philosophy is old but not gold. The idea of evolution, and broadly the biological and naturalistic language, has often been used in strict connection to finalism and determinism and to treat every attempt to change the constitutional order as illness. Moreover, social Darwinism misused Darwin categories in a way that made very costly, scientifically and politically, the use of evolutionist language and concepts in social sciences and political philosophy. We maintain that, on the contrary, productive dialogue with this discipline is possible because it may contribute to the conceptualization of non-determinist, finalist, contingent temporality. This kind of temporality has many implications for how to conceive of humanity and its history. One of the key elements is that we must be extremely cautious when we speak of "human beings." Every human form and *a fortiori* every society must be understood in their own terms. Both human beings and societies are endlessly evolving, responding to natural and cultural constraints.

The temporality that we propose to understand and develop Vico's philosophy also has implications for the conception of nature and culture. The history of humanity is also the story of our relationship with nature. A very strong tradition among Vico's scholars maintains that his philosophy is "without nature" [19]. But if we imply that the mind, body, and symbolic forms are profoundly intertwined, we should note that the opposition between culture and nature becomes weaker.

On the other hand, the symbolic intelligence that is at the basis of the humanization process is also at the basis of the fracture between humanity and the environment. In Vico's philosophy, an important part of mythology is interpreted as the symbolization of power over nature [2], par. 3].

From a modern-centric view, the fracture between nature and humanity has to do with modern times. But, as Ian Tattersall maintains, the reality is far more complex than this. The key rupture between human beings and nature comes from agriculture. We often forget how "pre-history" was full of inventions that really changed the relationship between humanity and nature. This included agriculture, obviously, but also complex hunting tactics and fire, which led to huge environmental changes [4]

If what has been maintained in this chapter makes sense, another consequence is that the history of humanity has a paradoxical unity. If symbolic intelligence is what makes us human, then the difference between history and pre-history vanishes. Every symbolic and social action is a genuine part of the construction of humanity, regardless of the difference in space and time. This is not to say that time is indifferent and makes human beings equal. On the contrary, what is really human is what makes every one of us different from each other.

Conclusion

This chapter is thought of as a contribution to the history of humanity. The argumentation that the author proposed may lead to some discontent because each part should be further developed. However, the aim of this chapter was not to fully develop a theory but rather to show the possibility of using Vico for a rethinking of the history of humanity, which could contribute to a new assessment of some important points.

The first one is that crossing the symbolic threshold gives humanity the faculty to make sense of things, not only to comprehend but also to imagine. However, reason and imagination are not opposite in his thought but complementary, both contributing to making the world a comfortable and fair place for humanity.

The second point is the constitutive ambivalence of the human mind. We have to remember that our most potentially dangerous asset is not fire, agriculture, GMOs, electricity, or nuclear energy, but our brains and our symbolic intelligence. That is to say that humanity has an intrinsic, hugely destructive power. But this is only part of the story because humanity also has great creative power. It is necessary to preserve and encourage societies' invention of the power of destruction humanity has while promoting equality, knowledge, and freedom.

The third point is strictly connected to the previous one. In fact, the meaning of cyclical (not circular) lies in the ambivalence and the human ability to make sense of things. Even if, as Vico says, the reasoning is considered the main human faculty, making sense is not entirely a matter of reason, essentially because in the human phase, the *pietas*, i.e., the faculty of imagination that permits imagining a just society, is still necessary.

Herein lies the core of Vico's contribution to political philosophy. We have stressed the difference between Vico's ideas of the "natural state" and those of the modern natural right theorists, such as Grotius, Pufendorf, and Hobbes. Vico's theory implies a different idea of politics and humanity. While the right natural doctrines maintain that humanity-built societies with an act of reason, Vico maintains that reason is the result of the complex process of humanization, and rational politics is just the result of historical conditions.

The emphasis that Vico placed on the process, rather than a set of immutable characteristics of human beings, may explain one of the many enigmas of Vico's philosophy, i.e., why he analyzes so carefully the mind of primitive and ancient people, and he devotes so little to the modern world.

If we look at the *long durée* of the modern world, modernization processes are just one chapter in the history of humanization, a history made of imagination and reason. Modern philosophy of history has recently been under attack from a wide range of critical theories. Modernity would be guilty of the essentialization of the human being and, consequently, of a linear philosophy of history that considers the history of Europe and Western civilization as the parameter against which to weigh every other civilization. Instrumental rationalism would be the main characteristic of Western modernity. However, while a modern philosopher, Vico does not fit within this narration and might be a key author for intercultural philosophy.

Modern science is also often part of this discomfort with modernity. Science has been seen solely as a positivist instrument, devoted to repeating the method of physics in the social sciences, and postulating a society ruled by deterministic laws. However, since Darwin, evolutionary biology developed precisely as opposition, within natural sciences, to the determinism and necessity of the model of physics. Of course, Darwin's thinking has nothing to do with social Darwinism, which he criticized while still alive. The mechanism of evolution, far from implying a deterministic and necessary temporality, has to do with adaptation and creativity.

Core Messages

- Language is both the creation of humanity and its tool.
- The relevance of Vico's ideas is to focus not on the study of "human nature" but the process of humanization.
- Humanization is not an individual process; there is a strong relation between humanization and socialization.
- Vico's philosophy deals with the modification of mind, the modification of social forms, and their relations.
- In Vico's thought, power is related to symbols; they do not speak for themselves, but they imply interpretation.

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Information Processing in Reasoning in the Environment of Forbidden Sentences

30

Wojciech Krysztofiak

> *"If liberty means anything at all, it means the right to tell people what they do not want to hear"*.
>
> George Orwell

Summary

The chapter presents a theory describing the logical mechanism of information processing in the environment of forbidden sentences. The research subject is the structures of discourse deduction that evolve over time, transforming due to formal shapes. The elements of these structures are sets of taboo functions, sets of penalization functions, and sets of logical consequence operators indexed by taboo functions. The constructed theory explains that some language users who have competence in classical logic do not accept inferences that they judge to be correct and whose assumptions are true sentences. This mental phenomenon occurs when the agent evaluates the reasoning with sentences forbidden by various language taboos. Formal concepts, which are defined based on the presented theory, make it possible to describe in a precise language of mathematical logic, among others, phenomena occurring in the processes of developing discourse, such as ideological wars and conflicts, freedom of deduction, and finally terrorization of discourse.

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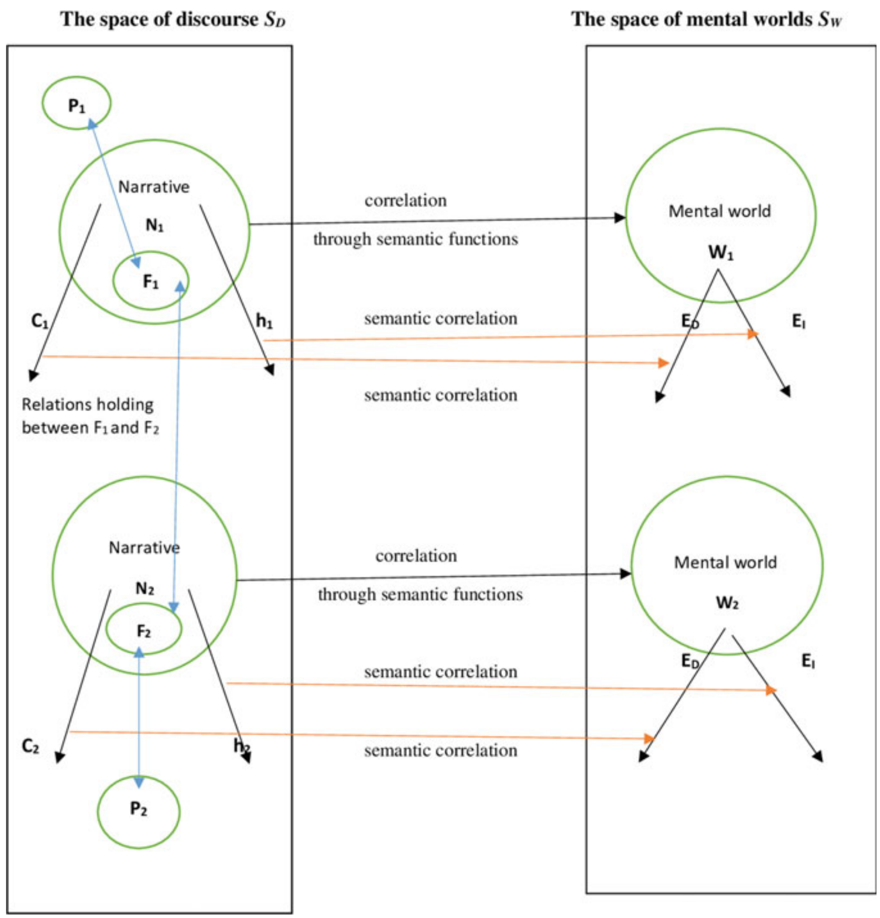
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_30



The space of discourse in relation to the space of mental worlds. Green circles in the left rectangle designate narratives N_1 and N_2 within the space of discourse S_D. Black arrows link them with green circles, representing mental worlds W_1 and W_2 prefabricated in the narratives N_1 and N_2 in the right rectangle. Arrows C_1 and C_2 refer to the processes of deductive processing narratives N_1 and N_2 by virtue of consequence operators C_1 and C_2 indexed with taboo functions. The semantic counterparts of the processes represented by arrows C_1 and C_2 are the expansion processes of mental worlds. This correspondence relation is marked with orange arrows connecting C_1 to E_D and C_2 to E_D. Arrows of the type E_D in the right rectangle designate the processes of deductive expansion of mental worlds. The arrows h_1 and h_2 in the left rectangle represent the processes of interpretive development of narratives N_1 and N_2, regulated by hermeneutic consequence operators. They are correlated by semantic relations represented by orange arrows, with arrows of the E_I type in the right rectangle. This type of arrow designates processes of interpretive expansion of mental worlds. Circles

F_1 and F_2 inside circles N_1 and N_2 represent sets of forbidden formulas from the points of view of elm experts who guard the proper development of their narratives. These circles can be understood as representing taboo functions. Blue arrows which connect circles F_1 and F_2 designate various relations holding between represented taboo functions. Circles P_1 and P_2 in the left rectangle represent penalty functions correlated with taboo functions F_1 and F_2.

Keywords

Blasphemy · Deductive structures · Discourse · Elm experts · Etatism · Liberalism · Penalty functions · Religious wars · Taboo · Taboo-indexed consequence operators · Terrorism

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

Each discourse is governed by an inferential mechanism enabling its deductive and hermeneutical processing. Participants in developing narratives within various discourse spaces form statements that are forbidden from different points of view. The sides of the ideological wars accuse each other of offending utterances and forbid the opposite party to articulate some statements classified by them as blasphemy, offense, or hate speech. Even logically valid inference acts are often stigmatized in the ideological exchange by the value of blasphemy or offense, making them unacceptable to the conflicted parties. History knows many examples of intellectuals who were given the death penalty for uttering forbidden sentences. Therefore, the following question arises: is there a logical narrative processing mechanism that triggers in mind the rejection of logically correct inferences judged to be forbidden?

The phenomenon of forbidding the use of certain words and forbidding language users to express certain meanings or refer to various fragments of reality is known as a linguistic taboo. It is the subject of research in linguistics, psychology, cultural anthropology, and even philosophy and logic. Freud had already pointed out that our minds are inhabited by mental censors. Their main function is to form mental barriers that make it difficult to "think forbidden thoughts" [1]. The phenomenon of a linguistic taboo appears at various levels of language functioning; for instance - in the derogatory speech [2], in illocutionary acts of expressing communicative roles and power [3], in slurring and swearing [4–9], and in the use of euphemisms and dysphemisms [10–13]. Linguists also explore grammatical ways of forming taboo words in different languages [14, 15]. The semantic and pragmatic mechanisms of taboo contamination are also an important area of research in linguistics [16]. In anthropology or sociology, for example, the following kinds of taboo reality are the subject of detailed study: sexual preferences [17, 18], homophobia [19], gender and sex [17, 18, 20], menstruation [17, 18, 21], death and diseases [22], aging [23], political correctness [24, 25], ideology [10, 11, 26]. There are many examples of research on linguistic taboos undertaken in various humanities. However, none of the research on taboos or offensive statements to date has attempted to describe and explain the mechanisms of deductive content processing in contexts with tabooed sentences.

Some language users who have mastered the competence of reasoning within the classical logic state that although some inferences presented to them are logically valid, they cannot accept conclusions even when the premises are true. Here is an example of such inference:

John Paul II was a pope. So John Paul II was a friend of pedophiles or a pope.

On the other hand, the same persons accept the logical validity and the conclusion of another inference:

Stalin was the leader of the Soviet Union. So Stalin was a murderer or the leader of the Soviet Union.

Both cases fall under the inference rule of disjunction addition which is logically valid in classical logic. The presented example shows the lability of inference rules during discursive actions, which means that some discourse participants accept the logical validity of inferences carried out under the valid rules of a given logic in some contexts. In other contexts, they do not accept the logical validity of inferences implemented according to the same rule, although they accept the premises for such unacceptable inferences. Why is it the case?

The simplest answer to the question above is that language speakers do not accept the first inference because it contains forbidden sentences from the point of view of their worldview, while they accept the second inference because of its logical validity and the absence of forbidden sentences. What is the deductive mechanism responsible for processing information in the environment of forbidden statements within discourses?

Spaces of Discourse

Each discourse may be comprehended in three dimensions: (i) language use; (ii) communicative; and (iii) interactive. From this point of view [27], each discourse is:

i. a sequence of speech acts organized in various ways (grammatically, semantically, and stylistically), characterized by a segmental order, expressing specific cognitive and affective content;
ii. addressed to the participants of the communicative situation, in a specific context including time, place, mental circumstances (knowledge, patterns, and frames of perceiving reality encoded in participants' memory), social position due to various indices determining it (social class, nationality, ideological identification, profession, gender, age, wealth status, etc.); and
iii. involved in the interaction (cooperation, provoking a reaction, and responding to an action).

Van Dijk and Kintsch [28] add that the agent's entanglement in discourse is strategic, which means that a goal or a plan drives his (her) actions, not necessarily consciously. These researchers pay attention to the fact that participants of a discourse perform information processing operations governed by various mechanisms, not only pragmatic but also deductive [28]. Each discourse is also entangled in certain macrostructures that define its theme, meaning, or guiding idea [28]. The entanglement of discourse in such macrostructures enables participants of discursive actions to understand and process its content.

Discourse should be distinguished from the narrative (text) comprehended as a finite sequence of language actions. Narratives (texts) possess the so-called thematic coherence. Many different texts can be constituents of the same discourse stretched over a very long time. For instance, when we talk about Christian discourse, we mean a discourse stretched over time: from the period when the Church Fathers wrote their first texts to the present day. Discourses are developed in various actions through the production of texts or oral statements on a given topic. They are thus processes that continue over time. Some of them are completed, but only because they have been forgotten.

The set of all narratives characterized by at least one common theme, remaining in relations of correspondence or opposition to each other, constitutes the space of discourse. A given narrative can therefore function in many different spaces of discourse. Narratives within a given discourse are linked through semantic functions with mental worlds, sometimes called worlds of texts, inhabited by objects, persons, states of affairs, situations, plots, stories, and other entities of various ontological categories. From this point of view, the agent's involvement in discourse is the practice of developing a particular mental world or, in other words, the world of the text within some space of discourse. The themes that language users attribute to narratives within a given discourse space are determined by the content and semantic structure of mental worlds. They are schematic conceptual structures remaining in the relation of dominance to other concepts used to synthesize a given world's content. Without going into detailed discussions on the mechanisms governing the processes of thematization of discourses, the theme of discourse can be treated as this property of mental worlds produced in narrative activity, which is the criterion for their content similarity.

The space of discourse can be defined as any set of narratives (theories) formulated in a particular language determined by the theme (domain) of the discourse, understood as the sets of formulas containing dogmas (assumptions, axioms, or hypotheses) and closed due to logical consequence operators and hermeneutical consequence operators. Each narrative corresponds to one operator of logical consequence, which is responsible for its deductive processing. Narratives may also be correlated with operators of hermeneutic consequences, which are responsible for their interpretative processing. Discourse spaces in which sets of hermeneutic consequence operators are empty can be called purely deductive discourse spaces. They usually function in the practice of creating formal sciences. In the humanities, researchers get entangled in deductive-hermeneutic spaces of discourse, i.e., those whose narratives are additionally processed based on hermeneutic consequence operators.

The space of discourse S_D at a specific stage of development t can be described as a structure of the form:

$$\langle L_D, Th_D, CN_D, H_D \rangle_t,$$

where L_D is the language of a given discourse understood as a syntactic-semantic structure generating a set of all its sentential formulas D. Th_D is a set of narratives (theories) formulated in L_D at the development stage t. The CN_D is the deductive structure of the space of a given discourse at stage t. H_D is the hermeneutic structure of the discourse at the stage t understood as a set of systems of hermeneutical inference rules. Therefore, discursive activity can be treated as any practice of producing sentential formulas and inferences within some narrative (theory) belonging to Th_D of a given space of discourse S_D, thanks to the deductive and hermeneutic processing mechanism determined by CN_D and H_D. This activity evokes, by virtue of the correlation determined by semantic functions, the processes of expansion of mental worlds.

Deductive Structures of Discourses

The deductive structure of discourse is a system of the form: $CN_D = \langle D, CN, T, PEN \rangle$, where D is a set of all sentential formulas of the language of discourse L_D, CN is a set of logical consequence operators indexed by taboo functions, T is the set of taboo functions, and PEN is the set of penalization functions correlated by virtue of one-to-one relationship with each taboo function belonging to T.

Taboo Functions and Elm Experts

Censorship institutions, indexes of forbidden books, informal rules of the so-called political correctness, paragraphs in penal codes prohibiting the formulation of statements that violate, for example, religious feelings, the good name of both natural and legal persons, or finally statements that offend the king, nation, or state authority are examples of institutions controlling the processes of producing various narratives within a given discourse space at a given stage of its development. Such institutions can be described using the category introduced by Putnam [29] and Fodor [30] as elm experts. According to Putnam's concept, there are experts in every language community who know the meanings of specific terms so that other speakers, thanks to the mechanism of the division of language labor, can use them efficiently without knowing the meanings of these terms [29]. Fodor [30] defined their roles in discourse as guarding the use of expressions (for example: 'elms,' 'beeches') in the language under conditions that establish criteria for the truthfulness of thoughts expressed with the help of such expressions. The concept of elm experts understood in this way can be extended. Elm experts can be given the additional role of imposing logical rules of inference and hermeneutic norms on a given discourse, along with establishing a specific linguistic taboo and rules for penalizing taboo-breaking practices.

Each narrative prefabricated within S_D is associated with its elm expert. Taboo functions can therefore be understood as representations of expert institutions functioning in the discourse space S_D at a given stage of its development. Hence, each narrative belonging to Th_D is correlated with exactly one taboo function.

The taboo functions, having exactly one argument, map the set of all discourse formulas D into specific subsets, which consist of forbidden sentences. They differ only in their values. For example, for an atheist participating in religious discourse, the saying: *God is a chimeric being* is not a formula forbidden by an atheistic expert, while for a theistic elm expert, the quoted sentence belongs to the taboo of the theological narrative of Catholicism. Kazimierz Łyszczyński was killed in 1689 by decapitation with the consent of the Polish King Jan III Sobieski for uttering sentences about the chimerical nature of God in the treatise *De non existentia dei* [31, 32]. In the initial phase of shaping the Christian discourse, various theological narratives were stigmatized by some producers of this discourse with the marker of heresy. The prime example is Arius's conception. According to it, Christ is not God the Father. In the fourth century, Nicene elm experts condemned Arianism that challenged the Trinity dogma, thus establishing a taboo function for the Nicene narrative. Under this function, several hundred years later, Arians were condemned to be burned at stake for publicly formulating the statement: *Christ is not God the Father* (on disputes with Arianism within the early Christian discourse, see [33]). Establishing forbidden sentences is also present in the Islamic discourse. Ahmad Al-Shamri and the poet Ashraf Fayadh were sentenced to death for preaching atheism in Saudi Arabia in 2015.

Taboo functions are established not only in the spaces of worldview or social discourses. The theses of Copernicus' astronomical theory were also prohibited from expressing them for several years. Even today, the prohibition of dividing by zero is widely used in the didactic practice of teaching arithmetic. The phenomenon of forbidding the use of formulas that are correctly syntactically structured, but not having the so-called mathematical sense, is present in mathematical discourse. For example, the formula: $y = log(-10) \equiv 10^y = -10$ cannot be processed in mathematical proofs because it is devoid of arithmetic sense. Logicians are looking for a logic that would describe the inferential mechanism of deduction processes in mathematics, implemented in an environment of correctly constructed formulas but not having a mathematical sense [34]. These kinds of logical calculi are called nonsense logics or infectious logics [35].

The role of taboo functions in deductive discourse structures is to modulate logical consequence operators in such a way that the logical consequence operator indexed by a given taboo function invalidates in the corresponding narrative all inferences that are composed of at least one formula forbidden by a given taboo function.

Logical Consequence Operators Indexed with Taboo Functions

The logical consequence operator indexed by a taboo function differs from the non-indexed standard logical consequence operator in that from the point of view of the latter, if there is one logically valid inference in an inference set of the same shape, then all the inferences of this set are logically valid, while from the point of view of the former, no operator whose index is a taboo function that takes as its value some non-empty set of formulas has such a property. Inference rules determined by standard logical consequence operators are usually characterized by substitution closure. Therefore, these operators are called structural, logical consequence operators. Consequence operators indexed with taboo functions are thus essentially non-structural (on structural consequence operators, see [36]). For example, according to the properties of the consequence operator defining the inferential mechanism of classical logic, all inferences that have a syntactic shape determined by the Modus Ponens are logically valid based on that operator. Suppose the consequence operator for classical logic is modulated by indexing it with some taboo function that returns some non-empty set of formulas contained in D. Hence, based on the new logical consequence operator obtained in this way, not all inferences having the shape determined by the Modus Ponens will be logically valid inferences.

The consequence operator, which determines the base logic of a given discourse space, is the operator indexed by the taboo function that returns the empty set as its value. Such a logical consequence operator behaves like any consequence operator satisfying Tarski's general conditions. From this point of view, logical consequence operators in Tarski's meaning are special cases of logical consequence operators indexed by taboo functions.

All logical consequence operators indexed with taboo functions from the set T modulate the consequence operator indexed by the taboo function whose value is the empty set (Fig. 30.1). All consequence operators obtained due to modulation with taboo functions must establish the same logic to enable the processing of all narratives within a given discourse space. Otherwise, narratives within the same discourse would be deductively incomparable. However, this logic, established by all taboo-indexed consequence operators, need not be the base logic. It may also happen that the base logic forms an empty set of provable tautologies. Some logics of infectious propositions, such as the logic determined by Bochvar matrices, determine empty sets of tautologies. However, they can be treated as sets of inferences, i.e., ordered pairs or sets of such pairs, the first element of which is a set of formulas, and the second a particular formula, satisfying the following condition: if any logical valuation function assigns the distinguished value to all formulas belonging to the first element of the pair, then it also adds the distinguished value to the formula constituting the second element of the pair. According to the construction of Bochvar matrices, there are no formulas that take the distinguished value for each logical valuation [37, 38]. The differences between taboo-indexed consequence operators concern only the scope of logically valid inferences that can be formulated in the language of discourse L_D, not the universe of logical theses.

How taboo indexed logical consequence operators work within a given discourse space can be exemplified by the following example. Let classical logic be the base logic. Let the taboo function k assign to the religious discourse D such a set of formulas that the sentence: *Jesus Christ is a cheat* belongs to $k(D)$. According to the logical consequence operator indexed by the taboo function k, the inference: *Jesus Christ is God, therefore Jesus Christ is a cheat or God*, is not logically valid because the sentence: *Jesus Christ is a cheat*, is forbidden. Hence, in Catholic narratives, the sentence: *Jesus Christ is a cheat or God*, cannot be considered true because it does not follow from the premise: *Jesus Christ is God*, believed by Catholics to be true. In the same space of discourse, atheistic elm experts establish a taboo function a such that the sentence: *Jesus Christ is a cheat*, does not belong to $a(D)$. Since the base logic of the discourse space D is classical logic and the quoted inference falls under the logically valid rule of disjunction addition, then based on C_a, the analyzed inference is logically valid. Thus, the atheist consequence operator C_k and the Catholic consequence operator C_k differ in terms of deductive processing of premises.

Suppose a given inference is formulated in the language L_D only using formulas that do not belong to sets of forbidden sentences, constituting the values of two different taboo functions, $i(D)$ and $k(D)$. In that case, if such inference is logically valid based on base logic, then it is also valid based on modulated logic, determined by consequence operators indexed with taboo functions: C_i and C_k. For example, although an atheist and a Catholic use different consequence operators in deductive processing of their narratives, they can jointly assess some inferences as logically valid because their logics are the same logic resulting by modulation of some joint base logic and because the sum of sets of forbidden formulas established by the atheist taboo function and the Catholic taboo function, which index the consequence operator settling base logic, is not identical to the set of all formulas of a given discourse.

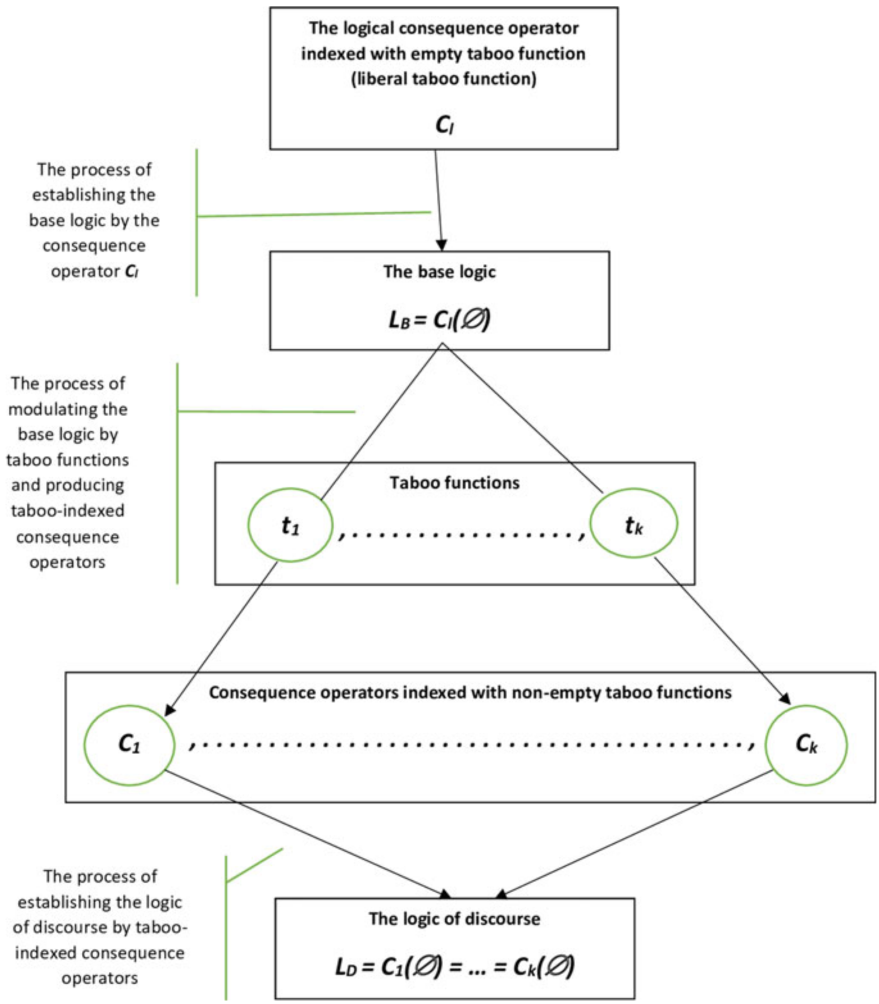


Fig. 30.1 The rectangle at the top represents the logical consequence operator $\boldsymbol{C_l}$, hereinafter referred to as the liberal consequence operator, whose index is a taboo function that returns the empty set. The second rectangle from the top indicates the base logic $\boldsymbol{L_B}$ determined by operator $\boldsymbol{C_l}$. The arrow connecting these two rectangles represents the process establishing $\boldsymbol{L_B}$ by $\boldsymbol{C_l}$. The next rectangle from the top denotes the taboo functions from $\boldsymbol{t_1}$ to $\boldsymbol{t_k}$, which modulate the base logic and produce consequence operators indexed with non-empty taboo functions. The rectangle at the bottom represents the discourse logic $\boldsymbol{L_D}$ established by all consequence operators indexed with taboo functions: $\boldsymbol{t_1}$, …, $\boldsymbol{t_k}$

Penalty Functions

Along with the establishment of taboo functions, elm experts establish conventions to punish discourse participants for committing acts of breaking language taboos. Thus, each taboo function and the corresponding operator of consequences are correlated with the penalty function, which assigns a certain intensity of penalty to sentences, sets of sentences, and inferences, which break a corresponding language taboo. For example, for publicly calling Stalin or Hitler a bandit in the Soviet Union and Nazi Germany, people were punished by death (shot, sent to a gulag or a concentration camp).

From the perspective of any taboo function, the intensities of penalties for breaking prohibitions are differentiated due to the utterance of one or another sentence or carrying out one or another inference. However, it can be assumed that the acts of uttering sentences or articulating inferences which break taboos are penalized with a fixed penalty of a certain constant intensity. From this point of view, with each taboo function and each logical consequence operator indexed by a given taboo function, exactly one penalty function is correlated, taking a particular constant value in the form of the resultant intensity of penalties.

Arguments of the penalty function corresponding to a given taboo function are forbidden formulas. This taboo function establishes sets of forbidden formulas and inferences infected with forbidden formulas. The values of any penalty functions constitute a linearly ordered, discrete set, in which one can distinguish a minimum value understood as no punishment, a maximum value understood as the annihilation of a discourse participant, and a value of alienation intensity understood as a threshold of pain whose passing across causes escape from the discourse space. Punishing discourse participants for breaking language taboos is supposed to evoke a sense of pain, which forces them to refrain from breaking a given taboo. There is a certain value of the intensity of penalty, which causes such a sense of pain among the discourse participants that they cease to formulate any statements within it. The state of silence in the discourse can be described as alienation from it. A participant in such a mental state not only does not break a given language taboo but also refrains from speaking in any way within a given discourse space.

By penalizing a given discourse, elm experts activate mechanisms that block both the deductive and hermeneutic activity of processing narratives among discourse participants. Since the narratives produced within a given space of discourse bring into existence certain mental worlds, blocking the activity of processing them in a certain way prevents the introduction of certain semantic entities (objects, situations, events, plots, etc.), which are the correlates of forbidden formulas, into the mental worlds. From this standpoint, the penalty functions are tools used by elm experts in their mission of upholding the proper development of the mental worlds produced in narrative practices. The penalty functions can thus be interpreted as a mechanism of inflicting pain on discourse participants by elm experts to block the processes of prefabrication of mental worlds in a specific manner contrary to experts' interests. Such discursive practices as hate speech, aggression, or linguistic violence, as well as the performative establishment of the facts of insulting in speech, are often manifested as penalty functions. The purpose of these practices is to evoke unpleasant affective states in the discourse participants, such as guilt, shame, or remorse.

Theory of Logical Consequence Operators Indexed by Taboo Functions

The subject of study of the presented theory is a structure of the form: $\langle D, CN, T, PEN\rangle$, called a penalizing-tabooing structure of deduction. There are two substructures in it: $\langle D, CN\rangle$ and $\langle D, CN, T\rangle$, where $\langle D, CN\rangle$ is a multi-deductive structure of discourse and $\langle D, CN, T\rangle$ is its taboo extension. Mono-deductive structures are special cases of multi-deductive structures. In his theory, standard deduction structures, described by Tarski, have the form: $\langle D, CN\rangle$, where CN consists of one element. They are mono-deductive structures. The deduction structure of Peano's arithmetic $\langle L(PA), \{C_{KL}\}\rangle$, where $L(PA)$ is the set of all formulas of PA and C_{KL} is the classical logical consequence operator, is a case of this type. Ideological discourse spaces in a non-initial stage of development are, in turn, usually regulated inferentially by multi-deductive structures of the shape: $\langle D, \{C_i, \ldots, C_k\}, T\rangle$.

Axiomatic for $\langle \mathbf{D}, \mathbf{CN}, \mathbf{T}\rangle$

Let us adopt the following conventions: i, variables: i, j, k, l represent taboo functions from the set T associated with the discourse D in its specific development phase; ii, variables: $C_i, \ldots, C_j, C_k$ refer to consequence operators indexed with functions from the set T; iii, variables: $X, Y, Z, X_1, \ldots, X_n$ represent elements of the power set 2^D; and iv, variables: $\alpha, \beta, \gamma, \delta$ represent formulas belonging to D.

$$(\forall i)(i \in T \rightarrow i \subset \{D\} \times 2^D) \tag{A1}$$

Each taboo function maps the set of all discourse formulas D into a subset constituting the language taboo of the discourse D according to function i.

$$(\forall i)(i \in T \wedge C_i \in CN \rightarrow C_i \subset 2^D \times 2^D) \tag{A2}$$

The consequence operators indexed with taboo functions map the set D subsets into the set of subsets of the set D.

$$(\forall i, k)[i \in T \wedge k \in T \wedge C_i \in CN \wedge C_k \in CN \rightarrow (i \neq k \equiv C_i \neq C_k)] \tag{A3}$$

Two taboo functions are different if and only if the consequence operators indexed by these functions are also different. This axiom establishes the correlation between each taboo function and its corresponding exactly one consequence operator.

$$(\forall i)(\forall \alpha)\{i \in T \rightarrow [\alpha \in I(D) \equiv \sim (\exists X)\alpha \in C_i(X)]\} \tag{A4}$$

A given formula is forbidden from the point of view of a given taboo function belonging to the set T if and only if there is no set of formulas in the language D from which this formula is derivable according to the consequence operator indexed by this taboo function. The A4 axiom expresses the principle of inferential sterility of formulas belonging to sets of forbidden formulas established by taboo functions. The same formula, inferentially sterile from the point of view of a given taboo function, does not have to be inferentially sterile from the standpoint of another taboo function associated with the discourse D.

$$(\forall i)(\forall k)(\forall X)[i \in T \wedge k \in T \rightarrow C_i(X - (i(D) \cup k(D))) = C_k(X - (i(D) \cup k(D)))] \tag{A5}$$

Two consequence operators indexed with any taboo indexes, acting on any set of formulas that is disjointed with the sum of sets of forbidden formulas settled by both taboo function indexes, return the same set. In other words, any two consequence operators indexed with different taboo functions behave logically the same, acting on sets of formulas not forbidden from the point of view of the sum of the values of these two taboo functions.

$$(\forall i)[i \in T \rightarrow (\forall X)(X \subset i(D) \rightarrow C_i(X) \subset C_i(\emptyset))] \tag{A6}$$

Any subset of a given set of forbidden sentences has such a property that the set of formulas derivable from it, under the consequence operator indexed by a taboo function establishing the given set of forbidden sentences, is included in the set of formulas derivable from the empty set according to this consequence operator. If the set of consequences of the empty set is the empty set, then no formula can be derived from any set of forbidden formulas.

$$(\forall i, k)\{i \in T \wedge k \in T \rightarrow [i(D) \subset k(D) \rightarrow (\forall X)C_k(X) \subset C_i(X)]\} \tag{A7}$$

Suppose a set of forbidden formulas settled by the first taboo function is included in the set of forbidden formulas settled by the second taboo function (the first taboo operator is weaker than the second, stronger taboo operator). In that case, the set of formulas derivable from a given set of formulas according to the consequence operator indexed by the second taboo function (stronger one) is included in the set of formulas derivable from the same set of formulas according to the consequence operator indexed by the first taboo function (weaker one). In other words, the weaker the taboo function, the stronger the inferential power of the consequence operator indexed by a given function, and the stronger the taboo function, the weaker the inferential power of the consequence operator indexed by a given function.

$$(\forall i)(\forall X)[i \in T \rightarrow X - i(D) \subset C_i(X - i(D))] \tag{A8}$$

Any set of formulas reduced by forbidden formulas settled by a given taboo function is included in the set of logical consequences indexed by this function, applied to a given set of formulas reduced by forbidden formulas. Only these formulas are derivable from themselves according to the consequence operator indexed by a given taboo function that does not belong to the set of forbidden formulas established by a given taboo function.

$$(\forall i)(\forall X)[i \in T \rightarrow C_i C_i(X) \subset C_i(X)] \tag{A9}$$

$$(\forall i)(\forall X)(\forall Y)\{i \in T \rightarrow [X \subset Y \rightarrow C_i(X) \subset C_i(Y)]\} \tag{A10}$$

$$(\forall i)(\forall \alpha)(\forall X)\{i \in T \rightarrow [\alpha \in C_i(X) \rightarrow (\exists Y)(Y \subset X \wedge Card(Y) < \aleph \wedge \alpha \in C_i(Y))]\} \tag{A11}$$

($\aleph$ is the power of a countably infinite set and *Card* is the cardinality function).

According to A9, A10, and A11, any consequence operator indexed with a taboo function is idempotent, monotonic, and finitistic. Thus, Tarski's three basic conditions for logical consequence operators are satisfied by consequence operators under study.

The presented system of axioms is a generalization of Tarski's theory of consequences. If the axiom TA is added to the presented axiomatic:

$$(\forall i)[i \in T \rightarrow i(D) = \emptyset], \tag{TA}$$

then A8 reduces itself to the formula: $(\forall i)(\forall X)[i \in T \rightarrow X \subset C_i(X)]$. Hence, the formulas: TA, A9, A10, and A11 constitute conditions for the Tarskian operators of logical consequence.

The axiom A3 implies that if the set of taboo functions associated with the discourse D is one-element, then the set of consequence operators CN is also one-element.

$$(\forall i, k)(i \in T \wedge k \in T \rightarrow i = k) \rightarrow (\forall i, k)(C_i \in CN \wedge C_k \in CN \rightarrow C_i = C_k) \tag{T1}$$

T1 expresses that any multi-deductive structure $\langle D, CN, T \rangle$ reduces itself to a mono-deductive structure as long as the set of T is one-element. The following theorem holds:

$$(\forall i)[i \in T \rightarrow i(D) = \emptyset] \rightarrow (\forall i, k)(i \in T \wedge k \in T \rightarrow i = k) \tag{T2}$$

From T2 and T1 it follows:

$$(\forall i)[i \in T \rightarrow i(D) = \emptyset] \rightarrow (\forall i, k)(C_i \in CN \wedge C_k \in CN \rightarrow C_i = C_k) \tag{T3}$$

T3 states that any deductive structure that satisfies general conditions of Tarski's theory of consequence is a mono-deductive structure.

Types of Taboo Functions and Indexed Consequence Operators

One can define a liberal taboo function that assigns to the discourse D an empty set of forbidden formulas.

$$l(D) = \emptyset \tag{DFl}$$

The consequence operator indexed by the function l, operator C_l, is called the liberal consequence operator. This operator establishes the base logic for a given discourse space (Fig. 30.1). If function l does not belong to the structure $\langle D, CN, T\rangle$, function C_l does not belong to it either. C_l satisfies the following conditions:

$$(\forall X)[l \in T \rightarrow X \subset C_l(X)] \tag{T4}$$

$$(\forall X)[l \in T \rightarrow C_l C_l(X) \subset C_l(X)] \tag{T5}$$

$$(\forall X)(\forall Y)\{l \in T \rightarrow [X \subset Y \rightarrow C_l(X) \subset C_l(Y)]\} \tag{T6}$$

The liberal consequence operator behaves logically in the same way as any Tarskian standard consequence operator.

Consequence operators indexed by taboo functions form a set of etatist consequence operators when their indexes are taboo functions that take values different than the empty set.

$$(\forall i)(C_i \in ETAT \equiv i(D) \neq \emptyset) \tag{DFET}$$

One may prove the following theorems:

$$(\forall i)\{C_i \in ETAT \wedge i \in T \wedge l \in T \rightarrow (\exists \alpha)(\exists X)[\alpha \in C_l(X) \wedge \sim(\alpha \in C_i(X))]\} \tag{T7}$$

$$(\forall i)(\forall X)[C_i \in ETAT \wedge i \in T \wedge X \cap i(D) = \emptyset \wedge l \in T \rightarrow C_i(X) = C_l(X)] \tag{T8}$$

According to T7, for every etatist logical consequence operator, there are such formulas and such sets of formulas that a given formula belongs to the set of formulas resulting by application of the liberal consequence operator to a given set of formulas but does not belong to the set resulting by application of a given etatist consequence operator to the same set of formulas. T8 states that each consequence operator with a given taboo index, acting on any set of formulas, in which there are no forbidden formulas from the point of view of this operator's taboo index, is indistinguishable from the liberal consequence operator acting on the same set of formulas.

The axiom A5 implies that any etatist consequence operator determines the same logic as determined by the liberal consequence operator.

$$(\forall i)[i \in T \wedge l \in T \rightarrow C_i(\emptyset) = C_l(\emptyset)] \tag{T9}$$

Moreover, any two taboo indexed consequence operators do not differ in their acting on the empty set.

$$(\forall i, k)[i \in T \wedge k \in T \rightarrow C_i(\emptyset) = C_k(\emptyset)] \tag{T10}$$

Two different etatist consequence operators differ from each other when they operate in the areas of forbidden formulas determined by the taboo functions constituting their indexes.

$$(\forall i, k)(\forall \alpha)[i \in T \wedge k \in T \wedge \alpha \in i(D) \wedge \sim(\alpha \in k(D)) \rightarrow (\exists X)(\alpha \in C_k(X) \wedge \sim(\alpha \in C_i(X)))] \tag{T11}$$

Another important consequence operator that may appear in the structure $\langle D, CN, T\rangle$ is the operator indexed by total taboo function t defined as follows:

$$t(D) = D \tag{DFt}$$

The following theorems characterize the properties of this operator:

$$t \in T \rightarrow (\forall X)C_t(X) = \emptyset \tag{T12}$$

$$t \in T \wedge l \in T \rightarrow C_l(\emptyset) = \emptyset \tag{T13}$$

$$t \in T \rightarrow (\forall i)(i \in T \rightarrow C_i(\emptyset) = \emptyset) \tag{T14}$$

According to T12, if the total taboo function belongs to the structure $\langle D, CN, T\rangle$, then the set of consequences of the operator indexed by the total taboo function applied to any set of formulas is an empty set. Based on the total taboo function, one can only keep quiet. According to (T13) and (T14), the introduction of the total taboo function to the deduction structure of a given discourse destroys the tautological nature of a given discourse. If there are experts associated with the deduction structure of a given discourse who forbid the articulation of any sentences within it, then such experts invalidate the validity of any inferences from the point of view of all operators of logical consequence associated with a given discourse space in a given phase of its development.

Axioms for Penalty Functions

Let $p_i, p_k, \ldots, p_j$ be variables representing functions belonging to *PEN*, where the indices i, j, k designate corresponding taboo functions belonging to T. Let K be a linearly ordered set of penalty intensities, where 0 is no penalty, and 1 is the maximum penalty intensity. Between 0 and 1, all rational numbers are values of some intermediate intensities of the penalty. Let a be the intensity of the punishment evoking a state of alienation from discourse. Let variables: $v, v_1, \ldots, v_n$ run through the set of penalty intensities. Let variables: $x, x_1, \ldots, x_h$ represent arguments of penalty functions.

Let $INFEC_i$ be a set of inferences infected by the taboo function i defined as follows:

$$(\forall X, \alpha)[\langle X, \alpha\rangle \in INFEC_i \equiv X \cap i(D) \neq \emptyset \vee \alpha \in i(D)] \tag{DFINF}$$

An inference is infected by the taboo function i if and only if some formula forbidden by the taboo function i occurs among its premises or such a formula is the conclusion of the given inference.

The penalty functions satisfy the following conditions:

$$(\forall p_i)(p_i \in PEN \rightarrow p_i \subset [i(D) \cup 2^{i(D)} \cup INFEC_i] \times K \tag{PEN1}$$

Each penalty function correlated with its taboo maps its set of arguments into a set of punishments causing pain of some intensity.

$$(\forall i,\ p_i)[i \in T \wedge p_i \in PEN \rightarrow (\forall x)(x \in i(D) \cup 2^{i(D)} \cup INFEC_i \rightarrow p_i(x) = const)] \tag{PEN2}$$

Each penalty function belonging to the structure $\langle D,\ CN,\ T,\ PEN\rangle$ is a constant function.

$$l \in T \rightarrow (\forall x)p_l(x) = 0 \tag{PEN3}$$

The penalty function indexed by the liberal taboo function returns the minimum value for each argument.

$$(\forall i,\ p_i)[i \in T \wedge i(D) \cap D \neq \emptyset \wedge p_i \in PEN \rightarrow (\forall x)(x \in i(D) \cup 2^{i(D)} \cup INFEC_i \rightarrow p_i(x) > 0)] \tag{PEN4}$$

Penalty functions correlated with etatist taboo functions assign to their arguments values of penalty intensity greater than 0.

Since all penalty functions are constant functions, one can define a function ρ that assigns to each taboo function the penalty intensity assigned to all arguments of the penalty function correlated with a given taboo function.

$$(\forall i)\{i \in T \rightarrow [\rho(i) = v \equiv (\forall x)(x \in i(D) \cup 2^{i(D)} \cup INFEC_i \rightarrow p_i(x) = v)]\} \tag{DFP}$$

If there is a total penalty function in the structure $\langle D, CN, T, PEN\rangle$, it is natural to assume that the penalization function correlated with the taboo function t works most severely among all taboo functions of a given deductive discourse structure.

$$t \in T \rightarrow (\forall i)(i \in T \wedge i \neq t \rightarrow \rho(t) > \rho(i)) \tag{PEN5}$$

Types of Penalizing-Tabooing Discourse Structures of Deduction

One may distinguish various types of discourse structures of deduction due to their structural properties. Elementary taboo deduction structures are those formatted with one consequence operator and one taboo function that is not a total taboo function.

$$\langle D, CN, T\rangle \in EL \equiv (\exists i)(CN = \{C_i\} \wedge T = \{i\} \wedge i \neq t) \tag{DF.EL}$$

Among the structures of the set *EL*, standard elementary structures can be distinguished, which are constituted by the liberal consequence operator.

$$\langle D, CN, T\rangle \in ST - EL \equiv (CN = \{C_l\} \wedge T = \{l\}) \tag{DF.ST − EL}$$

Each elementary taboo structure of deduction develops in the process of synthesizing a given discourse by the proliferation of elements of both the *CN* and the *T*. The final phase of such a process is the situation in which the sum of the values of the family of all taboo functions is identical to the set *D*. Then, within the discourse, any inference will be forbidden from the point of view of at least one taboo function and the corresponding consequence operator. The structure of discourse deduction in this phase of its development is called maximal.

$$\langle D, CN, T\rangle \in MAX \equiv (\forall \alpha)[\alpha \in D \rightarrow (\exists i)(i \in T \wedge \alpha \in i(D))] \tag{DF.MAX}$$

No maximal taboo structure of deduction is an elementary structure of deduction.

$$MAX \cap EL = \emptyset \tag{T15}$$

Each structure of the shape $\langle D, \{C_t\}, T\rangle$ is maximal. Moreover, any deduction structure that contains a total taboo function is also maximal.

$$\langle D, \{C_t\}, T\rangle \in MAX \tag{T16}$$

$$t \in T \rightarrow \langle D, CN, T \rangle \in MAX \tag{T17}$$

In the discourse associated with the *MAX* type deduction structure, any inference valid from one point of view is invalid from another standpoint.

$$\langle D, CN, T \rangle \in MAX \rightarrow (\forall i)(\forall X, \alpha)[C_i \in CN \wedge i \in T \wedge \alpha \in C_i(X) \rightarrow (\exists k)(C_k \in CN \wedge k \in T \wedge \sim (\alpha \in C_i(X)))] \tag{T18}$$

In the maximal deduction structures, the consequence operators do not establish a set of logical theses and tautologies.

$$\langle D, CN, T \rangle \in MAX \rightarrow (\forall i)(C_i \in CN \wedge i \in T \rightarrow C_i(\emptyset) = \emptyset) \tag{T19}$$

Some discourse deduction structures may possess a mechanism that blocks the evolution of the discourse space towards its maximal phase. This mechanism is described by the following condition:

$$(\forall i)(l \in T \wedge i \in T \wedge C_l(\emptyset) \neq \emptyset \rightarrow C_l(\emptyset) \cap i(D) = \emptyset) \tag{B}$$

According to (B), no taboo function in the deduction structure of a given discourse stigmatizes the logical theses with a prohibition determined by the liberal consequence operator. Therefore, if the set of logical theses determined by this operator is not an empty set, then according to A5, each consequence operator of a given deduction structure establishes a non-empty set of logical theses identical to the set of logical theses established by the C_l. Moreover, if there is no liberal consequence operator in the deduction structure of a given discourse, then it is impossible to introduce into this structure the mechanism described by (B) that blocks its development towards the maximal structure of deduction. Therefore, if condition (B) is satisfied for a given discourse structure, it is not maximal.

$$(\forall i)[l \in T \wedge i \in T \wedge C_l(\emptyset) \neq \emptyset \rightarrow C_l(\emptyset) \cap i(D) = \emptyset] \rightarrow \sim \langle D, CN, T \rangle \in MAX \tag{T20}$$

One may distinguish totalitarian deductive discourse structures. They are characterized by the fact that in the $\langle D, CN, T, PEN \rangle$ structure, there are taboo functions to which the function ρ assigns a maximum value 1.

$$\langle D, CN, T, PEN \rangle \in TOT \equiv (\exists i)(i \in T \wedge \rho(i) = 1) \tag{DFTOT}$$

Let us define the taboo extension relationship between the taboo functions.

$$(\forall i, k)[i(ext)k \equiv i(D) \subset k(D) \wedge i \neq k] \tag{DFEXT}$$

The taboo function k is an extension of the taboo function i if and only if the value of the function i is contained in the value of the function k and the two functions are different. If the totalitarian deduction structure of a given discourse space is characterized by the fact that the taboo function for which the function ρ takes the value 1 is an extension of all taboo functions, then such a structure characterizes the discourses in their development phases of the domination of one totalitarian elm expert. Such structures have a property that can be described as the totalitarian monopoly of an expert institution on punishment.

$$\langle D, CN, T, PEN\rangle \in M-TOT \equiv (\exists i)[i \in T \wedge \rho(i) = 1 \wedge (\forall k)(k \in T \wedge k \neq l \rightarrow k(ext)i)] \tag{DFM – TOT}$$

Between the logical consequence operators in the deduction structure $\langle D, CN, T\rangle$, there can be the conflict relationship.

$$(\forall i, k)[C_i(conflict)C_k \equiv (i \neq l \vee k \neq l) \wedge i(D) \cap k(D) = \emptyset] \tag{DFC}$$

Suppose the elm experts in the structure $\langle D, CN, T, PEN\rangle$ establish taboo functions that generate the conflict relationship between consequence operators indexed by these taboo functions, and the ρ function assigns them to values of the penalty intensity, causing the state of alienation from discourse. In that case, such a structure of deduction is called revolutionary.

$$\langle D, CN, T, PEN\rangle \in REV \equiv (\exists i, k)(i \in T \wedge k \in T \wedge C_i \in CN \wedge C_k \in CN \wedge C_i(conflict)C_k \wedge \rho(i) \geq a \wedge \rho(k) \geq a) \tag{DFREV}$$

In a revolutionary developmental phase of discourse, elm experts attack each other with severe punishments, inducing a sense of alienation among the discourse producers. In extreme cases, experts can kill each other. Then the structure of the *REV*-type becomes a terrorist deduction structure.

$$\langle D, CN, T, PEN\rangle \in TERR \equiv \langle D, CN, T, PEN\rangle \in REV \wedge (\forall i, k)(i \neq k \wedge i \in T \wedge k \in T \wedge C_i \in CN \wedge C_k \in CN \wedge C_i(conflict)C_k \rightarrow \rho(i) = 1 \wedge \rho(k) = 1) \tag{DFTERR}$$

In *TERR*-type structures, all sides of the discourse are in conflict with each other, without the ability to ally with any side in the fight against a third side; they try to eliminate each other from a given discourse space. The religious discourse during the French Revolution was correlated with such a revolutionary structure of deduction. Jacobins, Girondins, Sans-culottes, Royalists, and others killed each other to defend their views on religion.

Conclusion

The sketched theory of logical consequence operators indexed with taboo functions enables formal modeling of information processing within discursive practices. The theory shows that our discursive thinking is multi-deductive. This property is generated by the language taboo functions encoded in our minds by elm experts. Each such taboo function modulates the base logic underlying the discourse in its own way. Blocking inferences infected with forbidden formulas requires triggering in our minds the penalty functions responsible for feeling the pain inflicted by elm experts when we break the prohibitions during information processing within a discursive activity.

> *If the freedom of speech means anything at all, it means the right to make any deduction public.*
>
> Wojciech Krysztofiak

Core Messages

- Language wars in discourse spaces are governed by logical mechanisms encoded in people's minds.
- Killing others in the name of an idea is the result of the tabooing of our mental worlds.
- Linguistic taboos transform liberal logical information-processing mechanisms into totalitarian information-processing mechanisms.
- There are logics of thinking that are dangerous to our lives.
- Tarski's theory of logical consequence describes the logics that guarantees the freedom to process mental contents.

Acknowledgements The chapter is part of Project No. 2016/21/B/HS1/00821, supported by The National Science Centre, Poland.

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The Impact of Economic Science on Human Thinking

31

Khasankhonova Nodira Isametdinovna

> "*All economics is the science of how people make decisions*".
>
> James Dusenberry

Summary

This article examines the impact of economic science on human thinking, its actions, and deeds on the example of the Republic of Uzbekistan. During the pandemic, Uzbekistan's financial, economic thinking is reflected in its economic population's volatility. Therefore, it is crucial to analyze the behavior in a financially unstable situation. For this, income, employment, financial well-being, migration, and behavior are analyzed. According to the conclusions of the analysis, it is assumed that the driving force of economic thinking is the state's financial position and economic policy during a pandemic. In this position, economic thinking moves rationally. The article concludes that the way-out lies in the transition to the knowledge of the economy, which opens up opportunities for mental labor to improve the economic behavior and thinking at the population (or an individual) level.

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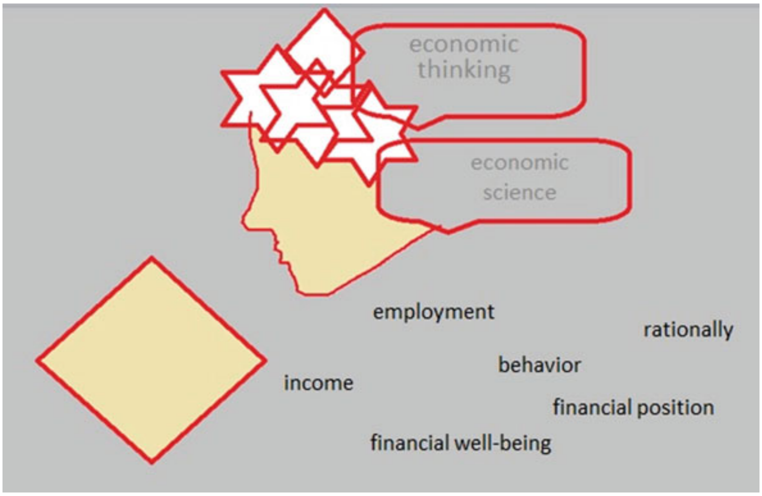
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_31



The impact of economic science on human thinking.

Keywords

Behavior · Economic policy · Economic science · Economic thinking · Employment · Financial position · Financial well-being · Income · Migration · Rationality

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

In the condition of pandemia, humankind enters a disordered world that requires flexible economic thinking. This situation is called a recession or a slowdown in economic growth in economic theory. More precisely, "the decline in production is characterized by zero growth in gross national product (GNP) (stagnation) or its fall for more than six months."1[1] As a phase of the economic cycle, the recession gives way to depression after a long smooth growth. It most often leads to massive drops in stock market indices, rising unemployment, and other cyclical signs of crises. Generally, the country's economy depends on other countries' economies; therefore, an economic downturn in one country or another can lead to a downturn in other economies and even a collapse on the world exchanges. It is believed that 2020 has witnessed the deepest recession since the Great Depression.

The recession of the economy is identified primarily by the following indicators that lead to the economic security of the world, country, or region:

- Low growth in global GDP; it is believed that if it is below 2%, then the economic security of the world is at risk;
- High unemployment, if it is above 15%, then this is a collapse in the labor sector;
- A decrease in foreign direct investment;
- Global export–import should not fall below 40%;
- The shutdown of existing production facilities, and the like

In a pandemic, humanity enters into a non-ordinate condition that requires flexible economic thinking. In each country, to improve the economy based on an uncertain situation and the requirements of a decent life for the population, jobs are created with remote work or work with lighter requirements. The priority at this level is still the digital economy or the knowledge-based economy. Therefore, along with the introduction of digital technologies that meet the requirements of today's market, the need to adapt the economic behavior of people to it also prevails.

What is Economic Thinking? How Can We Use?

Economics has long been the domain of the ivory tower, where specialized language and opaque theorems make it inaccessible to most people. That's a problem.

Featuring Ha-Joon Chang

The economic behavior of the population is based on the formation of economic thinking. Economic thinking involves studying how economic units (households, firms) make rational decisions and actions. Any economic activity is associated

[1] Thesis by Kravchenko V. Russian wheat market: current situation, existing problems and possible solutions (Doctoral dissertation, Empire State College).

with certain costs, the so-called "c costs," that are sacrifices caused by the production or purchase of one product and the refusal to produce or purchase another. For example, during a pandemic, purchasing high-cost goods (a refrigerator, television, or some real estate) is a meaningful and rational decision. Making rational decisions about what goods and what quantity to produce, sell or buy, how to spend their time: study or work, and if work, then where and under what conditions, or, choosing other alternatives, people compare the possible benefits with costs. When the ratio between the perceived benefits of an action and the expected costs increases, people are more likely to take these actions since they will become relatively more profitable, and vice versa.

Using the example of the Republic of Uzbekistan example, we comparatively review the economic situation assessments in the second quarter of 2019 and 2020. The population in 2020 is not satisfied with many sectors of the economy [1]. It is especially true for services that have been suspended from restaurants, bars, parks, etc., due to quarantine measures. Of course, it should be noted that economics is a field of scientific knowledge that studies people's economic relations, and the level of its implementation is a process based on economic thinking. Even if a person is the main subject of economic relations, his behavior is a thinking product. The main purpose of the study of economic thinking is to create a clear theoretical basis for the rise of humanity in terms of progress, its development, and increasing material well-being in society. Economic thinking is the basis for coordinating economic relations, deep thinking, and analysis of economic events and processes.

Theoretical approaches to the concept of "economic thinking" in economic science and practice, general issues related to the formation of economic thinking, or some of its aspects can be seen in many scientists' works—for example, L. I. Abalkin, G. N. Sokolova, and L. S. Blyaxman [2–4] considers economic thinking a product of consciousness in specific collective situations as a set of methods for assessing the situation and making decisions in management. They argue that embodied views, analyses, and solutions constitute the empirical stage of economic consciousness. It is used in everyday life; it is controlled but does not always lead to theoretical conclusions. They explain that the theoretical conclusion of economic consciousness is derived from economic thinking. G. N. Sokolova [3] considers economic thinking a product of economic consciousness that arises in collective situations. Based on the research conducted by G. P. Sokolova, the following main dominant categories of economic thinking can be identified:

- Attitude to work;
- Attitude to forms of private property; and
- Management relations

They are perceived by the individual as a certain process at the consciousness level and become an internal factor in economic thinking. These factors are embodied and fully realized in the processes of natural laws on a collective basis.

Heine [5] perceives economic thinking as a direction, as an "economic way of thinking." This trend, he says, is reflected in the willingness of individuals to act in their own self-interests. Based on an analysis of the current situation and its assessment, economic thinking shows that people's own benefits and incomes are associated with their alternative choices. This choice is presented in the form of two or more alternative ways of working. P. Heine expresses economic thinking by the following features, which are internally interconnected:

- Individuality, P. Heine believes that economic thinking depends on a person's own individual activity. Any economic decision, even if made by a group, will be made in favor of an individual in that group;
- Rationality, the person acts by evaluating the pros and cons of the previously accepted options. Such means that it is not acceptable in a state of emotional arousal; it requires clarity; and
- Collectivity, self-evident collective relations are among the processes in the form of market conditions, and, thus, they, in turn, are the mechanism for the implementation of economic thinking.

Consequently, some definitions emphasize that economic thinking is a conscious understanding of economic categories and laws. However, it should be noted that economic thinking depends on economic activity and its application. Not only laws and categories, but also the needs and interests of the subject in the field of economic activity emerge as an "independent source" of economic thinking.

It is clear that the definition of economic thinking comprises two main principles; on the one hand, it reflects concepts and conclusions formed based on economic relations; on the other hand, it is a process of the practical application of economic processes and categories.In addition to the authors mentioned above, one can also refer to, for example, A. P. Sudelsky and L. S. Blyakhman [4, 6]. They emphasize that economic thinking is interdependent and is also an internal mechanism of all activities. Thinking as an integral part of human activity in economics determines the integration of economic and psychological understanding. Sudelsky [6] notes that the subject's tasks are solved based on logical thinking and rational and internal economic criteria.

To summarize the above definitions, economic thinking is:

- Economic knowledge, views, and ideas arising from private needs and interests;
- A process of conscious understanding of economic categories and laws;
- Principles of development of economic relations; and
- A process of putting categories into practice.

As a result, we can define the concept of "economic thinking" as economic categories, conclusions, and decisions arising from the interaction of private (public) needs and interests, as well as economic actions formed on their basis. This definition considers three other important elements:

- The interaction of private (public) needs and interests;
- Economic categories, conclusions, and decisions; and
- Economic behavior

First of all, the reason for such a definition is the interests of the individual (society) and the implementation of actions aimed at meeting a person's primary needs and secondary needs. It is complemented by the economic understanding, conclusions, and decisions that are the second part of our definition. They rely on economic knowledge and experience passed down from generation to generation in the process of work, earnings, and consumption. Economic knowledge and experience help a person make decisions and draw conclusions in various financial situations. Economic behavior occurs due to the complexity of relationships and the creation and development of human life amenities. Based on the principles of the development of economic relations, the current level of technical development, we can say that here, in particular, the interconnection between information, technology, and economic relations in material production and the sphere of services will increase. It means that economic knowledge will evolve.

Private (public) interests and needs are the ideal but invisible means of people's economic thinking. Need and production are inseparable; they complement each other and are vital means. People's needs and interests motivate the state and enterprises (firms, corporations, organizations) to deepen the level of production.

The following main features characterize economic thinking:

i. It always presupposes choices made by people;
ii. The option will be made by a person. It is the fundamental unit in the field of economic thinking. The economic perception of individuals determines the adoption of collective decisions at households and firms. At the same time, when choosing the optimal solution in a team, group interests and social ties play an essential role;
iii. In rational decision-making, a person seeks to choose rationally, i.e., based on comparing costs and benefits to achieve maximum benefits and the most incredible efficiency. Of course, in reality, the actions of people are far from always being distinguished by rationality, since their decisions and actions are influenced by emotions, psychological and physical condition, the opinions of other people, and the inability to assess the prospects for the development of events accurately; and
iv. The economical choice is not entirely free; it depends on laws and regulations governing society's economic relations.

How the Pandemic Affects the Economic Thinking of the Population?

When conducting economic research, certain difficulties arise that prevent the formation of rational economic thinking.

i. First, they are associated with different interpretations of specific processes in everyday economic science. For example, a pandemic is usually associated with a medical point of view. However, in economic theory, a pandemic leads to colossal financial losses to both the state and the person. The term "marginal debt" in the ordinary sense can be interpreted as "maximum possible," but in macroeconomics, it means "additional" associated with each additional unit of cash;

ii. Secondly, they are caused by erroneous ideas about economic phenomena that have already been formed due to previous human experience and now impede objective economic analysis. For example, a person starting to study economics may consider the 1929–1933 crisis, although it was a consequence of classical economics, which reflected only sellers' economic interests; and

iii. Thirdly, difficulties can also be associated with logical thinking. One such misconception is that what is right during a pandemic increases the demand for essential goods, leading to an increase in their value. For example, there is a shortage of masks, antiseptics, which at the beginning, all other things being equal, gives a very high profit. However, if all firms raise prices, then profits for many of them will not only not increase but may decrease, or they will even incur losses. Thus, generalizations valid for individual units may be incorrect for their totality and vice versa. Another logically erroneous position is that if one event precedes another, the first event necessarily causes the second.

In economics, various processes are closely interconnected, and cause and effect can often change places. At the same time, the development of many externally interrelated processes can be determined by a third factor not taken into account in the analysis. For example, if a production decline occurs at an enterprise, this can be attributed to a lack of investment. However, the lack of investment can also be caused by a drop in production at the enterprise. In this case, cause and effect can be reversed with good reason. Nevertheless, the main reason for both the decline in production and the reduction in investment may be the state's ineffective economic policy (tax, budget, monetary, foreign economic, etc.).

In each country, some targeted measures are being taken to prevent the crisis and develop the economy. A prudent and consistent economic policy pursued at the present stage of the country's development shows its results not only in society but also in human relations and behavior. The ongoing modernization and diversification processes, macroeconomic measures, and financial strengthening of the state create economic stability in human behavior. The change in human thinking that embodies society's behavior and interests remains an important factor in all aspects of the country's economic environment. This is, therefore, reasonable that research shows some problems in the formation of the theoretical foundations of modern thinking and its methodological development.

Considering the above, the behavioral characteristics of a pandemic can include the population's income, employment, financial well-being, migration, and behavior. Income is the main motive for human economic behavior. Studying it gives us the answer to some questions, for example, regarding employment and financial well-being. In Uzbekistan, the decline in real growth rates of total per capita income for the six months of 2020 was 0.4% [7]. A survey was conducted among 100 thousand people living in Uzbekistan about the pandemic's impact on their income, employment, and migration. In Uzbekistan, employment in June continued to return to previous levels rapidly. The share of households in which one or more family members had a job drastically reduced to 40% in April and returned to 33% in June [7]. The respondents' share indicated that someone from the household "lost their job or stopped working" increased from 1 to 19% in April. In June, this share of respondents dropped to 3%. Almost all respondents indicated that they considered work breaks to be temporary. At the same time, the study notes that the employment rate remained significantly lower than the indicators of 2019 and trends before the onset of the COVID-19 pandemic. The "decline in employment was the most noticeable and lasting among the self-employed."[2] The share of respondents who indicated that they are self-employed fell by 67% in April and 26% in June. In contrast, the employment of wage earners in June on average returned to the level of 2019, with the return among men happening faster than among women [7]. Job data shows signs of recovery in the economy, the study concludes. Industries with the largest declines in new vacancies compared to the same period in 2019 included tourism, leisure and entertainment (−95%), bars and restaurants (−91%), and education (−85%). Even among the least affected occupations, the decline was 50% or more than the same period last year, with rapid recovery in the medical and construction industries in June. The people living less than the poverty line (for comparison, the level corresponding to lower-middle-income countries is used, $3.2 per person per day, expressed in PPP 2011), increased during the pandemic.

The World Bank predicts that the pandemic's poverty rate increased by 8.7–10% compared to the level before COVID-19, while the number of people who fall below the poverty line will range from 450 to 880 thousand. The share of households reporting that their food consumption has declined rose sharply to 26% in April but fell slightly to 22% in June. It is estimated that around 3.8 million people in Uzbekistan received some form of emergency support. About 11% of those surveyed indicated that they received direct support after the onset of the pandemic. According to the survey results, most (92%) of aid came in the form of non-material benefits or vouchers and was more widespread in urban areas. In May and June, the number of respondents who indicated that they could not receive medical care increased. After the onset of the outbreak, about 6–8% of respondents indicated that a family member needed medical treatment. In May–June, about 16% reported that their attempts to get treatment was unsuccessful, although this estimate is based in absolute terms on a small number of cases. Households that lost income were the most likely to report increased spending and the most affected economically by the pandemic. About 53% of respondents reported significant changes in their spending. Among them, 60–65% indicated that they spent more than usual in the last 30 days, the rest indicated less. The increased costs are associated with loss of income during the crisis, and those on lower incomes are likely to be "very concerned" about the pandemic's economic impact. A significant proportion of citizens indicated they lacked a saving account and could not satisfy their basic needs. The percentage of people who cannot afford food increased from about 9% to more than

[2] http://www.uzdaily.com/en/post/58702.

11% between April and June. According to the study, more than half lacked a savings account, and almost half were unable to deal with the issue of unexpected expenses of $ 9.8.

Local shortages of goods decreased in June. About 1% of respondents indicated that their area is out of stock, significantly lower than the 16% reported in April. In this case, it was often about food products, especially flour, along with information about price hikes. The conditions of drugs and masks out of stock fell from 5% in April to a minimum in June. The share of households getting foreign remittances increased after a fall in June but was still less compared to the levels of 2019.

In April, the share of households receiving any remittances fell by half compared to the same period last year, after which it more or less recovered in May and June. For those who received remittances, the average remittance size fell by 21% (in UZS, adjusted for inflation) in April but then rose in May, following the Russian ruble's strengthening. In April, the share of households whose members worked abroad was 3% less than at the same time in 2019. Among those still abroad, the share of actively employed people dropped from 88% to about 73%.

The difference between 2019 and 2020 have increased in May and June, at a time when migration has traditionally increased seasonally. Between April and June, the share of households participating in the Listening to the Citizens of Uzbekistan survey considering migrating abroad in the future fell to almost zero [7].

The study noted that respondents' concerns about the impact of the coronavirus remained high. Almost all respondents indicated that they know what COVID-19 is, and more than 75% noted that they "know very well" about it. About 80% indicated that their routines changed during the pandemic. Most often, this meant wearing masks (98%), reduced visits to family and friends (84%), more frequent hand washing (81%), reduced handshakes, greetings (77%), social distancing (72%), less time spent at work outside the home (51%), and self-isolation (17%) [7]. Almost none of the respondents answered that they had recently visited crowded places.

Looking at the above statistics, we can draw the following conclusions:

i. Incomes at the beginning of the pandemic fell due to a lack of understanding of the situation. However, as the panic gradually began to recede, the population gradually recovered its income. From this, we can conclude that economic behavior in times of uncertainty can become stupid, but gradually realizing its action begins to think. Flexibility manifests itself when the economy is clear;
ii. financial thinking stopped during the pandemic, as deposits stopped during this period. With this, the banking sector will suffer a bit of loss. Exchanges as another financial sector have also suffered from financial misunderstandings. The financial thinking of people is directed towards preserving their savings and avoiding any investments;
iii. employment among the self-employed fell because quarantine measures did not allow them to work for themselves. Self-employment in many states is a black market; they do not pay taxes to the state. Among the self-employed, those who are engaged in Internet trade remained the winner. In such a

situation, economic thinking in action becomes more complicated because the non-switches to how to make money to feed the family. In this case, remote forms of work help to revitalize economic thinking. To stabilize the market for labor in the country, it is planned to extend the maximum unemployment benefit, to provide temporary employment for those who are at risk of dismissal, to extend the payment of benefits for three months (if the unemployed cannot find a job), to triple the minimum benefit, and to provide additional payments to families with children where the parents were left without work;

iv. during the pandemic, approximately 40% of migrants from Uzbekistan lost their jobs in foreign countries. These are mostly illegal migrants. This also influenced financial thinking. On the financial side, income declined, leading to massive homecoming. They came to the country with the onset of COVID-19 disease; and

v. the economic behavior of the subjects in such a difficult situation manifested itself in different ways. Because of the loss of their jobs, some began to look for other ways of earning money, legal and illegal. Economic behavior appeared passively, but it began to act faster over time because a person had to earn a living.

So, the most important thing influenced by the COVID-19 pandemic turned out to be financial, economic thinking. Operations to raise money, loans, and payments on them, operations related to long-term obligations, and economic services such as planning, investment, forecasting, lending, insurance, and the settlement system become an important part of a person's economy and economic behavior. In this case, the individual or consumer must understand, decide, draw conclusions about financial services, take an active part, and trust them.

As we know, financial thinking is the assessment, action, behavior, and ability to make investment decisions. The financial behavior has a special importance among the other types of economic behavior of the population since it is related to the redistributional and investment of funds. The individual’s financial condition is one of the indicators of the consumer's social well-being and economic well-being. The manifestation of such behavior in the context of market relations ensures economic prosperity. It makes it possible to predict ways of influencing certain changes in the financial situation and structure of the population.

In a pandemic, as we can see, financial thinking comes first. Firstly, the population thinks about food, and secondly, the material situation that has arisen focuses on people’s resourcefulness to make money. However, at the same time, you can add that a person before the pandemic spent his finances both rationally and irrationally. During a pandemic, a person began to spend money rationally, thinking over every step. When speaking about factors influencing consumer behavior, F. Kotler distinguishes cultural (culture, subculture, social status), social (family, role and status, reference groups), personal (age, occupation and economic circumstances, lifestyle, personality type, etc.), and psychological (motivation, beliefs, etc.) characteristics.

An objective factor, like our example, a pandemic, has brought the economy to a new level of development. This level, which has just begun its trend, is the knowledge economy. The knowledge economy is a state of the economy when it rises to a new qualitative state directly with an increase in the value of theoretical knowledge, an increase in the role of high-tech industries, the process of increasing the share of the service sector (structural shifts) in the economy, and the influence of information network technologies (Internet). The knowledge economy includes the structure and factors of human capital accumulation, the role of knowledge as a public good, issues of intellectual property, management of an enterprise's cognitive environment, etc.

The practical development of the knowledge economy is the most relevant and attractive issue for the current situation associated with the pandemic. The knowledge economy results from economic systems, economic policy, and the population's actions. Since each country's economic system is different, the functioning and development of the knowledge economy are selected individually, affecting the country's economic strategy. The country's economic strategy can lead to the productivity of the current system; it can increase concentration in strategic sectors; finally, it can create real growth through the modernization of industry or services. Of course, all of these will be aimed at improving the country's economy.

In our opinion, during a pandemic, the development of the knowledge economy is very important to provide the following opportunities:

- an innovative environment with great technical development, which gives a great impetus to the digital society and raises innovative potential, scientific and technological potential, and human intellectual potential;
- the cooperation between business, government, science, and education services;
- the introduction of new professional educational programs to decrease the level of "brain drain";
- the maintenance and development of knowledge management processes at the level of individual business structures; and
- the development of innovative products and services that will enhance life's comfort noted that the pandemic's economic behavior would switch to the era of informatization and robotization.

The knowledge economy has been introduced globally; life quality and well-being are increasingly dependent on it. Also, there is a large-scale application of digital technologies in government organizations and structures. For the successful development of the knowledge economy, joint work of the state and business on the economy's further strategy is necessary. This activity also requires us to recognize problems, risks, and threats to focus resources and efforts to neutralize them.

Making a general conclusion, the influence of economic science at every stage of human development is important. Because the economy is a system that helps people and society to meet their needs by producing the necessary benefits of life, its main objective is to support the life of people, to create conditions for the humans. Therefore, during a pandemic, the problem associated with it matters in any country in the world. Without economics, this problem cannot be handled because of limitedness of resources. This forces the economy to develop in an intensive way, which implies the rationality and efficiency of resource use. From this approach's perspective, all available resources must be processed to achieve the main goal with minimum cost.

Conclusion

"An important indicator and result of the economic life of society is the standard of living of its members, which is understood as the degree to which the population is provided with goods, services and living conditions necessary for a comfortable and safe existence."[3] In a pandemic, a complete transition to the knowledge economy is a primary task. At first, mental work brings significantly more income than physical labor. Secondly, in Uzbekistan, as a developing country, a transition to the knowledge economy is needed. Still, its implementation is far from difficult because the population is mainly engaged in physical labor and, therefore, mastering technology is a big challenge. It is necessary to raise a new generation that thinks financially correctly, learns technology faster, and is engaged in scientific achievements to implement mental work.

Core Messages

- In each country, jobs are created remotely to improve the economy based on an uncertain situation and the requirements of a decent life for the population.
- Economic thinking is economic categories, conclusions, and decisions arising from the interaction of private (public) needs and interests and economic actions formed on their basis.
- During a pandemic, financial thinking comes first; firstly, the population thinks about their food, and secondly, the material situation has made people focused on resourcefulness to make money.
- The priority is still the digital economy or the knowledge economy.

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Generations of Systems Thinking: Models for Future Learning

32

Stephen Spain

> "*In the case of all things which have several parts…the whole is not, as it were, a mere heap, but the totality is something besides the parts*".
>
> Aristotle

Summary

This chapter demonstrates how systems thinking (ST) informs a new language of thought for future curriculum modeling and learning. The problems that beset us in education today are systemic ones that require systemic solutions. Therefore, we must take an ST approach in order to prepare for and adapt to a world that is complex and unpredictable. ST, as quoted above, has its origins in Greek Philosophy through Aristotle's dictum, the origin of which dates back to Aristotle's *Metaphysics*. This chapter also makes explicit ST about learning, emphasizing the importance of relationships rather than reducing the world into separate elements or parts. We trust that this will build the capacity for thinkers, educators, and curriculum designers at all levels to assist in designing more integrated curriculum models that are responsive in real-time in mitigating the effects of the changing demands of lecturers, teachers, and their students.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_32

Lamenterra: Search for Australia Felix by Stephen Spain.

Keywords

Cybernetics · Ecological · Holism · Human ecology · Organismic · Reductionism · Systems thinking

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

The author briefly considers the antecedents of systems thinking (ST), in particular, general systems thinking (GST) and cybernetics founded by Karl Ludwig von Bertalanffy and Norbert Wiener, respectively. The origins of ST, which are distinct and interdependent, include considerations of GST, cybernetics, complexity theory, system dynamics, and thermodynamics.

This chapter will delve more into how Karl Ludwig von Bertalanffy's dynamic equilibrium and Fritjof Capra's organismic biology contribute to new contemporary thought for educational modeling and the embedding of sustainability across all curricula. At times, it will differentiate within each context between compulsory education, post-compulsory education, and higher education.

General Systems Thinking

The origins of ST occur in theoretical biology, which led to the development of GST. Specifically, Karl Ludwig von Bertalanffy stated that an organism as a whole possesses a deep connection and openness to the environment [2]. Von Bertalanffy came to reject reductionist science that was void of humanism in favor of science for the benefit of humanity.

Whole ST is a subset of GST. Both focus on the difference between a system and its parts and how it organizes its parts to function. A study of the relationships between the parts is necessary to understand thoroughly how best to cultivate functional sustainability. For example, education curriculum designers are to be cognizant of the relationships of the parts and the whole to create a curriculum that provides an opportunity for sustained learner growth [3, 4].

The origins of von Bertalanffy's idea of an organism are taken from the principles of thermodynamics. He states that "*living systems are open systems, maintaining themselves in exchange of materials with environment, and in continuous building up and breaking down of their components*" [2, p. 23]. It is defined as 'dynamic equilibrium'—a steady-state. It is not an equilibrium in the conventional sense but a continuously changing state while maintaining integrity or form. The application of this open system to various contexts and situations led to the development of GST.

Von Bertalanffy was the first academic of the modern era to apply values and ethics to science through ST, resulting in a more humanistic discipline challenging the prevailing wisdom of empiricism during his early period. As von Bertalanffy gave ST a common language, educators and policymakers need to develop a new language of thinking to inform organismic curriculum design and modeling.

In applying GST more widely, we come to realize structural similarities across a range of entities that are vastly different. For example, the same mathematical laws apply to bacteria, humans, and animals, regardless of causal mechanisms [2].

Cybernetics

Norbert Wiener [5] coined the term cybernetics and published his seminal text in 1948. Cybernetics is from the Greek Kubernetes, to mean 'steersman'—an entire field of control and communication [5, p. 11]. This term was originally applied to an engine governor that controls revolutions per minute in regulating engine operational parameters. Wiener defined cybernetics as two key concepts: control and communication, which are highly related. Wiener stated that these concepts could be expressed as feedback for intelligent systems to self-correct in steering toward intended goals. Cybernetics, therefore, is highly relevant for curriculum designers in responding to student achievement and development feedback within compulsory and non-compulsory education. This feedback becomes very powerful in informing curriculum construction from an ecocentric (ecologically oriented) worldview. Cybernetics is a process of trying, acting, sensing, comparing to the goal and changing. All intelligent systems have such a process, which is a form of self-correction and adaptation [6].

Pangaro et al. [6] describe cybernetics as a systemic language that enables all goal-seeking systems, both biological and mechanical, to adapt and change according to set design imperatives. These attributes, which will be elaborated upon further in this chapter, facilitate self-correction and adaptation. As a language and methodology, it is the conscientious application of cybernetics that empowers us, or any given intelligent system, to operate at optimal levels. Pangaro states that goal-based systems use intermediary feedback to orientate or make course corrections in reaching pre-determined goals.

Pangaro et al. [6] state: "*If systems, then cybernetics—because the interactions and complexity of systems involve humans, we must incorporate goals, feedback, and information, because we are driven by these things. And these are what cybernetics is all about*" [6, p. 23]. This, from an elementary perspective, can also readily apply to educational evaluation. Teachers and educators at all levels can evaluate their lessons, lectures, and tutorials, and students can self-assess their growth over time through positive and negative feedback against their learning goals.

Gregory Bateson strived to develop a language of thinking governing information transfer between the two disciplines. It can be defined as transdisciplinary, as he saw commonalities across fields comprising the beginnings of Cybernetics [7]. This is in contrast to Cartesian philosophy, which according to Bateson, corrupted epistemology due to Descartes' partitioning of the physical and mental realms. In contrast, Bateson favored a more unifying perspective. Ramage and Shipp [2] state, "*… this is a call to a new form of epistemology, which understands humanity within its environment, and Bateson's answer to it lay within his conception of an ecology of mind*" [2, p. 14].

Bateson studied the patterns among different mental and physical processes throughout nature to address how entities interact with their environment, ultimately informing his ecological worldview. Bateson's [8] *Mind and Nature* explores his concept of connective patterns that applies to all living things and, in particular, their inter-relationships, similarities, and differences. These relationships are in a constant state of change: "*a dance of interacting parts only secondarily pegged down by various sorts of physical limits*" [8, p. 13].

A Unifying Vision

Capra and Luigi Luisi's [1] *Systems View of Life* portrays the twenty-first century as having inherited major problems involving the environment, energy, climate change, biosecurity, and financial security. They characterize these as systemic problems in that they are all connected. Historically, a reductionist analysis has been applied to the big problems facing humanity in general by reducing crises such as climate change and poverty and conflict to numerous problems, which represents a poverty of perception and a redundant worldview. These problems appear as one integrated problem or crisis, which we might consider being further exacerbated or impacted in unforeseen ways by the current COVID-19 pandemic.

Any new language of thinking should consider the attributes of systemic integration before action. It ensures that any intervention is compatible with those nested systems and other interdependent nested systems that constitute the macrosystem at work. Capra and Fischer suggest a radical shift in our language of thinking in establishing a sustainable society that supports all life.

Capra's deep ecological view requires a "*radically new conception of life*" and a new understanding of how the world is changing [1, p. ix]. Our planet comprises a series of interrelationships constituting a self-regulating open system. In this concept, the Cartesian mechanistic view of the human body is replaced by an organismic (like an organism), a complex, self-regulating open system.

By taking a systems view of life, we integrate the "*ideas, models and theories into a coherent framework*" [1, p. xii]. A unified systemic vision represents dimensions of biology, cognition, society, and ecology. The author contends that such an integrated view is necessary to solve and mitigate the many crises that plague our global community in serving the common good, not least of which is the current pandemic. This systemic view of life informs a new human ecology and a new ecology of learning.

All living things are complex and non-linear, which can be problematic for conveying ST, given that language is linear. However, language can be applied systemically by employing various systems-based tools such as geographic information systems (GIS), spatial mapping, and visual understanding environments (VUE), which break the linear constraints.

However, any attempt at developing a unifying vision must first consider the evolution of science and the scientific method. Capra and Luigi Luisi [1] state that science has been defined as *knowledge* from the Middle Ages and attributed to the Scientific revolution. The word came from the Latin Scientia and was originally known as Natural Philosophy. Isaac Newton published *Philosophiae naturalis* *principia mathematica,* which was to become the foundation of modern science. The modern context uses a scientific method to acquire knowledge. The scientific method came to full fruition during the twentieth century, where empirical science was characterized as a system, which

i. involves the systematic observation of phenomena;
ii. makes connections with the data; and
iii. tests a hypothesis to develop a well-founded theory.

Empiricism and theory building is the very essence of the scientific method. However, science can only provide tentative answers to phenomena. In comparison, ST enables students, teachers, and academics to possess a unifying vision in perceiving, learning, and solving at a very high level of complexity characteristic of our living world.

Science and Society

"*The emerging new scientific conception of life .... can be seen as part of a broader paradigm shift from a mechanistic to a holistic and ecological worldview*" [1, p. 4]. It illustrates a switch from our world's vision '*as a machine*' to a world '*as a network.*' The progression to an ecological paradigm took place in various scientific fields. Capra and Luigi Luisi [1] state that tension prevailed between reductionism (a focus on elements or parts) and organismic or holism (systemic like an organism).

The dynamic of holism and mechanism can be traced through biology. The ancient Greeks saw the world as a cosmos organized and structured and in the sixth century BCE as an organism, not a mechanical system. Their perception was that all parts of our world had a functional purpose, which contributed to an organismic whole, and that elements or objects assumed their functional place. This teleological premise was present within ancient Greek Philosophy and Science. This ancient perspective of the cosmos as an organism also served as an analogy of the interrelationship between the earth and the human body as one, as supported by Plato [1].

Aristotle's treatises integrated the thinking of science and philosophy through to the Renaissance. However, Christian scholars did not recognize Aristotle until Thomas Aquinas during the thirteenth century, who integrated Aristotle's body of work with Christian teaching. Aquinas saw no division between Aristotle's work on nature and the Bible, as the view was that both were authored or inspired by God.

The Renaissance was shaped by philosophy, humanism, and individual expression. I draw upon this cultural shift later in arguing for a new human ecology based on a return to humanism in promoting student self-efficacy within modern education. However, during the Middle Ages period, dogma gave way to a more secular perspective and an intellectual focus on our human capacity to create art, music, architecture, and literature. Classical Studies, Greek philosophy, linguistic translation, rationalism, and scientific thought became the new intellectual foci.

Capra states that Leonardo da Vinci (1453–1519) developed the foundation of modern science. Leonardo developed an organismic *systematic observation of nature, reasoning and mathematics*" [1, p. 7]. Leonardo created a unique integration between art and science by organizing a groundwork for understanding the nature and underlying principles of function. He did not study science, engineering, and anatomy to control nature but pursued knowledge and truth for insight and enlightenment. Leonardo saw complexity in living things and that human design was subordinate to nature at every level. He was instead inspired by nature, which informed his ideas and designs, ultimately contributing to an ecological worldview, which we now hold in high regard.

Rene Descartes (1596–1650) categorized life into two realms: the mind and the matter, in that all livings things and the material world were viewed as a machine, which could be understood by reducing it to its smallest parts for analysis. Galileo and Descartes' machine-like perspective saw the natural world as organized and governed by the laws of mathematics, which was developed further by 17th-century Newtonian mechanics. From here, Newtonian mechanics was applied to medical science in attempting to illustrate and understand the human body. However, this simplistic paradigm was superseded in the eighteenth century through developments in chemistry and biology.

The pendulum swung back towards a Cartesian mechanistic view of the natural world and living things. The world like a machine became the new reductionist root metaphor dominated by Copernicus, Kepler, Galileo, Bacon, Descartes, and Newton, responsible for the revolution in physics and autonomy. However, unfortunately, in essence, this reductionist worldview continues to this day–reducing education to that of an industrial age-stratified curricula model so prevalent in the USA, UK, Europe, and Australia.

Modern Biology

The poet William Blake (1757–1827) criticized Descartes and Newton's mechanistic worldview, leading to a shift attributed to romantic poetry and philosophy. This new worldview favored a biological, whole systems perspective that served as an antecedent of modern ST today, viewing the earth as an integrated whole. This organ-like view of the earth and all living things aligns with Leonardo da Vinci and, more recently, James Lovelock's Gaia theory 'mother' earth–to include all living things as a living organism.

A new study of microbiology led, particularly by Louis Pasteur (1822–1895), resulted in a shift from a whole systems view of life to a cellular perspective *which could also now be not simply observed, but placed under human control?* This view dealt with disease mitigation and the formation of biochemistry. At the turn of the

20th-century, microbiology failed to progress in providing a lens for understanding life on earth, and a new worldview was founded in ‘organismic biology.’ This new view of life as an organism, which began with Aristotle and Goethe, was seen as a living system, which cannot be broken down into separate elements and can only be understood through systemic relationships and interactions [1].

Another perspective of holism came from the Gestalt (organic form) psychologists who directly applied the phrase: “*the whole is more than the sum of its parts*.” This described modern ST, but in a way that has its origins with Aristotle’s Metaphysics Book 8 during the fifth century BCE. The ecology field eventually emerged from organismic biology during the late nineteenth century from biologists’ study of organisms. It informs the curriculum in terms of considering balance about reconciling education with learning and teaching with an assessment where there are disconnects and imbalance in favor of traditional subjects and high stakes standardized assessment that fails to promote creativity, growth, and complex problem-solving [9, 10].

By the 1940s, ST became consolidated as theory, methodology, and a new view of life, leading to GST and cybernetics, as previously stated. I will now explore this new ecological worldview.

This 21st-century ecological worldview embraced a holistic perspective or deep ecology as previously discussed, recognizing the interdependence of phenomena and that “we are all embedded in the cyclical process of nature” [1, p. 12]. An anthropocentric (human-centered) perspective is exclusively a human ecology and is classified as a ‘shallow’ ecology, whereas a ‘deep ecology’ includes the earth and all living things as an inclusive ecology. This informs and has implications for most modern education systems at all levels, which are essentially anthropocentric or human-centered in placing humans at the center of nature and ecological interactions at the expense of deep ecology, which embeds humans into the broader ecology.

Lessons from Australian Indigenous Scholarship—Unlearning the Western Paradigm

Capra states that there is a poverty of perception due to the prevailing reductionist thinking, which goes to the heart of the Cartesian dualism critique–a chasm between contemporary thought and the natural world. This is further illustrated by the disparity of thinking between (predominantly) white Australian (western paradigm) teaching on history and geography and Australian Indigenous culture and continuous lived experience. Australian Aboriginals and Torres Strait Islanders have a deep connection with the natural world, now recognized to extend back in a continuous lineage for tens of thousands of years. Their cultural and knowledge systems are diverse but include the four pillars of Kanyini from northern Australia (connectedness):

i. *tjukurrpa*, knowledge of creation or dreaming;
ii. *ngura*, place, land;
iii. *walytja*, kinship; and
iv. *kurunpa*, spirit [11].

This disconnect between the western paradigm of knowledge and understanding of the world with Indigenous culture can be extrapolated upon within most colonized populations across the globe.

Dark Emu by Bruce Pascoe [12] enlightens us of an ancient agricultural culture in Australia for at least 50,000 years. Contrary to the contemporary Australian narrative, it has always been a sophisticated, ecologically sensitive agricultural society. This emerging Indigenous narrative challenges our 'textbook' view of world history, which states that agriculture emerged 10,000 years ago from the Fertile Crescent "*spanning modern-day Iraq, Syria, Lebanon, Israel, Palestine, Jordan, Egypt, together with the south-eastern region of Turkey and the western fringes of Iran.*" Deconstructing this long-held view of 'civilization' in western teaching is an important process in developing better ST approaches in teaching the humanities, history, and critical thinking.

Pascoe's [12] narrative challenges conventional thinking about aboriginal life and culture on the Australian continent. He cites empirical evidence from explorer and colonist journals of the eighteenth and nineteenth centuries, which Pascoe uses to dispel the hunter-gatherer myth in demonstrating that Australian Aboriginals were, in fact, farmers with a highly developed practice of agriculture to include irrigation technologies, the production of cropping and aquaculture systems. Pascoe's work demonstrates the emergence of a highly ecocentric Indigenous economy, potentially extending back at least 50,000 years ago as an ancient culture that has practiced systemic agriculture in-tune with the earth as a living entity. Pascoe makes references to the Indigenous building of "*dams and wells; planting, irrigating and harvesting seed; preserving surplus and storing it in houses, sheds or secure vessels as well as examples of… (ecologically) manipulating the landscape*" [12, p. 2], such as through the use of fire, as examples of sustainable land management practice.

The Australian Indigenous have a systemic perspective embedded in their belief system through their emu story stemming from the dark space evident in the Milky Way: "*The emu is inextricably linked with the wide grasslands of Australia, the landscape managed by Aboriginals. The fate of the emu, people, and grain are locked in step because, for Aboriginal people, the economy and the spirit are inseparable. Europeans stare at the stars, but Aboriginal people also see the spaces in between where the Spirit Emu resides*" [12, np].

This quotation clearly illustrates the systemic, organismic connection between Aboriginals, flora, fauna, the earth, and their spiritual dimension. This, it would seem, is in stark contrast to their European counterparts, who view the cosmos from a more astronomical perspective.

The Aboriginal belief system illustrates a consciousness of dynamic equilibrium and an ecocentric, reciprocal relationship based on deep ecology and a spiritual connection with the country. This Indigenous perspective, in turn, nourishes all living things, not just themselves, through reciprocity. This is the antithesis of our current predominant paradigm that places humans at the center of the earth's ecology, aligning with a Cartesian mechanistic view of nature.

*Europeans saw Terra Australi*s as a golden opportunity for a new market through the agency of cheap convict labor. Colonists saw this ancient Australian continent as a land ripe for exploitation. This object was achieved from a European perspective, resulting in increased wealth to include new towns/cities being built to embrace a growing industrial expansion in serving those colonists and their countries of origin. Gold mining and resource extraction attracted Asian cultures from the middle of the nineteenth century.

Europeans afforded themselves an innate superiority in the sciences, economics, and religion, which informed a destiny over non-European inhabitants and ancient cultures. This was partly attributed to Darwinian theory, leading to the domination over the 'beast' in favor of a Eurocentric view of civilized man. This extended to religious domination by Christianity based on the precept of *Terra Nullius:* land deemed to be legally unoccupied or uninhabited. This was based on the Roman definition of a civilized society comprising a walled city. In particular, the British entitled themselves to a natural authority ordained by their Christian God.

It was unfortunate that 18th and 19th-century colonists not always sought empiricism over pre-enlightenment. The legacy of *absolute truth* ordained by God was still playing out during the colonization of Australia, regardless that Aboriginal cultural practice was aligned with the principles of ST (holism).

Australian Indigenous agricultural systems went well beyond that of their European counterparts and have done so for over 50,000 years in context and harmony with Australia's ecology. For example, advanced aquaculture was observed and dismissed by colonists based on their prejudicial agenda of cultural erasure and displacement. Australian Aboriginals have a common language of ST and know that it innately aligns with earth systems and organismic (organ-like) biology.

The farming of yams (Indigenous potatoes) serves as an excellent example of systemic and sustainable practice by Aboriginals. However, the introduction of cloven-hooved animals and European agriculture was highly reductionist and destructive, resulting in yam scarcity and flora decimation in general. This incursion failed to align with the fragile Australian ecology, destroying ancient systems of sustainable Indigenous practice, which evolved over thousands of years.

Indigenous systemic thinking extended to the trading in seed with relatives with sensitivity to earth systems as a reciprocal ecological process. These practices also serve as evidence of Aboriginal tribes as the first bakers, preceding Egyptians by 15,000 years. "*If we look at the evidence presented to us by the explorers and explain to our children that Aboriginal people did build houses, did build dams, did sow, irrigate and till the land, did alter the course of rivers, did sew their clothes, and did construct a system of pan-continental government that generated peace and prosperity, then it is likely we will admire and love our land all the more*" [12, np].

Australian Indigenous rice was systemically cultivated by Aboriginals in such a way that they were cognisant of biosecurity. This is in contrast to Asian rice, which was becoming less resilient to an emerging disease. These practices also align with cybernetics in that Australia's first peoples were mindful of feedback mechanisms to inform systemic intervention. These practices were evident from the diversity of flora and the ecological interdependence that evolved alongside the Indigenous population, making the entire ecology of pre-colonial Australia biosecure. Furthermore, long-term grain management and food production techniques developed did not require intensive irrigation, nor poisonous fertilizers and pesticides so detrimental to soils, crops, and fauna. These ancient cultural practices impacted very little upon the environment.

'Long term cereal production systems' were also developed by Indigenous peoples. This was achieved by making changes to the 'genomes and habits of plants' through the ongoing intervention of growth cycles and seed selection strategies, establishing a continuous cereal production. This systemic innovation developed a perennial integrated pasture that included a grain crop [12, p. 43–44]. This is an ancient innovation of global significance to inform biosecurity and food production throughout the world. In summary, pre-colonial Australia was a magnificent large-scale garden: *Hortus Magnificum Australis*—tendered by Aboriginal stewards through a culture of reciprocity.

What Is Broken Now?

The Earth, by Humans? This new deeper ecology, as previously stated and informed by Indigenous Australians, challenges us all to question the old reductionist paradigm that characterizes the western industrial worldview. This has implications for our human interactions and relationships within a wider ecology in seeking and identifying solutions to our complex problems. However, as a species, humans have fractured the connections between living entities and their environment. This is evident from the destruction of our wider ecology and the reductionist educational modeling. One only needs to cite the systemically closed Australian, US, and English curricula [13, 14]. This is not surprising given that these countries' educational systems function as closed systems [9, 15, 16].

Bateson tells us that closed systems do not allow matter and energy to pass through their boundaries. Therefore, in extrapolating from a curriculum modeling perspective, closed systems are highly constrained in catering to educational needs due to a disconnect with natural systems. Closed, homogenized systems, whether they be populations of living things or social models, are unsustainable because they are estranged from their ecological environments. A systemically closed entity destroys both itself and its environment. This further relates to our western modeling and, more specifically, curriculum modeling and educational systems in general that do not align with their environmental ecologies [1, 9, 16].

"*If an organism ends up destroying its environment, it has in fact destroyed itself. And we may very easily see this process carried to its ultimate reductio ad absurdum in the next 20 years. The unit of survival is not the breeding organism, or the family line, or the society*" [2, 7, p. 15]. This proposition is analogous to the AC, as the AC fails to display the attributes of an open, ecological system and fails to adhere to the ecological principle of subsidiarity. This suggests that we need to go beyond the current economic paradigm and traditional cognitive constructivism in favor of ST-based social constructivism to inform a deeper ecology. It is important, therefore, to recognize that humans are integral to natural systems and therefore dependent upon nature to exist, function, and survive. To differentiate the human species from the rest of nature is ecologically flawed [1, 17].

New Ways of Knowing and Learning

ST more effectively connects students with their prior knowledge and new knowledge. This is how meaningful learning is constructed. By applying ST, students are actively engaged in learning at all levels and are provided with options in contributing to their community of practice [18].

For example, Robson [19] suggests, in navigating social media spaces, we need to be mindful of embedded ideals that exist within all social contexts. Therefore, we share social norms, behaviors, and ways of thinking and being. This includes approaches to relating to people within a whole social system. Embedded 'ideals' are also 'particular discourses that inform knowledge and identity. Within education, this can be understood concerning 'ideal identity.' Ideals are embedded within complex systemic technological contexts and are nested within complex social systems and environments. Gatekeeper hierarchies and power structures curate dominant discourses about knowledge production, practice, and identity, informing powerful agendas. Engagement with these embedded ideals is either aspired to or rejected.

We must go beyond conventional discourse about online engagement within the education profession and also consider our underlying assumptions of technological determinism. Furthermore, there needs to be more systemic thinking within the critical discourse about the embedded social nature of online social familiarities and wider social issues. Embedded ideals and associated structures require greater critique to moderate bias and prejudice of the inherent power structures, ultimately affecting student knowledge construction within compulsory, post-compulsory, and higher education.

There is also a need to identify and regulate the online gatekeepers from a systemic perspective to make explicit to users: students and communities engaging online to surface hidden agendas. Students of all levels (age-appropriate) should also be equipped to identify ideals and the overall design in terms of how it constructs user engagement.

By applying organismic biology and being cognisant of dynamic equilibrium, we see the world through fresh eyes: a world of ecology and ecologies within ecologies or systems within systems. ST is a metasystemic methodology that enables us to perceive, understand systems, and intervene to manage goal-based open systems that characterize living things and closed systems that define non-living material things.

This mosaic lens is a powerful way of knowing and learning. This is because it connects with the earth's many systems and is sensitive to the life cycle of all fauna and flora. ST is supported by sound ecological and organismic biological theory, which I will elaborate upon later.

ST also aligns with being group smart in that innovation comes from collaboration with others by drawing upon the natural world. Smart Swarm by Peter Miller [20] conveys how nature teaches us how mass collaboration serves better organization to inform functionality. Miller goes on to teach us that historically our (educational) institutions have 'defaulted to traditional hierarchies.' Smart Swarm transforms how we see our world and others as reciprocal agents for learning, knowing, change, and problem-solving intervention.

Tapscott, who wrote the forward to Millers' text, states that Smart Swarm challenges the 'tenets of hierarchical control' in collaborating across organizational silos. He also challenges us all to rethink power through people rather than over people. "*This model has worked well as a way of systematizing work, establishing authority, deploying resources, allocating tasks, defining relationships, and enabling organisations to operate*" [20, np]. This comes from a more organismic approach to organizational hierarchies in allowing systemic self-organized networking and interconnection to form collaborative teams globally. This informs educational curriculum modeling in exploring and sharing best learning design practices to employing connective ST-based social principles such as subsidiarity, solidarity, and the common good. Now I will delve more deeply into curriculum modeling.

Current Curriculum Modelling

The problem with current curriculum modeling is that we are not cognisant of 'dynamic equilibrium' and systemic thinking in general and tend to overreact to the dynamic peaks and troughs within our education systems. Closed systems such as the Australian Curriculum (AC) [21] administered under the Australian Curriculum, Assessment and Reporting Authority (ACARA) mitigate reductionist curricula by implementing patch and mend strategies or short-term symptomatic remedies. The natural world further illustrates this in that change and fluctuation is natural phenomenon, requiring actions that are sensitive and mindful of the dynamics of fluctuation and change. By way of analogy, it is akin to moving house in the advent of a one in a one-hundred-year flood. It poses the question; how do we mitigate such flooding and keep the integrity of our waterway systems?

Curriculum modeling is not dissimilar in that contextual change (such as the COVID-19 pandemic) poses a shock, but we are still human, and we are still part of the natural world, requiring a sensitivity for the moving parts or ecological variables. To overreact by closing ourselves off to the wider ecology through autocratic policies and models results in a fracture between policy and curriculum [13, 22]. I will now address how ST may address systemic problems with systems solutions.

Can ST Fix This?

Bateson and Capra suggest drawing upon the natural world through biology to build more resilient systems of knowing and learning. This can be constructed by unifying our thinking in creating stronger links with our natural systems. Humans are self-regulating open systems, just like the entire earth's ecology. We regulate our bodies but have the power of choice that sets us apart as a species. This is a clue in considering how to mitigate the problems that beset us and how to live sustainably in allowing our entire ecology to flourish as a whole system.

Policymakers could integrate this ecological worldview into our education systems, policy settings, and curriculum modeling. Pangaro et al. [6] suggest utilizing feedback from our actions through the employment of cybernetics in that we can course-correct in real-time to reach our set goals.

This ecological worldview is similar to organismic biology and also links to von Bertalanaffy's [3] Dynamic Equilibrium by being cognisant of both negative and positive feedback mechanisms that assist us in self-regulating at every ecological level. In applying this as a language for curriculum modeling and learning, teachers and academics must also consider our collective imperatives in progressing a new educational ecosystem [23].

Teachers today generally regard themselves as facilitators of learning in a complex environment [10]. If this is the case, then learning will be our key educational goal. Then we must ask, what is learning, and how do we measure growth and success? In simple terms, education, Curriculum, learning, and teaching are not easily defined. For example, the funding of an education system, the communication of a curriculum, and teaching practices do not always mean that learning is taking place. In some instances, quite the contrary. For learning to occur, a creative process culminating in producing a cultural artifact may have been necessary that is useful to the student(s) and their community. A goal must be made explicit, and the journey negotiated with the learner researcher to be measured within a continuum of development and growth without the fear of standardized grading. The assessment then becomes a collaborative goal-based narrative by both the educator and student.

ST Curriculum Modelling

In drawing upon my curriculum models [24, 25], I will further demonstrate how ST informs Curriculum and pedagogical innovation by mitigating traditional schooling effects. In the western tradition, the ‘schooled mindset’ served 19th and 20th-century industrialism for occupations that no longer exist or are in the process of being overtaken by roles fit for a digital society. Educators and students are left with a production model legacy in the twenty-first century characterized by an age-stratified education system compounded by a subject-based curriculum structure [25].

In contrast, an ST approach to curriculum modeling and pedagogy favors interdisciplinarity and returns to a village model of the classroom or age mixed environment. This approach reinforces social connection and is mindful of how students are socially and intellectually situated. Other attributes of ST include the promotion of student self-efficacy and agency in fostering resilient, independent learners.

Organismic Biology Informs Compulsory Educational Modelling: Open Systems

Organismic, open system education modeling promotes increased flexibility. For example, by applying disciplinary lenses as threads in gathering real-world elements in forming thematic curricula modules. This creative synthesis embeds traditional disciplines within meaningful, relevant contexts that resonate with students. This process emulates an organism, which is evident through its connection seeking and consolidation/defense attributes. This mitigates the constraints of the current divisions of knowledge as defined by traditional subjects.

This transdisciplinary thematic focus provides much-needed stimulus and scope for creative, virtual worlds curricula and problem-solving simulation development. Chow [26] states that being present in a virtual world learning environment promotes more effective learning for students. Robinson [9] states that we live in a virtual world of ideas, which align with this approach as it connects to our enormous creative capacity. Furthermore, this virtual environment also allows students to connect with and model behaviors for real-world applications to include cultural artifacts useful to themselves and their communities.

This form of systemic learning is applied engagement within a collaborative ecology instead of the listening and absorbing learning model, which is highly passive. The role of the teacher undergoes changes to that of a mentor and co-learner with the student. It is a shift from reductionist schooling to a higher emphasis on student self-efficacy. This new paradigm also enhances the systemic UX (user experience) design, allocating students as agents of their own education construction, design, and synthesis. Such a model can also be informed by vertical curriculum modeling in mitigating the adverse effects of age-stratified design and learning. This is reinforced by positive psychology that provides greater agency for users in strengthening this UX focus.

Students, as agents of change, can potentially progress such educational modeling through this systemic UX focus as an ongoing organic process in collaboration with teachers, academics, and specialists. This challenges the Cartesian machine-like approach by developing an ecology of systemic practice. The emphasis here is ecology and holism, which contrasts with the prevailing deficit approach that seeks to view students as being educationally deficient in need of homogeneous schooling or treatment [27].

Ivan Ilich [27] critiqued the role of schooling, noting that within its traditional/industrialized western form, it has confused substance and process in promoting the view that clinical, educational treatment leads to a well-educated person and, ultimately, to success. Ilich also states that this also disenfranchises the individual and his/her communities of practice. Within traditional schooling, imagination becomes schooled to include a severe decline in creativity. Robinson [8] states that there is a negative *corollary* between a child's school life and a decline in creativity. This is a travesty because creativity is of paramount importance for students and young adults to become innovative, independent, collaborative learners.

Discussion

An Existential Threat in All Its Dimensions

Utilitarianism has been the main object of the West at the expense of the Common Good and Human Flourishing. The litmus test is, are we thriving or just surviving? The connection between education and socio-political objectives remains the prominent driver of education policy and the resultant curricula of many countries. Of particular issue is the socio-economic underpinning of access to and participation in education, regardless of the relative wealth of nations.

Herman and Chomsky [28] state that poverty is 'by design' and is a socio-economic construct that structurally allows developed nations to create wealth, privilege, and power over others. This ethos has corrupted political systems and education. For example, Chomsky states that in the US, democracy as a lexicon has been emptied of its original meaning to an exploitative end driven by a neo-liberal super-rich elite who represent less than 1% of the US population. The US corporate Politcal Action Committees dictate policy and shape legislation in dividends and invested interests after funding targeted politicians to get elected. From a functional structuralist perspective, education is unavoidably affected and shaped by this through a nationalistic narrative taught in schools, for example, Truth, Justice, and the American way, a well-known American slogan. Unfortunately, this culture of money-for-policy exists throughout developed countries to the detriment of the democratic process financed by large corporations. One way of mitigating this is to apply ST principles in creating a level playing field by capping political donations and promoting subsidiarity and more equitable community access and representation.

Integrating ST throughout education, within both compulsory and non-compulsory sectors, potentially empowers students to interact and make decisions and contributions in ecologically sustainable ways. As our future policy advisors, from social justice to mitigating climate change to living in balance, I think if ST was embedded in our education systems globally, we would not have, for example, exploitative policies rendering 1 billion people in a state of poverty worldwide. Developed countries live at the rate of three planets earth, while the rest struggle to live healthy, equitable lives.

Education here has a very important role to play in educating our population to be engaged, ethical citizens at all levels. It requires that educators, learning designers, and policymakers think anew by drawing upon ST, Indigenous belief systems, wisdom traditions, and philosophy to instill an ethical dimension and a moral purpose in student graduate attributes at all sector levels. This could also include employing, for example, ST in promoting a critical frame of mind in ultimately mitigating manufactured consent as perpetrated by the popular 'media propaganda machine' as identified by Herman and Chomsky [28]. Unfortunately, critical thought has been subsumed by manufactured truths based on the tenet of a protectionist narrative, whereby the instruments of government and media censor truth and reality. Unfiltered truth becomes a threat to the corporate culture, foreign policy, and therefore the western power base: 'power is the right to dictate reality.'

We learn stability from living organisms. However, unfortunately, neo-liberalism, compounded by an anthropocentric worldview, has little empathy for our declining earth, particularly given the corporate control of the earth's resources. Indeed, there is a proposition for a new language of thinking. Indigenous ecocentric cultures are a long way from Wall Street, where the earth is viewed as a resource to be exploited regardless of the consequences, which is in stark contrast to the Indigenous, who view our earth as an organism and a living entity that must be respected. I will expand more on this by exploring the Australian Indigenous culture later in this chapter.

Embedding Sustainability Across All Curricula

The knowledge divisions are at odds with ST because they reflect a Cartesian industrial construct, not a socioecological one. For example, by adopting a more systemic, age-mixed transdisciplinary education model worldwide, we enhance our capacity to adapt to changing contexts and environments. As humans, we are self-directed systems wired for change and adaptation to new environments and contexts. Therefore, it is important to be cognizant of this disposition and align our learning and curricula accordingly, but with a sensitivity of all ecologies that we are nested within. This respects the earth as a valued entity that we are dependent upon for our survival and the survival of all living species.

We need to bridge the Cartesian gulf between the mind and the physical realm by employing circular systemic problem-solving in addressing root causes. The proposition of a 'circular economy' may be one positive example, although this too has its critics as an example of 'shallow ecology.' This can be achieved by reflecting, modeling, and acting in proposing ecocentric approaches. This then informs preventative, sustainable solutions that appreciate the earth as a living organism that provides an indispensable life support system. Cybernetics is also relevant here by applying positive and negative feedback in correcting our course of action against goals.

The human body serves as an instructive metaphor in illustrating this proposition further. The body requires stimulus, food nourishment, social interaction, and exercise for mind and body to maintain the human person in all its dimensions: emotional, physical, cognitive, intellectual, and social. These are also interdependencies in that any singular weakness potentially creates a systemic breakdown and dysfunction. This human system is nested within a myriad of ecological systems that we, humans, are dependent upon to survive.

Change, Our New Constant

Our world is never static, but most western countries educate their populations as if it was. We live in a world of change and interconnection. Predicting our future is fraught with misconceptions and a denial that we have progressed from the Enlightenment period given our industrial education paradigm. For example, in the history case study exemplars in the Australian Curriculum, one can only be impressed by the paper-based colored pencil illustrations. Some insightful work seems to be an absence of contemporary artifact examples reflecting new modeling and digital literacies. Well done to those students and their efforts—valid study here, no intention to disparage. However, it is produced with 60 s technologies.

Today we need a new way of thinking that requires a web of diversity, not convergence—exploring many answers to those complex problems that beset us. Traditional schooling prescribes answers and formalizes our thinking and modeling by applying a patch and mend addressing today's symptoms. As educators, we should instead deal with the root causes attributed to an outdated legacy of thinking perpetuated by neo-liberalism.

The dynamics of our interrelationships could benefit from a group smart systemic culture of thinking. The Age of Paradox by Charles Handy tells us that unemployment from companies and institutions removes the shackles that stifle our initiative by allowing a channeling of a new collective potential for a new business ecology, as we become consumers of each other's goods and services within a reciprocal economy. This poses a more collaborative ecological economy that is more disposed to social justice and the common good through interdependence [29].

Systems Thinking and Digital Virtual Worlds

To further enhance our new systemic language of thinking, Digital Twin Technology (DTT) can be employed to inform education modeling and simulation from real-world scenarios. DTT virtually replicates a given environment, system, or program for future modeling, simulation, redesign, critique, and problem-solving. This could theoretically help build a new human ecology that values individual self-efficacy, interdependence, and collaborative learning.

A systemic DTT application has particular relevance if Virtual World learning environments are being considered and developed, as it becomes a developmental bridge for UX (user experience) design. This approach also informs simulations to teach cause and effect and long and short-term consequences of human actions. For example, as previously stated, embedding sustainability across a school and university Curriculum mitigates the effects of climate change and promotes graduate attributes that foster sustainability in all its dimensions in living within the limited resources of our planet earth. Systemic thinking informs us that we live within a materially closed system and that where possible, these materials need to be recycled or ecologically offset.

These Virtual World environments align very effectively to how humans systemically function in that we already live in a virtual world of ideas. For example, our ability to dream, imagine, and create and construct our mental world. Senge [30] tells us of a mental model that informs our thinking and reality and that new experiences alter these states of being by being engaged in new learning experiences.

A systemic DTT approach assists educators in designing, building, and operating new education models. Furthermore, this new thinking and modeling inform ST Cybernetics and student goals in constructing innovative Curriculum and learning to reflect student learning priorities within compulsory and non-compulsory education.

At a higher education level, systemic collaboration can lead to the development of incubators of innovations by students and academics. It is evident given the Advanced Teaching and Learning program at Warwick University and the *Systems* and Environmental *Sciences* Department at Open University UK, where transdisciplinary programs flourish through students practicing their own production, creativity, and systemic problem-solving.

Narratives in Sound Art

ST can be illustrated by arts collaboration. In further developing a systemic approach to Virtual Worlds by employing sound and graphic art composition, provides an immersive experience, rich UX experience for academics, teachers, and students at all levels. By exploiting sound, graphic, and animation art through contemporary narrative, students can construct their own worlds and provide collaborative case studies and artifacts as integrated learning outcomes to be published in the public domain. It enables students as knowledge producers and consumers within a reciprocal learning community.

Through an augmentation of verbal phonics, we can access an entire sound resource that reflects at many levels, both semantic meaning, literary device, and narrative soundscape composition. This represents the employment of the human system as a creative resource. For example, a soundscape composition based on the word Lamenterra, which I composed in 1995, was a term created to reflect a lamentation and celebration of the earth (see Appendix I). By augmenting or reducing the spoken word frequency: Terra (earth) to produce a percussive phonic effect, I created an entire soundscape narrative from both a literary and sound art perspective. This was conceived and defined as a creative aesthetic system as an element of this art installation. Search for Australia Felix also portrayed the earth as an organism [31].

Search for Australia Felix

Search for Australia Felix was a systemic process that involved a diverse group of artists, including composers, graphic artists, choreographers, and communities from various cultural backgrounds to include an Aboriginal College with the local townspeople of Benalla, Victoria, Australia. This project included Indigenous stories, dance, and music, which contributed an aesthetic dimension to the creative, collaborative methods. This Indigenous contribution provided fresh, insightful perspectives on creative expression through their belief system.

The Aboriginal input also brought a contrasting value system to this project, reflecting connections with the earth and its inhabitants. "*A western understanding of* '*dreaming*' *is as a timeless state of being and believing. The aboriginal tradition traces cultural journeys from their ancestral past and assists in reinstating our web-like organismic relationships through realising the creative and celebratory bonds that still exist between people and the earth. By amplifying the strengths of these relationships, we serve to disseminate issues of awareness and provoke questions of past, present and future*" [31, p. 6].

Conclusion

We must develop a new language of thought that disenthralls us from the old industrial, educational model. As humans, we are self-correcting, goal-based open systems that function best within a social climate informed by an ecological ST worldview. However, unfortunately, an anthropocentric education model has predominated since the introduction of mass education in the nineteenth century. This education model has been characterized by reductionist industrialism and commodification for an era that longer exists [10, 15]. "*The most ethical thing we can do is increase the choices of others*" [33]. By establishing and developing ST as a new language of thought, we empower all to serve the future needs of our communities.

Core Messages

- There is a need for a new human ecology in education that aligns with our earth's ecosystem.
- Adopting an ecological worldview through curriculum and learning models helps mitigate the multitude of crises we face worldwide.
- Moving from an anthropocentric education paradigm towards an ecocentric one is imperative for sustainability.
- Indigenous curricular perspectives, inform learning and teaching with greater ecological sensitivity.
- The principles of ST in education are quite promising in promoting social justice, human dignity, and the common good.

Art Performance

Search for Australia Felix (*Lamenterra Project Production Film by Spain, S., Power, M., Pollard, M. and Balla, T., 1996;* https://bit.ly/30oUBsV)

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Systems Thinking and Action for an Entrepreneurial Journey Towards the House of Lab Science

33

Christian Hugo Hoffmann

"*The development of systems thinking is crucial for the survival of humanity.*"

John D. Sterman, 1994

Summary

Systemics is a movement which results from communicative activities, crossing disciplinary boundaries to overcome the fragmentation of science; in other words, as Ackoff reminds us, "stop acting as though nature were organized into disciplines in the same way that universities are." In this paper, we briefly sketch the scope and importance of that movement as well as a specification, namely the St. Gallen Management Model, in the context of, on the one hand, dynamic complexity inside of and around businesses and innovation or entrepreneurship, on the other. We observe, though, that the proposals made remain far from having an impact and becoming manifested in venture-building. Therefore, we study the case of the startup House of Lab Science as a paradigmatic example of systems thinking and *action*, which not only integrates different disciplines, from bioengineering to piano performance but, first and foremost, many different stakeholders aligned to the goal of establishing a prosperous cluster and ecosystem.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_33

House of Lab Science

Keywords

Complexity · Entrepreneurship · House of lab science · St. Gallen management model · Systems thinking

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction

As Von Bertalanffy' pointed out in Kuhnian terms [1], the systems movement and penetration of systems thinking into science have led to the development of a novel "paradigm".[1] Now is the time of improving the *modus operandi* of the business practice, particularly venture-building as the backbone of the economy [5]. This has

[1] In Kuhn' terms [2], "[p]aradigms are self-consistent communities of like-minded scientists, sharing a worldview encompassing not only a body of theory and evidence but also methods of inquiry, standards of proof, textbook examples, and heroes" [3]. "Eventually comes a period when the ruling paradigm cannot solve certain problems, and scientists start questioning the paradigm's fundamental assumptions. When enough scientists become convinced that it is impossible to solve the anomalies accumulating within the framework of the ruling paradigm, and only if an alternative paradigm is available, then a scientific revolution takes place" [4].

been demonstrated impressively in recent months and years with the coronavirus disease (COVID), the exponential development of case numbers, the economic risks of the pandemic as well as startups facing liquidity problems. Specifically, most organizations, at least at the beginning of the pandemic, have been probably just poking around in the dark as they have fallen short of specifying their right environmental spheres and as they do not know the mechanisms or causal factors in the relevant environment, nor their impact on their financial risks and key performance indicators. This renders it difficult, if not impossible, for them to apply their standard repertoire of management instruments.

New tools have been proposed in the literature in the spirit of the systems movement. For this reason, we first summarize the evolution of the systems movement in the next section in a systematic, not historical manner. In the third section, we turn to a management approach, the so-called St. Gallen Management Model, and discuss it in some more detail since it was put forward to focus on the heart of the problems which is found in dynamic complexity and relevant characteristics thereof such as spillover effects. At the same time, proponents of this approach appreciate the important role of entrepreneurship and the founding of companies, making it stand out in this context. Yet, even though this might be a sound expression of systems thinking, we miss the link to action and to concrete implications for venture-building, respectively.

To fill the gap, we study the case of a Swiss startup, the House of Lab Science, as a paradigmatic example of systems thinking *and* action, which, on the one hand, integrates different academic disciplines, from bioengineering to piano performance. On the other hand, the example also shows that many different generations and stakeholders (beyond their common classification into groups, industries, or sectors) can be aligned to the goal of establishing a prosperous cluster and ecosystem. Thereby, this chapter calls for a Kuhnian paradigm shift in the business practice of venture-building. The final section concludes.

The Systems Movement

As emphasized in the relevant literature [6], the term *system* has multiple definitions, among which Schwaninger [7] focuses on the following:

i. "A portion of the world sufficiently well-defined to be the subject of study; something characterized by a structure, for example, a social system (Anatol Rapoport);" and
ii. "A system is a family of relationships between its members acting as a whole (International Society for the Systems Sciences)."

These two examples show that "systems" do not need to apply to the real world [8]. By contrast, the conception of the word "system" allows us to formally embrace many different forms of phenomena and objects; as such, there is a broad range of classical objects and other things to which the concept system can be effectively applied. Examples of classical objects are financial and economic systems and ecosystems. Yet, also things such as problems can be covered under the umbrella of a system. In this manner, "[w]e have also come to realize that no problem ever exists in complete isolation. Every problem interacts with other problems and is, therefore, part of a set of interrelated problems, a *system of problems*" [9–13].

Each system, however, is characterized by a boundary that demarcates the system from the surrounding environment [14]. The degree of demarcation depends on the type of the system, ranging from *closed systems*, in which its components are not related to the environment outside the system [8], to *open systems,* wherein the material, information, and/or energy transfers occur via the system's boundary. However, this boundary appears to be a rather theoretical issue. Indeed, the function of the boundary and the degree of demarcation is not overly deterministic [14] but hinges on the working condition [11, 15] (Fig. 33.1).

The introduction of the term *systems* to the field of *science* remains under discussion, and despite attempts to identify a systems movement or a systems approach for it becomes practicable somewhat [16], the collective of the words *systems* and *science*, as "systems science," has often been applied loosely at most. Systems science is the result of communicative activities that cross disciplinary boundaries in order to overcome an over-fragmentation of science; in other words, Ackoff says, "stop acting as though nature were organized into disciplines in the same way that universities are" [17].

In Klir's words, systems science is [18] "a science whose domain of inquiry consists of those properties of systems and associated problems that emanate from the general notion of systemhood." Such definition, in turn, challenges us with what systemhood is, as yet the term systemhood has not been available in The Oxford English Dictionary (OED Online, accessed April 24, 2020).

Fragmentation is the main characteristic of efforts to determine the capacity of systems science as a discipline [8], with several sciences playing a role in the evolution of the systems movement (Fig. 33.2).

The systems movement, also known as systemics, is, therefore, proposed as a term that incorporates a wide range of views instead of being focused on a single dimension of systems theory [7]. Keeping such an approach in mind, it is, as I already explained elsewhere [19], possible to tackle the issue of what systems science is on two overlapping bases:

i. "First, it is noteworthy that a very close relationship exists between the different systems theories, on the one hand, and an underlying methodological holistic way of thinking on the other. The common denominator of the different systems approaches in our day is that they are aligned around a worldview which is an integrating, an analytical as well as a synthesizing [11], form of thinking, expanding one's horizon, starting from larger contexts and taking many factors into account, compared to a more isolating and decomposing analytical procedure. Rather, to be an effective systems scientist, we must at the same time be both a *holist*, looking at the system as a whole (e.g., the financial system and its

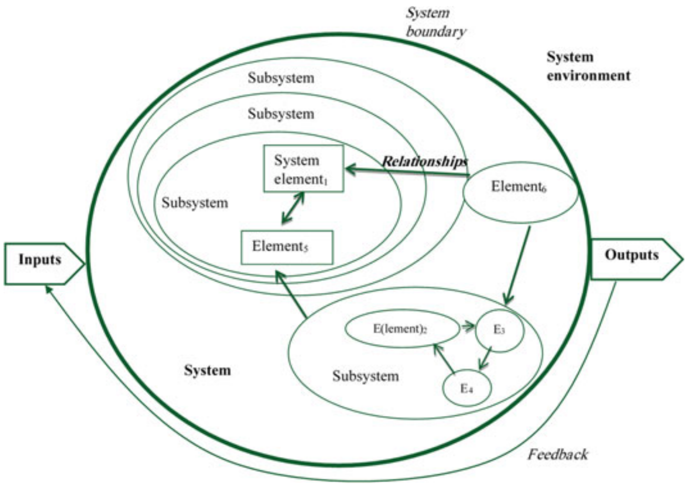

Fig. 33.1 The systems view in general terms. It presents the scheme of the system as a whole, whose constituents are elements, subsystems, relationships, and environment [21]

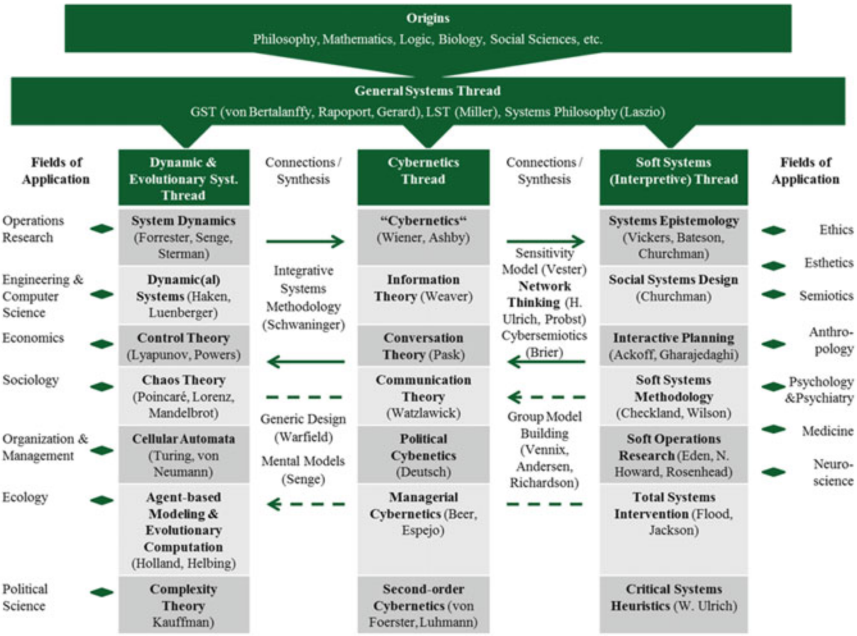

Fig. 33.2 The evolution of the systems approach [7], GST, general systems theory; LST, living systems theory

dynamic complexity), and a *reductionist*, discerning the system in more detailed forms (e.g., analysis of single financial risks) [8, 20]. The various systems approaches originate from a form of thinking which involves "seeing" interconnections and relationships, i.e., the whole picture as well as the component parts [11]. Systems theories are then formalizations of holistic, systemic or *systems thinking* [8], not systematic thinking [11]. Only the former is circular [21–23]. Furthermore, it has been said that systems thinking is a framework of thought that helps us deal with complex things in a holistic way [7, 8, 24], which hints at the second aspect in response to the quest for an overview understanding;" and

ii. "second, when reflecting on what systems science is all about, the classic answer, reinforced by the purpose of systems thinking, is that it is all about dealing with complexity [8, 11].[2] This identifies a need to clearly comprehend the concept of complexity which can bear many possible meanings. For example, many, first and foremost *social* systems are non-trivial [25] or complex in the sense that a certain input (see Fig. 33.1) is not always transformed into the same output by the system because the system possesses its own internal dynamics (*eigendynamics*), the transformation function is not unvarying [11]." In this context, Helbing [26] put forward three categories of complexity: structural complexity, dynamic complexity, and algorithmic complexity.[3] The first two are within the scope of the present chapter and can be defined as follows:

- "Structural complexity or complicatedness refers to systems that have many (moving) parts, but they operate in patterned ways [27]. A complicated system can be meaningfully analyzed and integrated, i.e., it can be taken apart into its components and reassembled from those components, which means crucially that it can be described by a mathematical system founded on *linearity* [28, 29]. Structural complexity or complicatedness applies, for example, to a car, which is a designed and complicated system made up of many parts. But these parts are constructed in a way that let them behave in a predictable and deterministic way, i.e., according to fixed rules. Therefore, a car is relatively easy to control [26]. In other words, a complicated system is folded (Latin "*plic*") and consequently conceals its internal structure. Nevertheless, given enough time, we can discover how it works [30]; and
- instead of the previous 'analytical' or 'reductionist' approach, characterized by "decomposing a system in components, such that the detailed understanding of each component was believed to bring understanding in the functioning of

[2] There is no inversion to occur, since not all modes for handling complex issues are systemic [19].

[3] Andrei Kolmogorov, Ray Solomonov and Gregory Chaitin introduced the term "algorithmic complexity" as a quantitative measure of important resources, e.g., time and storage that works using algorithm-based methods or a computer. Its usage often happens in association with traditional theoretical computer science, and is less applicable to systems thinking of entrepreneurship. This is so because as, for example, Nicolis says in [16], "algorithmic complexity is a static, equilibrium like concept." Another tentative exploration of the concept of complexity can be found in [20].

the whole" [31], dynamic complexity demands that one tries to comprehend the interconnections and relationships, i.e., "the whole picture as well as the component parts" (ibid.); this, in turn, includes analysis as well as synthesis (so-called 'systems thinking' is circular, as stated above). Dynamic complexity can arise even in simple systems[4] [33, 34] in terms of a low number of variables or components in a system (low levels of *combinatorial* or *detail* complexity; [35, 36])[5]; but, ceteris paribus, the more complex the system in the structural or combinatorial sense, the more it is dynamically complex. The latter primarily results from the interactions among the agents of a system *over time"* [35, 36]. It may be illustrated by freeway traffic where "the interaction of many independent driver-vehicle units with a largely autonomous behavior can cause the self-organization of different kinds of traffic jams, the occurrence of which is hard to predict" [26].[6]

Systems Thinking for Tackling Complexity in Business

Businesses have interconnected components, such as departments and teams, that join forces in forming a dynamic and open whole that qualify them as systems [11, 37, 38]. Dynamic features allow them to alter the company size and marketing strategies while interacting with the external environment to import information and export relevant products.

[4] A system is defined as simple when it works with a limited number of interactions and so we see its behavior can be predicted, i.e., the system is behaving the same way and produces the same results. Such a simple system is at work as we are switching a light on and off [27]. From a deeper philosophical point of view, we refer to Rosen's definition of a simple system [32] as a system for which "Aristotelian causal categories can be independently segregated from one another." Among many competing definitions, it would be noteworthy mentioning Weaver' definition [13].

[5] The term *combinatorial complexity* or *detail complexity* are not further explicated by Sterman [3] and Senge [24].

[6] "At first glance, it might be objected that it would be illegitimate or overstating the case to draw a *qualitative* distinction between structural and dynamic complexity: If a 'combinatorially complex' situation is understood as one where you have to expect a large amount of possible outcome states (whose individual probabilities may be difficult to determine because they depend on a large number of aspects or variables), then taking additionally into account the interaction between agents over time just seems to multiply the number of possible outcome states. Indeed, it is hard to see why a 'purely combinatorially complex' system, able to assume many different states because of high numbers of components in a system and/or combinations, cannot be as complex as a dynamically complex system in finite time (i.e., in terms of the degree of complexity or variety) whose agents or system elements interact heavily, but are only few in number. Therefore, for the sake of the argument, interaction over time by itself seems simply to be one among other factors increasing the overall complexity. While this objection might be valid to some complexity or systems researchers, because they do not sufficiently explain the difference between different notions of complexity (e.g., [3, 24]), it ought to be elaborated on the special features of systems as *dynamically* complex, which require, for example, specific modeling approaches, pointing, in turn, to a qualitative distinction between dynamic and other forms of complexity [13]", as I already explained in [19].

More precisely, businesses are projected as organic or viable systems [11, 12, 15]. For such systems, living entities (human capital) play a crucial role in satisfying the survival needs under changing conditions to make them adaptive. Consequently, these systems have been increasingly complex. From Thompson's view [39], complex organization is a collective of interdependent components when being enrolled together in the formation of a whole that is dependent upon a larger environment. Daft refers to complexity as "the number of activities or subsystems within the organization" [40]. For an organizational structure, he considers complexity as a three-dimensional measure that consists of[7]:

i. *vertical complexity*, it corresponds to "the number of levels" of a hierarchy;
ii. *horizontal complexity,* it corresponds to "the number of functions, units, or jobs"; and
iii. *spatial complexity,* it corresponds to "the number of geographical locations."

Moreover, in the environment, we face complex organizations and businesses rather than simple and complicated systems. For the environmental organizations and businesses, we can refer to Scott [42], who conceives complexity as the number of things, including elements and items, that an organization must take into account simultaneously. As a matter of fact, already acknowledged by several scholars, large organizations are, mostly, belonging to a larger economic system that is already considered complex. This statement is directly applicable to the current condition, leading us to conclude that the economic system, given its interconnectedness with other systems such as health or pandemics, is complex [43]: "[A]s one moves to considerations of larger and larger systems, the problems of complexity become enormous" [44].

When we now move to systems thinking as an effective way to deal with complexity inside of and around businesses as systems, we come across concepts, constructs, and even theories such as Beer's [12] viable system models or the *St. Gallen Management Model* [45, 46] which help tackle the encountered challenges. Inspired by the systems movement, those management theories emphasize the organization's embeddedness in and dynamic interaction with its environment or stakeholders and are therefore communication-oriented. In particular, the current 4th generation of the St. Gallen Management Model (SGMM) [45] conceptualizes management as a reflective design practice and pays special attention to entrepreneurship.

In contrast to our everyday understanding, the SGMM does not grasp the environment as the entire world outside an organization. Rather, the environment is seen as that part of the world that it *selects* [47] as relevant to its existence [48] or that it makes use of for its own value creation. In this connection, stakeholders [49] can broadly be understood as organizationally relevant representatives of or voices for environmental spheres [45], which, on the one hand, significantly influence the

[7] There have been other occasions that organizations could be conceptualized as complex systems [41].

businesses' scope for action and, on the other hand, are affected by the total effects of their activities. Businesses' activities, in turn, determine their economic value added (EVA), which, following the SGMM, is referred to as a process, thus relying on requirements that have to be met in their environment as "room for possibilities" and transformed into an organization-specific resource configuration enabled by communication [45].

A paradigmatic example of this structuring through communication is the founding process of a company. In this process, the business idea with the desired added value must be communicatively negotiated, clarified, and successively concretized by the founders (see Fig. 33.3). In the course of this process, ideas for a meaningful division of labor and expectations of an appropriate work structure with associated rights and obligations emerge as well. Over time, stable roles, rules, and routines are formed, which must also, at some point, be formalized: in a business plan, in articles of association, in a competence order, or contracts with suppliers, employees, and investors. A founding process is fundamentally based on communication and on decisions that are solidified into premises for future decisions and actions. All those creative ideas, expertise, and demands that are not or cannot be incorporated into the joint communication and that get stuck in the heads of the participants, so to speak, cannot be rendered effective: what counts is not what the founders think, but what makes it into organizational communication. Therefore, the targeted creation of conducive conditions, attitudes, and rules for open and constructive communication is an essential prerequisite for success right from the start.

The viable co-evolution of a business and the specific environment relevant for its existence depends on a sustainable, differentiating creation of value for this environment. Value creation not only has to make a difference but also is nowadays based on the dynamic interplay between the differentiation of subsystems and the integration of contributions to value creation relying on the division of labor principles. Such clarification of "systemic" approaches in the context of business and entrepreneurship is helpful for further understanding both concepts and language as well as it comes crucially with *practice*. It is, therefore, a matter of succeeding discussion.

A Case Study for Systems Action: The House of Lab Science

How can those abstract ideas and approaches now be rendered concrete to generate an impact in practice? The following presentation of a startup in the field of "lab science," integrating and going beyond the known disciplines of biotechnology, nanotechnology, information technology, microtechnology, mechatronics, might serve as a good starting point by demonstrating not only systems thinking but mainly systems *action*.

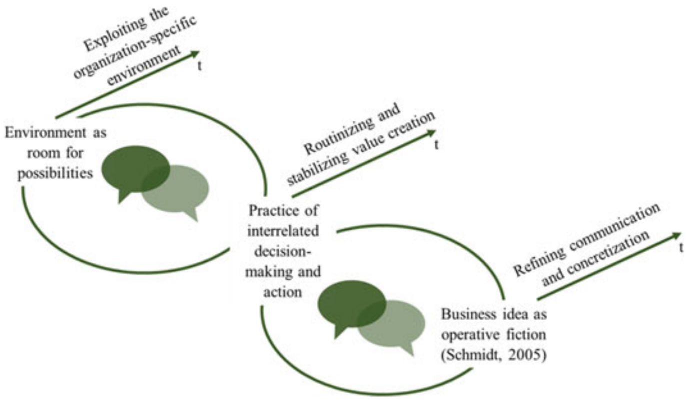

Fig. 33.3 The process of founding a company according to the SGMM (after [45])

By this startup, House of Lab Science, an innovation campus for the Swiss laboratory technology sector is established, a physical and virtual place to be. (Fig. 33.4).

Switzerland hosts a strong cluster of internationally leading laboratory technology companies.[8] As a beacon with a global reach, the House of Lab Science aims to further strengthen the networking or eco*system* of this future-oriented industry by attracting additional young as well as established companies and talents with different backgrounds.

The connected office buildings at Garstligweg 6 and 8 in Hombrechtikon provide ideal conditions for research and development as well as for networking and public relations activities. For decades, they were the home base of well-known laboratory technology companies such as Tecan, Rosys, and Qiagen Instruments; but "ideal" also in the sense that there is, perhaps with the only exception of the greater area of Boston, no other place in the world with so many stakeholders in the immediate vicinity that can benefit from a lab science innovation park.[9] In cooperation with the

[8] With around 25′000 employees, the local laboratory technology manufacturers today generate an estimated sales of CHF 5 billion out of which 95% of products are exported.

[9] For example, the Basel region is connected to the large pharmaceutical and chemical companies such as Roche and Novartis, large users of lab tech in the world. Switzerland's universities and universities of applied sciences are among the best in the world. Schlieren's growing biotech park counts more and more start-ups turning into mature players. The Swiss Mittelland is the location of many of the world's leading laboratory equipment manufacturers and analytical companies. On top of that, there are the numerous Swiss technology companies that distribute the entire spectrum of highly specialized products and services. With the House of Lab Science, a center is being created that brings all these players together.

Fig. 33.4 A collage of impressions from the House of Lab Science in Hombrechtikon, Switzerland

landlord of the property, we, a group of entrepreneurs, including the author,[10] have developed a concept that offers the following facilities and opportunities in a thriving ecosystem with a high degree of flexibility:

- Innovation rooms, lab rooms, and test rooms to carry out research and development work;
- Collaboration rooms to enable innovation teams to develop new mechatronic devices;
- Small offices, individual workstations, and meeting rooms for startups to rent their own office space to lay the foundation for further growth; and
- The Life Sciences Academy, where high school and university students, professionals, but also the broader public are invited to become involved and to attend courses and events

In the House of Lab Science, industry associations, startups, SMEs, universities, and institutes from the aforementioned disciplines find suitable rooms for their own activities and for developing partnerships so that the to some extent, arbitrary organization of nature into (academic) disciplines, which Ackoff [17] bemoans, is left behind in favor of a systemic approach and practice.

Moreover, the House of Lab Science not only exceeds artificial, narrow system boundaries in the physical sphere but is to become a virtual meeting place for the international laboratory technology community. Its main objective is to make laboratory technology visible, to promote cooperation between organizations and the scientific community in Switzerland and abroad, and to increase the laboratory space and test rooms, not least for the creation of jobs in a booming ecosystem.

Laboratory technology is the key to the growth markets of the life sciences sector. Triggered by the Human Genome Project, which, completed in 2003, made it possible to benefit from blueprint genetics in moving towards a fully bio-human being and the med-tech scene has been gripped by a veritable wave of automation in recent years which is maybe only comparable to the Internet revolution in the 1990s. The lab technologies are, thus, turning into the decisive factor for the innovation speed of research and development in all life sciences disciplines. Against this background, the innovation parks of the House of Lab Science bundle activities in one place to release additional network synergies in the Swiss laboratory technology cluster. It thus helps consolidate and further expand the strong position in this future market.

Yet, the House of Lab Science does not only address research and development. With consulting services for startups, mutual learning offerings, platforms for exchange, public events, and activities for young people choosing a career to older

[10] The core team consists of two more people: Oana Monica Vrabie is a purpose driven marketing, communications & community expert with experience in the innovative, creative and cultural industries and with an educational background in piano performance. Hans Noser is a serial *clusterpreneur* who founded 18 startups and serves as chairman of the Board of Directors at HSE AG among others, the largest Swiss medical device and life science engineering services company.

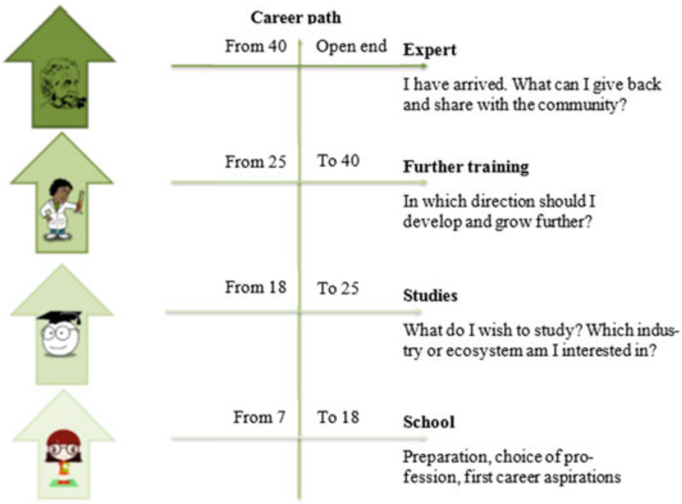

Fig. 33.5 The House of Lab Science does not discriminate and is open to all ages

people sharing experiences from their career at a fireside chat, the laboratory technology sector in its entirety is sustainably as well as holistically promoted, which points to the systemic DNA of the startup as well (Fig. 33.5).

The following chart summarizes the environment, including the key stakeholders, which the House of Lab Science defined for itself in a systemic manner, following the SGMM guidelines (Fig. 33.6).

Conclusion

The current COVID pandemic is a tragic wake-up call of how a complex and interconnected world is fragile and prone to major shocks and contagion within and between systems. Systems Thinking has emerged as a valuable and effective measure to deal with complex systems and challenges from a Systems Movement point of view, which is regarded as a meta-discipline, yet enters the stage in a fragmented way. By this integrating, i.e., analytical as well as a synthesizing form of thinking, we are principally enabled to tackle particularly dynamic complexity in a holistic way that characterizes businesses and their environment. In this connection, more specific but still abstract models and theories have been proposed in the literature. We briefly discussed the St. Gallen Management Model due to its focus on entrepreneurship and innovation. Yet, holistic or systems *thinking*, even in the most elaborate forms of the SGMM, is of utmost importance towards a holistic *action*-based perspective on complex problems of management and society that remain unaddressed.

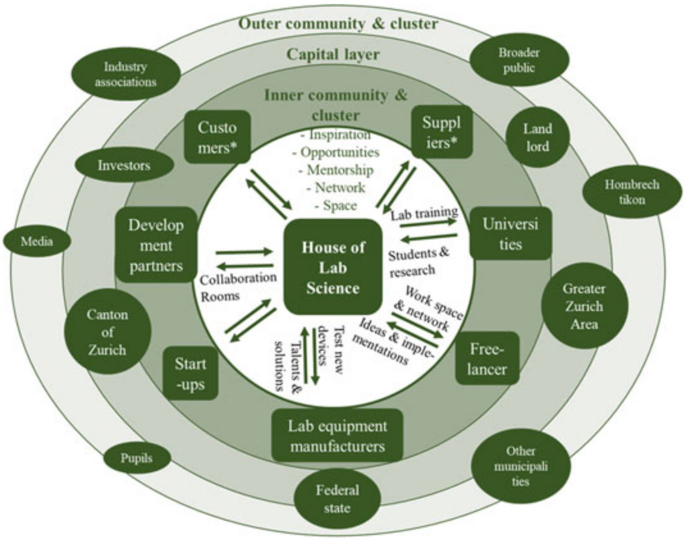

Fig. 33.6 The House of Lab Science's stakeholder landscape from a systemic angle. *Along the supply chain of the laboratory technology cluster. Some captions for the arrows were left out to enhance readability

Therefore, to move beyond the conceptual and abstract level, the concrete, systemically conceived startup House of Lab Science was presented that is not just an idea but already in the making. An S2 laboratory is already in operation, co-operation agreements with large companies and the innovation park in Dübendorf as well as with the biotech park in Schlieren are in place. In addition, 80 work-stations and, thus, 3′000 out of 8′000 square meters are already occupied (at the time of writing, i.e., beginning of May 2020). Further indications of interest (IOIs) from many more parties exist, and the reasons for this commitment are clear:

- New business models emerge
- New contacts are made within the supply chain
- Higher productivity and thus economic growth are generated
- Costs and time savings
- Business excellence is increased
- The right talents are found
- A thriving ecosystem is established
- The transfer of knowledge and resources between companies, universities, and research institutions is to be increased

In the wake of the digital transformation, the House of Lab Science was created as an institution that uses new technologies to bring people closer together. The chance to realize such a vision focusing on innovation in the here and now is certainly unique. The House of Lab Science is to combine the strengths of Swiss industries, the economy, universities, and research in a truly systemic manner.

Core Messages

- Systemics tackles complexity and adopts an integrating, analytical and synthesizing worldview.
- Dynamic complexity demands that we attempt to comprehend the interconnections and relationships, i.e., the whole picture and the constituent parts.
- Businesses have interconnected components involved in forming a dynamic and open whole that qualify them as systems.
- Systems thinking is an effective way to deal with complexity inside and around businesses and is calibrated in the St. Gallen Management Model.
- The House of Lab Science expresses the transition from systems thinking to systems action in the life sciences.

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34 Systems Approach for Modeling Multifactorial Human Interactions that Affect Ecological and Environmental Systems

Fernando Ramos-Quintana and Ana Itzel Casarrubias-Jaimez

> *"There is nothing like returning to a place that remains unchanged to find the ways in which you yourself have altered."*
>
> Nelson Mandela

Summary

Anthropogenic activities derived from population and economic growth affect ecological and environmental systems. Ecosystem services provided for the benefit of humans have constantly declined over the whole world as the population and economy continued to grow. Likewise, the state of pressure variables such as the quality of drinking water, solid and urban waste, air pollution, and loss of vegetation cover have worsened as population and economy have increased, thus affecting the quality of the environmental state. In addition, as the state of such pressure variables worsens, CO_2 emissions have increased significantly, thus contributing to climate change. The multifactorial interactions involved in the dynamics of ecological and environmental systems hinder the understanding of the processes that damage their state quality. Such a lack of understanding hinders adequate state assessments. Understanding the dynamics and assessment of the state of such complex systems will support the decision-making processes required to develop sustainable environmental

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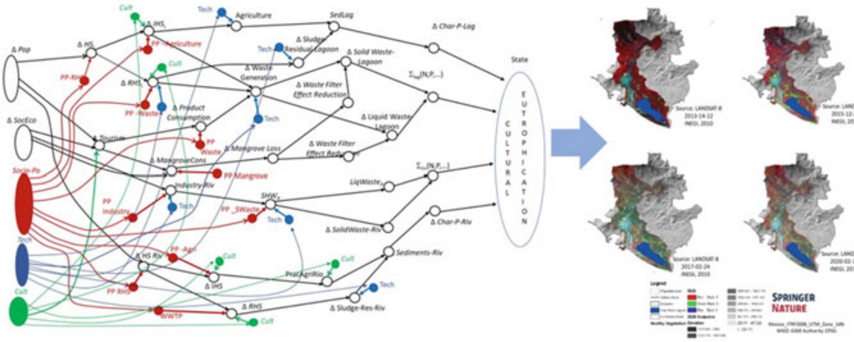
N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_34

management systems. This chapter addresses the problem of modeling the multifactorial interactions associated with human activities that damage ecological and environmental systems. We highlight the role of conceptual frameworks, based on systems thinking approach, to pave the way for developing a sustainable environmental management system. As a case study, we analyze multifactorial interactions that cause the eutrophication process in a coastal lagoon.



Multifactorial interactions between indirect and direct factors cause changes in ecosystems such as coastal lagoons.

Keywords

Anthropogenic activities · Coastal Lagoons · Conceptual frameworks · Drivers · Ecosystems · Environmental systems

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art*.

Introduction

In general, the state of any system is defined by the adopted values of the involved variables at a given time t. For instance, in the case of the environmental state, such variables are related to the loss of biodiversity, the quality of the availability of fresh water, the liquid, and solid wastes, the particulate matter (PM) for the case of air pollution, and the CO_2 emissions, among the most important [1]. Meanwhile, the quality and quantity of services provided by an ecosystem are useful indicators to assess its state [2, 3]. Such ecosystem services can be represented by food, fresh water, fishery, timber, and recreational activities, among others [4–6]. It has been documented that from the second part of the last century, as population and economy have increased so importantly, anthropogenic activities on nature have caused a relevant decline of both the environmental state of regions and ecosystem services [7–9].

Different organizations around the world propose different environmental measures and initiatives to mitigate the damage caused to environmental and ecological systems. Some of these institutions and organizations are EPA (Environmental Protection Agency), EEA (European Environment Agency), UNEP (United Nations Environment Programme), OECD (The Organization for Economic Co-operation and Development), WWF (World Wildlife Fund), IPCC (Intergovernmental Panel on Climate Change), MAS (Millennium Ecosystems Assessments), IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). One of the most important efforts of these organizations and institutions is to implement sustainable environmental management systems as a desirable goal to a certain extent. However, before reaching the level of sustainable environmental management systems oriented to preserve the environmental quality, they need first to meet the level of an environmental management system. This goal may be feasible for many developed countries, but it is certainly unfeasible for most developing countries.

Anyway, for both developed and developing countries, assessing the environmental state of a region and/or ecosystem services is an essential requirement to help decision-making processes and select management actions to improve the quality of their state [10]. To build adequate assessment methods, the developers should consider multiple socio-economic, sociopolitical, demographic, technological, and cultural factors. Otherwise, the assessments will be incomplete because important factors could not be considered in the assessment, which means that the decision-making processes were not well supported to select adequate management actions [11, 12]. Adequate assessment and decision-making processes underpin the selection of environmental management actions with a good performance. Thus, the weakness of these two processes will hinder the development of an environmental management system (EMS) with an acceptable performance level.

Most methods to assess the quality state of an ecological and/or an environmental regional system do not consider sociopolitical and socio-economic factors, which are mostly considered indirect driving factors that exert effects on direct driving factors, thus affecting the environmental state and ecosystems. However, the multifactorial interactions result in a complex dynamic system, which is very hard to model and consequently very hard to understand. We argue that the dynamic of a complex system should primarily be understood before assessing its state. Otherwise, the state assessments will be weak, and consequently, they are unable to underpin the processes related to decision-making for selecting management actions.

In this chapter, we deal with the problem of modeling the multifactorial aspects that affect the state of ecosystems services and the quality of an environmental state at a regional level. We show how a conceptual framework can guide building a causal network to facilitate the understanding of dynamic complex systems related to ecological and environmental regional systems. We use a "systems thinking" approach that supports the processes within the conceptual framework by considering both open and closed systems in constructing a sustainable environmental management system. An analysis of a causal network representing an ecosystem (a coastal lagoon) will show whether the development of a sustainable environmental management system for this coastal lagoon is feasible or not. Based on this analysis, we will show why sociopolitical, socio-economic, and cultural factors, among the most important, hinder the construction of a management system for ecosystem sustainability. The remaining sections of this chapter deal with the following topics: human activities that affect the quality of a regional environmental state and the quality of ecosystems; the DPSIR framework approach to assess the state of the environment; the importance of using a conceptual framework supported by a systems thinking approach to build an environmental management system; an approach based on indirect and direct drivers to analyze the feasibility of building a sustainable environmental management system for an ecosystem represented by a coastal lagoon; and finally, a conclusion.

Human Activities Affecting the Quality State of Environmental and Ecological Systems

The Effects of the Population Increase on Key Environmental Variables

As we already know, consumption habits have changed as the population and economy increase, causing an accelerated rise of solid and liquid wastes and, consequently, an important rise in CO_2 emissions. Table 34.1 lists some other environmental consequences of the increased population.

Units increase (tons, liters, m^2, etc.) related to key environmental variables and population increases are not necessarily proportional, but, commonly such relationships are governed by nonlinear behaviors. However, the behavior over time of cause-effect relationships can be approximated by a straight linear equation, which may give us a good idea about the trends of such relationships through the slope of the equation.

Table 34.1 Cause-effect relationships between the population increase and other key environmental variables

Cause	Effect (increase)	Effect (decrease)	Comments and references
As population increases	Waste production		In the past century, waste production has grown ten times more than the population growth [1]
		Water availability	[2–5]
	Solid waste		[6–11]
	CO_2 emissions		[12–15]
	Transportation and CO_2		As transportation sector grows CO_2 emissions increase [16, 17]
	Forest fires	Vegetation cover	Intentional or unintentional forest occur as population increases, thus causing important loss of vegetation cover [18, 19]
	Road construction	Vegetation cover	As the construction of roads increases vegetation cover decreases thus producing changes in the ecology systems and in the physical environment [20]

Usually, along with interpolated linear equation representing the behavior of the relationship, it is also shown the correlation and the determination coefficients and the slope value of the straight line. The correlation coefficient shows how much the independent or explanatory variable changes the dependent variable. As the correlation coefficient gets close to 1, the dependence relationship is stronger. Meanwhile, the determination coefficient reveals how close or far the observation points are to or from the interpolated linear equation. As the determination coefficient value gets close to 1, the observation points are distributed closer to the interpolated straight line. Meanwhile, the slope may represent the relationship between the independent and dependent variables. The relationships can be labeled as: "influence relationships," "cause-effect relationships," and "dependency relationships," among others. From all of these types of relationships, we can analyze certain variables that may exert influence on others by examining dependency relationships that may exist [13].

The analysis of the slope value in a relationship reveals meaningful information about the strength of the dependency and its trend (upward or downward trend, for example). To facilitate this analysis, we show an example where we assume that the slope value will fall inside the positive values of the independent (abscissa axis) and dependent (ordinate axis) variables. In this case, the slope value may fall from 0° to 90° or between 0 and ∞ tangent values. In case that the slope value is close to 0°, very low effects will be exerted by the independent variable on the dependent variable. Qualitative values of relationships close to 0° could be deemed "very low influence." On the contrary, when slope values are close to 90°, independent variable values will cause an important influence on the dependent variable, which is, in qualitative terms, expressed as the independent variable exerts a "very strong influence" on the dependent variable.

This chapter deals with coastal lagoons (CL), which are viewed and analyzed as ecosystems that provide services. One of the specific problems to be addressed in water bodies is the process of eutrophication, which represents a major concern in marine ecosystems [14–18]. The growth of plants derived from the enrichment of nutrients, which are, in turn, the result of human activities, characterized the process of eutrophication. Such human activities include deforestation [19], the application of fertilizers in agricultural activities [20], and nitrogen emissions [21].

Coastal lagoons are deemed as very important productive ecosystems. They provide key ecosystem services, fisheries, wild fauna and plants, trees for construction, fresh water, and areas for recreation [22]. Moreover, the CLs offer natural landscapes to be enjoyed, thus resulting very attractive for the development of tourist activities [7, 23–26]. In conclusion, coastal lagoon ecosystems are not only ecologically valuable, but they also provide human beings with services related to the environment, as well as social and economic conditions for a better quality of life [4, 5, 27–31]. Even though CLs are highly productive because they foster economic activities, they have been threatened through pressures from anthropogenic activities. Fast population growth and tourist development affect the water bodies, thus reducing the ecosystem quality and, as a result, their service potential [32–34].

CLs are mainly characterized by shallow waters and exchange of water with the sea, which causes their salinity to vary from oligohaline (5% NaCl g/L) to hypersaline (>300% NaCl g/L). Due to this, the environmental conditions allow the reproduction of certain species during the early stages or the whole life cycle. They function as natural barriers by mitigating hurricane effects; they also play an important role in climate regulation [35].

The European Environment Agency (EEA) defines CLs as sensitive areas with a particular vulnerability to the eutrophication processes [36] which are mainly due to human settlements, thus favoring the nutrient exchange derived from multiple anthropogenic activities [37, 38]. The excessive use of these bodies of water by human beings causes pressures or direct drivers that may damage their trophic state. The trophic state can vary from oligotrophic (non-productive) to mesotrophic (more or less productive) and eutrophic (very productive) [39]. The vulnerability of coastal lagoons is largely caused by changes in the trophic state, which, in turn, is caused by the excessive presence of nitrogen and phosphorus [40–43]. It is worth highlighting that despite eutrophication being a process that can occur naturally, the concept of cultural eutrophication (CE) has been incorporated. Cultural eutrophication refers to those processes derived from activities associated with human settlements that contribute to damage the trophic state of the water bodies, thus favoring the exchange of nutrients [18, 44–51].

Eutrophication processes have taken place in different water bodies around the world. Eutrophication is usually defined as the process leading to eutrophic status, usually the result of the input of nutrients. On the Mediterranean coast, the cultural eutrophication of coastal lagoons represents the major problem to be addressed.

Thus, the amount of nitrogen and phosphorus discharged into water bodies should be reduced to improve their water quality [52].

Derived from the impact caused by cultural eutrophication, Trophic State Indices (TSI) have been proposed, which assess the trophic state of different water bodies. The word **Trophic** is a term related to nutrition. A Trophic State Index (TSI) serves to classify the biological productivity of a water body. Four parameters may define trophic states: chlorophyll, mostly related to the green pigment of algae; phosphorous and nitrogen, nutrients necessary for the growth of algae and aquatic plants; and water clarity, largely dependent on water transparency. The four trophic states are as follows:

(i) Oligotrophic state where water bodies are characterized by low biological productivity;
(ii) Mesotrophic state, characterized by moderate biological productivity;
(iii) Eutrophic state, characterized by high biological productivity;
(iv) Hypertrophic state, characterized by the highest biological productivity

In Brazil, a TSI was used along with three indices, each associated with the categories of the Pressure-State-Response framework. This framework was proposed by OECD [53]. In this framework, pressure factors (P) cause changes in the state (S); thus, a response (R) from the society is required to improve the state of the system. This framework is represented by a causal chain, which is easy to understand. Still, it has limitations to express the interactions that take place in real situations to a certain extent. In the case of Brazil mentioned before, the Pressure category uses an index that measures the overall human influence; an index representing overall human influence is used for the State category; and an index for determining the future outlook for the Response category. Using a TSI, the results of trophic state and the determination of a future outlook for five lagoons named Mundaú, Manguaba, Guarapina, Piratininga, and Paraiba do Soul are the following: four of them showed high eutrophic conditions and just one showed good conditions [17].

The Bojorquez lagoon belongs to Cancun's touristic development in Mexico and has been classified as oligotrophic. Due to the high level of tourist activities in Cancun, which have brought about an important number of human activities, thus contributing to the accumulations of an important amount of organic matter, a cultural eutrophication process has taken place in this lagoon. Cancun is part of Mexico's Yucatan Peninsula, where important coastal lagoons are located. Assessing the current state of the coastal lagoons belonging to the Yucatan Peninsula is recommended to search for economic support in favor of adequate water management.

Ten coastal lagoons are located in Guerrero, situated on the Pacific Coast of Mexico. One of the most important is the Tres Palos Lagoon, located within the municipality of Acapulco. This coastal lagoon has suffered environmental and social degradation processes for many decades ago (since the middle of the last century), mainly caused by regular and irregular human settlements. Irregular settlements are defined as dwellings or groups of dwellings that lack, for example, access to drinking water, drainage, security of tenure, the durability of dwelling (waste materials and location in risk areas), and insufficient area to live [54].

It is suggested that the CE is a process within which multiple interactions between human activities and the ecosystem occur, thus intensifying the pressures that damage the quality state of the ecosystem [16, 46–49, 52]. The multiple interactions bring about dynamic processes related to complex systems, which are hard to understand, thus making their assessment difficult [7, 55, 56]. The lack of an adequate understanding and assessment of such dynamic processes seriously hinders the development of a sustainable environmental management system. The dynamics understanding taking place in environmental and ecological systems due to the processes composed of multiple interactions between different factors and their quality assessment of such systems are a key support to be provided to the decision-making processes, which aimed at selecting management actions to improve the quality of their state. The actions to be implemented to improve the environmental state should be monitored and assessed through a feedback process and then should be corrected and/or improved in case of a bad performance.

DPSIR Framework Applied to Assess the State of Key Environmental Variables

A frequent discussion occurs when we deal with driving force and pressure factors. The conceptual framework DPSIR is composed of Driving-Force factors, Pressure factors, the State of the System, the Impact on the system, and the societal Response. It was proposed by the OECD [57] to improve the performance and expressivity of its ancestor, the PSR framework. The representation of interactions between the driving force and pressure factors can be performed by building a causal network using the DPSIR framework, which corresponds more to real situations. The DPSIR framework has been broadly used to support the understanding and assessment of the complex dynamics derived from multifactorial interactions between the driving force and pressure factors, thus affecting the environmental state of a region. Using the DPSIR framework seems to be very practical to communicate with stakeholders, who argue that this approach is accessible and easy to understand. However, this is a practical approach but not complete enough to consider it in holistic analysis and assessments.

The driving force is commonly related to the population increase and the economic factors [58, 59]. However, factors related to population growth and rising incomes contribute to the change in consumption behavior of the population, which in turn has an effect on the increase of waste, both solid and liquid. Population increase represents an important driving force factor that increases CO_2 emissions [60]. Population increase causes urban growth and brings about the decline of water availability [61]. In this context, Kristensen pointed out that pressure factors, such as those related to water, CO_2 emissions, and waste, affect the environmental state quality [62]. Meanwhile, the concept of pressure factors is usually related to key environmental variables such as CO_2 emissions, air quality usually associated with particles PM_{10} and $PM_{2.5}$, water quality, solid and liquid wastes, and biodiversity [63].

The DPSIR framework has been applied in different studies. For instance, the driving forces related to energy use and transportation cause climate changes with their effects on biodiversity [64]. The EBM-DPSER (Ecosystem-Based Management/Driving Force-Pressure-State Ecosystem service and Response resulted from the integration of the DPSIR framework and ecosystem services into the management of air pollution [65, 66] and water resources [67]. The DPSIR framework was also applied to build biodiversity indicators [68], for assessing, e.g., the vulnerability of water resources to environmental change [69], the environmental quality due to the effects of population increase, risks related to the biodiversity [70], and water management [67].

Assessing the Quality of Water Bodies Using the DPSIR Framework

The assessment of the eutrophic state of the Tagus estuary (Portugal) was based on the PSR framework proposed by the OECD to address the management options [14]. However, developing a sustainable environmental management system requires driving force factors that affect pressure factors. The assessment of the system's state and monitoring systems should be incorporated to assess the performance of implemented actions. DPSIR was used to assess the environmental pollution of the Ebrié Lagoon in Cote d'Ivoire. Eutrophication has been identified as a process that causes major damages in the state of water bodies based on assessments of nutrient levels over time. The excess of nutrients derived from waste discharged by humans living in the nearby city of Abidjan, along with the use of fertilizers on farms in the catchment, was the cause of the state change of water bodies. As conclusion, the pollution drivers in the Ebrié lagoon were agricultural activities and human waste, but not the industrial development in Abidjan, as expected [71]. A review of applications of DPSIR is carried out in coastal ecological systems by highlighting social aspects [72].

Integrating the DPSIR into the ecosystem and societal services was carried out to support the decision-making process to improve the marine environmental system [73]. The importance of water resource management is highlighted because water consumption increases, mainly due to economic development. In addition, industrial and agriculture pollutants have caused pressures on water resources. The DPSIR was used in Bayannur, China, to assess sustainability related to the management of water resources [74]. A set of formulated recommendations for integrated and sustainable management of European lagoons have been proposed using the DPSIR framework. Four European lagoons were selected: Ria de Aveiro (Portugal), Mar Menor (Spain), Tyligulskyi Liman (Ukraine), and Vistula Lagoon (Poland and Russia). Important anthropogenic stress has been made on these coastal lagoons, more than others in Europe. In such a way that policies were needed to protect them as ecosystems that provide services and consider that they should be sustainable to a great extent. It is worth mentioning that these European coastal lagoons have no similar characteristics related to the hydrology, land use, and governance factors. The main pressures exerted on these coastal lagoons are population increase and density, tourist activities, harvest activities, and demand for natural resources. As we can see, the role played by anthropogenic activities in the damage caused to coastal lagoons is very important. It is important to highlight two aspects derived from this study that are related to our concerns [73]:

(i) The contribution of this study, from an ecological and socio-economic perspective to the understanding of the outcomes for the sake of building a structure of relevant options for public policies; and
(ii) in general, each coastal lagoon has particular characteristics that decision-makers should take into account during the process of generation of public policies. Consequently, it is suggested to consider the particular context of coastal lagoons when local management is applied.

Conceptual Frameworks Guiding the Development of Environmental Management Systems (EMS)

Conceptual Frameworks Within the Context of Complex Dynamic Systems

The dynamics taking place within environmental and ecological systems are characterized by multiple interactions between factors of diverse nature. Thus, this complex aspect hinders the understanding of the dynamics associated with the systems, and consequently, the state assessments of environmental and ecological systems become very hard to be performed. Both the understanding and the assessment of the system state are essential supports to the decision-making during the selection process of management actions aimed at improving the environmental state and the state of ecosystems. Up to the execution of management actions provided by the decision-making system, the environmental management system is, from a systems perspective, viewed as an open system.

Conceptual frameworks are models able to guide and facilitate the analysis of complex systems by providing users with powerful means to support the understanding of dynamic processes and the system state assessment. In addition, the following processes: decision-making; monitoring the performance of implemented management actions; and correction of malfunctioning of a system through feedback mechanisms aim to improve the environmental and/or ecosystem state under study. Derived from the properties of conceptual frameworks mentioned before, we affirm that they can guide the development of environmental management systems towards sustainability [11, 12]. The capacities of conceptual frameworks are reinforced when they are supported by analysis based on the systems thinking approach, whose main characteristic is to divide a system into subsystems, each playing a specific role within the context of the correct functioning of the whole system. Thus, an inappropriate functioning of any of the subsystems would affect the whole system.

A Conceptual Framework Represented by a Closed System for an EMS

A closed system is required for building a sustainable environmental management system (EMS).

Before dealing with the functional characteristics of a closed system, we describe the processes related to an open system, which is an important component of a closed system. We would like to highlight that the closed system to be described is applied to environmental and/or ecosystem problems. Thus, for other applications the processes to be considered may be different. The open system is composed of the following processes: the construction of causal networks to understand the complex dynamics derived from multifactorial interactions; the assessment of the environmental and/or ecosystem state; and the decision-making processes to select management actions to improve the environmental and/or ecosystem state. However, we need other processes to correct, eliminate or replace those implemented management actions with poor performance. These last processes should be incorporated to build a closed system. In the case of our environmental application, the processes to be added to convert an open system into a closed system are: the monitoring and assessment of management actions that have been implemented; the feedback mechanism, which used the assessments of the monitoring system to correct, eliminate or replace the management actions with poor performance.

A whole system, open and closed system, along with its subsystems, is shown in Fig. 34.1.

The open system shown in Fig. 34.1 undertakes, as the main role, the processing of input data and/or resources to produce state assessments that will support the selection of management actions to be applied to the real world. The open system hosts the following sequence of subsystems:

- the subsystem in charge of characterizing the driving factors that cause environmental and/or ecological system changes. This subsystem is composed of demographic, socio-economic, sociopolitical, technological, and cultural factors;
- the subsystem of the pressure factors with effects on the state of the environmental and/or ecological system
- the subsystem that integrates the subsystems of driving factors and pressure factors. This subsystem plays the following role: to build a casual network composed of casual relationships between driving force and pressure factors. This causal network aims at representing the dynamics that brings about changes in the state of the environmental and/or ecological system;

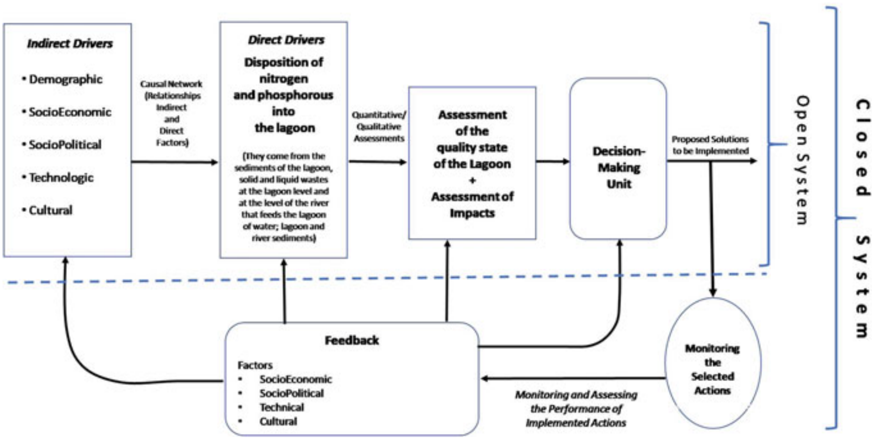


Fig. 34.1 A conceptual framework that shows the open and the closed system that paves the way towards the development of a sustainable ecological management system

- the subsystems that contain the environmental and/or ecosystem state and their impacts; and
- finally, the decision-making subsystem, where the processes for selecting appropriate management actions occur.

The final goal of an open system is to provide management actions to be applied in the real world. These management actions applied to the real world may result in desirable or undesirable effects. To close the system, we need to monitor and assess these management actions and correct them through a feedback subsystem in case of a bad performance. The open system plus the feedback subsystem build the closed system, as shown in Fig. 34.1.

Indirect and Direct Drivers Affecting the State of Ecosystems: A Case Study

Sociopolitical, socio-economic, technological, and cultural factors should be considered in analyzing and assessing ecosystems affected by human activities, such as the cultural eutrophication process. As expressed by Holzhauer et al. [75], the analysis of institutional interactions, such as subsidy rates, should be taken into account in the impacts on the levels of under or oversupply of ecosystems services to know how the actions selected by institutional actors affect their temporal and spatial dynamics.

In the MEA [11] and IPBES [12] reports that deal with assessments of the quality state of ecosystems services and biodiversity, conceptual approaches that consider indirect and direct drivers are used. The MA report was focused on ecosystem services. Meanwhile, the IPBES report was focused on biodiversity. We do not want to discuss the fact that the DPSIR framework has two categories, drivers and pressure factors, where interactions cause damage to coastal lagoon systems. Meanwhile, in the context of the MEA and IPBES reports, they refer to indirect and direct drivers where interactions between them also cause damage to the ecosystem under study. Apparently, both approaches have similar purposes or intentions. However, we prefer the indirect and direct drivers approach, just for semantic reasons. The following question was asked in the MEA report [11]: What are the most critical factors causing ecosystems changes? These factors belong to two categories: the factors related to indirect and direct drivers.

MEA suggests the following classifications related to indirect and direct drivers:

- Indirect drivers: population increase, economic activities, sociopolitical activities, cultural factors (in fact, the cultural eutrophication is associated with this factor), and technological factors; and
- Direct drivers: habitat change; overexploitation of resources such as those provided by forests, rivers, mangroves, lakes, coastal lagoons, etc.; invasive species; pollution (for instance, excessive nitrogen and phosphorus discharges into the lagoon); as well as climate change

Case Study: Analysis of the Tres Palos Coastal Lagoon State

The following analysis is mainly related to ecosystems and, in particular, the analysis of the Tres Palos Lagoon, which is located on the Pacific Ocean coast in Acapulco, Guerrero, Mexico. We consider that the economic and population increase contribute to the decline of resources of these ecosystem services, thus contributing significantly to the cultural eutrophication process taking place in this lagoon. Among the direct drivers, we are mostly concerned with habitat change, overexploitation of mangroves, and pollution caused by nitrogen and phosphorus discharges into the lagoon. Nitrogen and phosphorus discharge into the lagoon is usually associated with the cultural eutrophication process. Based on classifications suggested in the MEA reports, we show the main indirect and direct drivers causing trophic changes in the Tres Palos Lagoon treated in this chapter.

Indirect Drivers

At the high level of abstraction, the indirect drivers for the case of the Tres Palos Lagoon are related to population change factors, economic factors, socio-political factors, science and technological factors, and cultural and religious factors.

Direct Drivers

Likewise, the factors associated with direct drivers causing damage to the Tres Palos Lagoon are:

- nitrogen and phosphorous discharges into the lagoon, coming from the lagoon sediments,
- solid and liquid wastes associated with the lagoon,
- the river that feeds the lagoon with water; and
- lagoon and river sediments.

Figure 34.2 shows the causal network that resulted from the multiple interactions between indirect and direct drivers. This casual network is the bridge that links indirect drivers with direct drivers. This complex causal network is composed of specific activities consisting of the linkage between indirect drivers and direct drivers, thus causing damage to the lagoon state. Human settlements, both regular and irregular, and their associated activities along the river and around the lagoon require special attention. Other harmful activities, such as agricultural practices, tourism, and industrial production, are also responsible for discharging nutrients into the lagoon.

An analysis of the causal network can provide us with insights into the feasibility of developing an environmental management system to achieve sustainable conditions in the Tres Palos Lagoon. Derived from the causal network analysis, public policies are needed to avoid certain practices that damage the lagoon. Such public policies are related to the regulations of several activities that damage the lagoon, such as irregular human settlements, illegal agricultural practices, urban solid waste management, the regulation of industrial activities along the river, the consumption of mangrove resources, and control of tourist activities. Some of these public policies related to the Tres Palos Lagoon exist but are not formally applied; at least, there are no monitoring actions able to confirm or assess the performance of the management actions derived from these public policies. Some others are necessary, but they do not exist. Another important issue is related to the existence of databases of variables associated with nodes of the causal network. If there is no data, then it is impossible to assess the quality state of the lagoon. Consequently, it is not possible to support decision-makers to select adequate management actions. As we have already pointed out in this chapter, without adequate assessments, the selection of management actions would be erroneous, and the intention of building a sustainable management environmental system will be doomed to failure. Unfortunately, the lack of data on the involved variables of an environmental and/or ecological system is a recurring problem in developing countries, as well as the socio-political factors, such as the timely generation and correct implementation of public policies. These are very different in developed and developing countries.

Important changes in the Tres Palos Coastal Lagoon caused by human activities are shown in Fig. 34.3, which are represented by a sequence of four Landsat-8 satellite images corresponding to the years 2013 (A), 2015 (B), 2017 (C), and 2020 (D), of the municipality of Acapulco, Guerrero state, Mexico. We can observe through the bands R:5, G:4, B:3 the healthy vegetation distributed in the La Sabana basin, which belongs to hydrologic region No. 19 in the Costa Grande of Guerrero state. Despite the short time between the first image (2013) and the most recent one (2020), we can verify the degradation of healthy vegetation, represented by the

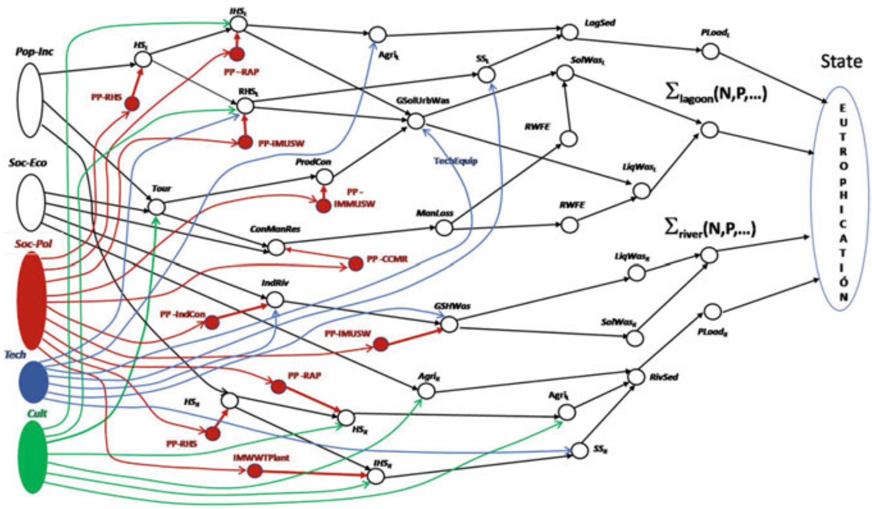


Fig. 34.2 Causal network showing the multiple interactions between indirect and direct driver factors that causes damage to the Tres Palos Coastal lagoon. Population increase, Pop-Inc; SocioEconomic, Soc-Eco; SocioPolitical, Soc-Pol; Technology, Tech; Cultural, Cult; Human Settlements around the lagoon, HS_L; Human Settlements around the River, HS_R; Irregular Human Settlements around the Lagoon, IHS_L; Regular Human Settlements around the Lagoon = RHS_L; Agriculture around the Lagoon, $Agri_L$; Agriculture around the River, $Agri_R$; Lagoon Sediments, LagSed; Sewage Sludge from the River, SS_R; Sewage Sludge from the Lagoon, SS_L; Sewage Sludge from the River, SSR; Solid Waste from the Lagoon, $SolWas_L$; Phosphorous Load from the Lagoon, $PLoad_L$; Phosphorous Load from the River, $PLoad_R$; Generation of Solid Urban Waste, GSolUrbWas; Reduction of the Waste Filter Effect, RWFE; Tourism, Tour; Product Consumption, ProdCon; Technical Equipment, TechEquip; Liquid Waste from Lagoon, $LiqWas_L$; Consumption of Mangrove Resources, ConManRes; Mangrove Loss, ManLoss; Industry around the River, IndRiv; Generation of special handling waste, GSHWas; Liquid waste from river, $LiqWas_R$; Solid waste from the river, $SolWas_R$; Integral management of wastewater treatment plant, IMWWTPlant; Public Policies to Regulate Human Settlements, PPRHS; Public Policies to Regulate Agricultural Practices, PPRAP; Public Policies for the integral management of urban solid waste, PP-IMUSW; Public Policies to control the consumption of mangrove resources, PP-CCMR; Public Policies for the industrial control, PP-IndCon; Public Policies to regulate agricultural practices, PP-RAP

polygon in red. As expected, the image shows the increase of human settlements around the lagoon, represented by different green areas. The polygon depicts the Tres Palos Coastal Lagoon in blue.

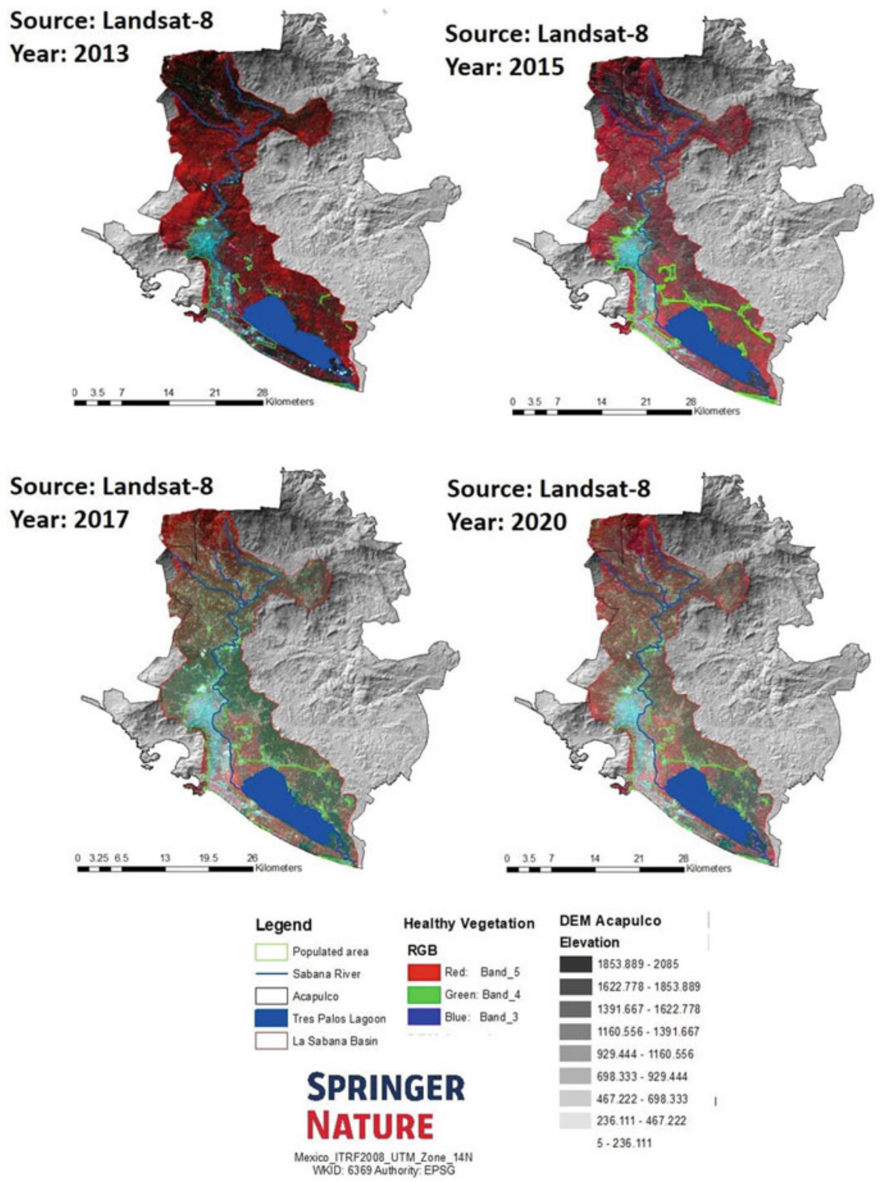


Fig. 34.3 Four satellite images corresponding to 2013, 2015, 2017, and 2020. It shows relevant changes in healthy vegetation and the increase of human settlements

Conclusion

It has been broadly documented that as people's population and economic power increase, human activities damage the environmental and ecological state, requiring assessments to know the level of damage on these systems. Based on these assessments, decision-makers will select implementable and affordable management actions to improve the state of such systems. However, most of the time, the assessments are not deemed holistic contexts. In other words, the evaluations are incomplete and therefore not objective and very far removed from reality because important factors are not involved.

Derived from the causal network that depicts the interactions between indirect and direct drivers that damage the coastal lagoon under study, it is suggested an analysis of multifactorial interactions by taking into account socio-political, socio-economic, demographic, technological, and cultural factors to assess the environmental and ecological state. If not, the assessments will result incomplete. However, we know that multifactorial interactions inevitably result in complex systems, which are often less understandable and assessable. To address the complexity problem derived from multifactorial interactions, we propose using conceptual frameworks, supported by a systems approach, for building environmental management system capable of achieving sustainable performance.

Based on a qualitative analysis of the causal network representing interactions between indirect and direct drivers that damage the Tres Palos Coastal Lagoon, we have concluded that due to the lack of relevant data associated with the involved variables and the lack of public policies related to diverse activities that damage the lagoon, it is practically unfeasible to develop an acceptable environmental management system and consequently impossible to reach the desirable sustainable conditions for the lagoon. And these are typical problems of developing countries.

Core Messages

- Human activities damage environmental and ecological systems.
- Multifactorial interactions exist between indirect drivers and direct drivers that impact on environment and ecosystems.
- We can link indirect drivers and direct drivers to assess the state of environmental and ecological systems.
- The eutrophication process damages the trophic state of a coastal lagoon.
- A systems approach-based conceptual framework can help us build a sustainable environmental management system.

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Cradle to Cradle and Cradle to Grave: Discussing the Case of Eco-coffins

35

Grace Anywar, Helen Kopnina, and Kim Poldner

> "*You must teach your children that the ground beneath their feet is the ashes of our grandfathers. So that they will respect the land, tell your children that the Earth is rich with the lives of our kin. Teach your children what we have taught our children. That the Earth is our mother. Whatever befalls the Earth befalls the sons of the Earth. If men spit upon the ground, they spit upon themselves*".
>
> Chief Seattle

Summary

This chapter addresses dichotomous thinking about culture and nature, life and death, and humans and the environment by discussing the principles of the Cradle-to-Cradle framework in application to eco-coffins. Eco-coffins are used as a vessel "to question whether our commitment to the future and immortality could be manifested through our relationship to nature." The chapter reflects on how eco-coffins can provide an example of regeneration and a dismantling of dichotomous thinking in the context of sustainability. The investigation focuses

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_35

on coffin design and burial procedures within the context of the continuous biological life cycle. It concludes that while dealing with death, eco-coffins can stand as a metaphor for uniting ecological and social worlds, both in terms of practical design and evolving values.

Capsula Mundi
(Adapted with permission from Rodolfo Bretzel, Capsula Mundi)

Keywords

Eco-coffins · Cradle to cradle · Human–environment dichotomies · Sustainability

QR Code

Scanning the QR code directs you to the word cloud of the chapter that is made up of the words we discussed throughout the whole book in relation to the chapter's keyword, which is intentionally not included in the word cloud. Find the keyword and put it in place in the puzzle according to the clues provided in Chap. 36. The mystery hidden in the puzzle is the quote of *THINKING: Bioengineering of Science and Art.*

Introduction: "Cautious Optimism"

Though written in 1972, Perry's adaptation of Chief Seattle's speech still holds an important message today. In an Anthropocentric world of almost 8 billion consumers, industrial production and mass consumption have become our greatest sustainability challenges. A combination of the omnipresent dualism that holds humans and nature apart [1, 2] and our devotion to industrial and technological progress [3] paints a bleak picture of the future. Many scholars share this pessimistic outlook. However, anthropologist Kenneth Smail [4] expresses his 'cautious optimism' about humanity's ability to avert an ecological crisis and writes: "all humans—despite our many differences—share a deep-rooted investment in immortality, an individual and collective concern for posterity. This powerful commitment to the future manifests itself biologically (through the children we beget), socio-culturally (through our relationships with others), and morally (through our religious and/or ethical systems)" [4, p. 295].

While reflecting on this "investment in immortality," e.g., the need to create stories, "make a difference" or leave behind a "legacy" for future generations, and the significance of birth and death in our lives; seasonal cycles, product lifespans and, of course, our mortality, this chapter will use eco-coffins as a vessel to examine whether our commitment to the future and immortality could manifest itself socio-ecologically through our relationship with the environment.

As a tribute to mortality, nature-based sacred spaces and materialities that identify and express collective consciousness have been commonplace throughout human history [5–7]. The Norse had totems of their "guardian spirits," while Celtic clan names and mythologies were connected to animals and birds intertwined with stories of shape-shifting ancestors. Like the Aboriginal clans of Australia and Native Americans of America, the early inhabitants of Britain revered the natural world, perceiving woodland, rivers, rocks, hills, and trees as the dwelling places of the spirits [6, 7]. Veronica Strang's [1, 8] research with Aboriginal groups, Euro Australian pastoralists, and other land users in Northern Queensland observed that, although the pastoralists had more complex notions of place and their relationship with the environment, their ideas arose from perceptions of nature as a wilderness or "other;" inferior to man and something to be controlled. In comparison, indigenous notions of self and nature were intrinsic and interconnected with social and environmental sustainability instead of the co-dependent relationship that the pastoralists, indeed Western thought, had with nature.

In order to explore the significance of eco-coffins within the more extensive discussion of sustainability, and specifically within the context of Cradle to Cradle (C2C), developed by McDonough and Braungart [9], we shall first address the dichotomies that structure our thinking; in this case those of life and death, and nature and culture. Dichotomous thinking exposes powers of discourse, categorization, and separation. It has instilled within us the anthropocentric notion of human supremacy over nature, which is at the core of the environmental crisis [10, p. 45]. The traditional coffin or casket becomes a valuable tool because it exemplifies the life and death dichotomy as a "cradle to grave" product by name and nature. We outline how eco-coffins provide an environmentally benign alternative to the commonly used coffins or caskets. We also discuss how "natural burials" reflect the core principles of the C2C philosophy by closing a biological loop in human life cycles, providing essential regulatory and cultural ecosystem services that could facilitate the reconciliation of humans and nature. This investigation will culminate in the reflection on how coffin design and burial procedures, while having to do with death, can remind us of our place within the biological life cycle.

Human-Nature Dichotomies

There has been a growing discourse surrounding binaries that discuss the relationship between humans and the environment enlivening the cognitive, natural, and social sciences in recent years. Claude Lévi-Strauss [6] suggested that human reasoning required dialectical and binary concepts for organizational purposes. The *human-nature dichotomy,* therefore, has often been described as two opposing concepts, i.e., human and nature.

We can see from multidisciplinary foundations that the study of human history has mainly focused on our social differences, assuming that all humans share the same cognitive characteristics [11] and, more recently, the knowledge to shape and alter the environment in response to our material demands [2, 12].

As for "nature," the (at times interchangeable) terms *biophysical* or *natural environment* are often used to describe all things that occur *naturally* as opposed to those created or manipulated by human activity [13]. They refer to the type of environment that creates and supports the conditions that guarantee the survival of ecosystems and habitats [13].

These concepts of the biophysical and natural environment are often used in opposition to the concepts of *built* or *modified environments*, which are *artificial* landscapes that have been engineered or physically constructed by humans [14]. The terms "built" or "modified" typically refer to structures or spaces that have been influenced by, or modified for, human activity, e.g., gardens, car parks, furniture, and houses [14]. Seen in this light, the "built environment" [14] can be seen as inseparable from both human labor and the biophysical world as it necessitates the two in order to exist; when trees become furniture, for example [15]. Thus, the environment can refer to the world outside of human activity, but it can include humans too.

These binary concepts of the environment—whether dead or alive–have given rise to several inquiries about human–environment dichotomies and the role they play in the broader discussion on *sustainability* [12]. They also raise questions regarding the opposition between progress in "taming nature" on the one hand and protecting "romantic nature" on the other hand [16]. The interdisciplinary theories rejecting this dichotomy, such as *more-than-human geography* [17] and *multi-species ethnography* [18, 19], can instruct a particular view of sustainability further explored in the case of coffins.

The literature on deep ecology [20] and land ethics [21] has identified some inconsistencies between culture and nature [22–24], especially with regards to human industrial activity, which has had an unprecedented effect on other species" habitats.

From Cradle to Grave

One of the central features of our industrial production system is the denial that death (of an animal, tree, or person) contributes to the circularity of materials in an essentially sustainable circle of life and death. As Affifi and Christie [25] have argued, "our own mortality and that of our loved ones feels painful and threatening, *yet* the mortality of the biosphere unthinkable" and inconceivable. Consequently, the authors argue, we try to avoid and distract ourselves from thoughts about death with our globalizing consumer culture "colluding in our evasiveness" [25].

In both ethics and practice, however, there is little recognition of death. One example includes our moral blind spot for the short and brutal lives of animals in intensive farming, medical testing [26], hunting [19, 27], roadkill [28], or indirectly through the clearing of habitats to make way for development [10]. Sadly, there is currently little legislature protecting the lives or condemning the deaths of non-humans or nature [29]. Another example of brushing death away is the ubiquitous urban practice of clearing autumn leaves and disposing them in mixed garbage containers [15]. Yet, these leaves could serve as "food" for organisms that help create new soil by supporting one of the fundamental principles of C2C—"waste equals food." In a similar vein, the burning of garbage to produce supposedly "green" energy incinerates mixed materials, including paper, metal, and glass, that go up in smoke [30].

The scars of human industrial and technological activity are carved on the globe in various ways [31]. They occur in power plants, factories, mines, and swathes of land set aside for agriculture, the scattered urban areas, polluted waterways, oil spills, and barren landscapes where forests once flourished. Our cities, these assemblages of artistic and architectural development, transport networks, and human activity, have ecological footprints that go far beyond their built environments [32, pp. 15–16].

Indeed, the consequences of anthropogenic activity on the planet have become so ingrained in modern society's mechanisms that it is almost taken as a given that a biospheric impact must inevitably come about as a result [9]. Ulrich Beck [3] suggests that the environmental impacts of our "Risk Society" go far beyond oil spills and air pollution. "They are manufactured uncertainties induced by the unwanted side-effects of technological development;" climate change and "constantly emerging disease[s]" like Avian flu [33, p. 11] or, as we are currently bearing witness to, novel coronaviruses. According to Beck, all of these "manufactured uncertainties" are due to human technological development and how it transforms the relationship between our social and biological worlds [3].

Yet, according to McDonough and Braungart [9], we need not look to "manufactured uncertainties" to be disturbed by the way our industrial and technological developments are consistently impacting our lives. Rather, we can find them in our own homes in the form of heavy metals, hazardous chemicals, acids, plastics, and mutagenic materials that leach out of the fibers in our sofas, cooking appliances, toys, clothes, phones, and computers. Of course, there are things that we would find hard to live without—the materials in a computer are necessary for it to function and we need the clothes on our backs. However, what happens when we no longer want or use these items? What about when they meet the end of their life cycle, and we must dispose of them?

In contrast to our current linear system of "take, make, waste"—i.e., the collection of raw materials, the manufacture of the product, and its disposal once it comes to the end of its life—waste within the C2C framework equals food. It implies that all components in C2C products can either be retrieved and reused (technical cycle) or composted/biodegraded (biological cycle) once the product has come to the end of its life cycle. For example, electronic goods such as mobile phones and hair dryers would belong to the technical cycle. During the manufacturing process, these items would be made with both their material value and their next service life is taken into consideration; they would be manufactured with high-quality materials and with easy upgrading or dismantling in mind. Once discarded, the items would be dismantled and have their components retrieved and sorted by material so they could be reintroduced to a new technical cycle in the form of a new product. This ensures the circularity, opposed to linearity, of C2C production (https://www.ellenmacarthurfoundation.org/). In the biological cycle, we have biodegradable items such as wood, paper, and food waste, all of which have a post-life value as they can be upcycled, reused, or composted, thereby restoring their biological nutrients to the soil and completing a biological cycle. Thus, a C2C cycle is accomplished by products that complete, and restart, a biological or technological cycle. Yet, in our current system, once discarded to landfill or incinerated, any biological or technological "nutrients" that could have become food, reused, or recycled lose their value and thus end their life cycle in a "cradle to grave" fashion [9]. We are curious about how such cradle-to-grave products can provide a practical example of regeneration in the context of sustainability?

Case Study: Green Coffins

Since the 1950s, the coffin industry has become increasingly dominated by large manufacturers that run highly automated, industrialized manufacturing plants [34]. Indeed, funerals and burials themselves have become increasingly commercialized and, in some cases, profitable methods of temporarily masking the harsh reality of death [35]. In much of the industrialized world, caskets and coffins can be made from various materials such as solid oak or pine or a more economical, coated, or veneered chipboard that has been bonded with a formaldehyde-based resin [36]. They can also be made from plastic, fiberglass, and even metals like steel, bronze, and copper [35].

Sadly, regardless of the material used, traditional coffins and caskets quickly become a capsule for anaerobic decay, contributing to the demand for raw materials and formaldehyde-based embalming fluids that are buried in the US cemeteries every year [37]. In the UK, due to a growing shortage of burial space, cremations are often chosen over burials. In his *Guide to a Good Death*, Hickman [36] used data from the Federation of British Cremation Authorities to conclude that the average cremator consumes around the same amount of domestic energy *per cremation* as the average person would in a month. This equates to about the same amount of energy as an 800 km car journey [38]. The toxicity of polluting dioxins emitted into the atmosphere, such as mercury emissions vaporized during cremation [37], is another cause for concern.

Addressing Casket Production

A standard casket production process entails the following: industrial machines cut several long wooden slats wedged into a frame and glued together to form the lid and the casket's base frame [39]. These slats are then placed into a large vice that applies pressure to create a permanent bond, while an industrial saw is used to cut away excess wood and create a shape [39]. Extra slats of wood give the casket its identifiable shape while more glue is added, and the vice is tightened again to create a bond that is kept secure with large industrial nails. The rough shape is then sanded down, and any engravings and decorative molds are added. Once the shape is formed, it is sprayed with wood stain or paint and oven "cooked" to dry before adding lacquers, handles, various types of wood, metals, or plastics to adorn the outer frame [40]. The inside of the casket or coffin is usually upholstered using silk, velvet, or polyester. Finally, a simple wooden bed is fitted inside and covered with a light fabric such as linen [34, 39].

Though "classic" in style, both caskets and coffins can be referred to as what McDonough and Braungart [9] would call "monstrous hybrids." The name was given to consumer items made up of a mixture of technical and biological materials that cannot be retrieved once they have met their use [p. 99]. Thus, they are "Frankenstein products," inappropriate for upcycling, recycling, or reuse. Rather, they are responsible for contaminating the soil via the slow release of toxins from the coffin's technological make-up and the (unnecessarily) slowly decomposing body that it encapsulates. It is much the same for the cremation process, which we have already scrutinized regarding environmental standards, energy use, carbon emissions, and the burning of such a volatile cocktail of chemicals [36]. This constant consumption of raw and crude materials alongside the production of such high levels of waste and pollution for a product with a *single-use* lifespan is a shamefully unfortunate, yet well-ingrained, consequence of outdated and unintelligent design [9, p. 43].

From C2C: Capsules, Cocoons, and Eco-coffins

Perhaps in response to a surge of environmental awareness in recent years, there has been a rise in the number of manufacturers who specialize in "Eco-Coffins" and with them a growing interest in "green" and "natural burials" [41]. The Funeral Consumers Alliance [42] defines a "Green (or natural) Burial" as one that focuses on "simplicity and environmental sustainability." To qualify as green burial, a body must not be prepared using embalming fluids or chemicals. Rather, it is simply bathed before being laid to rest in a biodegradable casket or shroud and placed directly in the Earth (without a burial vault). This allows the casket, or shroud, direct contact with soil-based bacteria that cause it to biodegrade, facilitating the body's decomposition and returning to the soil, thus completing a biological cycle. Only then can a burial truly be "ashes to ashes, dust to dust" [41].

There are currently several "Eco-Coffin" options available on the market, such as those made from Banana or Bamboo [43]. They can also be made from a mix of raw organic materials like rattan, wood, and cotton, and others are made entirely from cardboard [44]. The alternatives discussed here are The Capsula Mundi from Italy [45], herein referred to as the "Capsule" (Graphical Abstract)—and the Leaf Cocoon from Bellacouche [46, 47]—herein referred to as the "Leaf Cocoon" (Fig. 35.1).

The *Capsula Mundi* ("Capsule") is made from a bioplastic that comes from organic materials [45], and the Leaf Cocoon is made from hand-felted wool that has been collected from locally grazing (rather than industrially farmed) sheep and

Fig. 35.1 Leaf Cocoon. Adapted with permission from Yuli Sømme, Bellacouche

wood that is collected from local woodland trees such as Hazelwood [47]. Besides these two core ingredients, a small number of nails, sewing threads, and cotton ties, made from organic or locally spun threads, are incorporated to bring the Leaf Cocoon together [46, 47]. The only two elements that are currently non-renewable are the (fossil-sourced) electricity needed to sew some of the elements together and a handful of nails. However, due to its low energy demand, enough power to create a Leaf Cocoon could be sourced via solar energy, and both biodegradable and reusable nails are readily available.

There is little detailed information about the exact materials and manufacturing process of the Capsule design, but a perusal of the Capsula Mundi website indicates that it is made from bioplastic derived from organic materials. This bioplastic is then molded into an egg shape within which the deceased body or ashes can be placed. The Capsule is then placed in the ground with a tree seed or sapling directly above it so that both the Capsule and body become a nutritional source for the growing tree [45, 48]. As of this moment, the Capsula Mundi is only available as an urn to be buried, but the long-term goal is to be able to release their full burial option, which has been on display at the Broken Nature exhibition by Paolo Antonelli at the XXII Triennale di Milano [49].

The Leaf Cocoon construction lightly entails the following: at the heart of the Leaf Cocoon is felted wool. The felting process is very simple and low on energy, although perhaps time-consuming. It is a simple process of adding a home-made solution or "detergent" to scour and clean the wool and then a mechanical tangling of the wool using felting needles. The process can also be done using water, but if it is done by needle, this allows room for personalization and individual creativity like the adage of local flowers or foliage. It also removes the need for extra resources [46]. The Leaf Cocoon base is made up of a wooden frame that is covered with woolen felt and sewn securely. The "Cocoon," which is like a shroud in which the body is wrapped, is made of soft wool with fastening ties sewn into the felt layers to ensure its secure fastening to the frame. A top cover—or top "leaf"—of woolen felt, which can be personalized with naturally dyed motifs of native flora and sewn patterns (Fig. 35.1) or simply left white, lies atop the Cocoon. This can either be taken home as a keepsake or be buried alongside the deceased by fastening it down with hand-shaped wooden toggles made from hazelwood collected from local coppices [46, 47]. There is also a simpler cremation tested alternative that incorporates wood from the Willow tree [47].

Thus, the manufacturing process of the Leaf Cocoon lies in stark contrast to the industrial, resource-heavy, and chemically-laden process that is needed to construct a conventional coffin. The resources that go into the Leaf Cocoon construction are locally sourced and selected specifically for their long-term sustainability during all stages of production, use, and disposal. They promise that no raw materials need to be shipped, no tropical hardwood or ancient woodland needs to be cut down, and no chemicals, oil-based dyes, or lacquers are needed. Hazelwood and Willow can be hand collected while pruning brush and woodland, which keeps the woodland healthy, and the wool is harvested once a year on an Eco-farm, which provides wool with "zero fiber miles alongside complete transparency and traceability" [50]. The main source of energy needed to construct the Leaf Cocoon comes from the women who build, felt the wool, sew, and shape each Leaf Cocoon component. There is also an electrical source that powers the workshop and sewing machine, but beyond that, it is the solar energy that feeds the grass upon which the sheep graze and the trees grow [47].

Though it may appear novel in design and concept compared to the more commonly known casket, the Leaf Cocoon shroud has historical precedence [46]. In Europe, for instance, since the Middle Ages, only those who were lost to war, famine, or during the time of plague were buried *without* a shroud [51, p. 410]. Of course, many will have heard of the Shroud of Turin. This burial shroud is thought by some to be the burial shroud that Jesus of Nazareth was wrapped in following his crucifixion. This is not to suggest that wooden coffins and caskets are an entirely modern invention as there is evidence that they have been used by ancient civilizations such as the Norse Vikings [52, p. 59]. However, they were thought to have been reserved for those of a higher status [52]. With this history of shroud use in mind, designs such as the Leaf Cocoon are simply "merging ancient and new technologies" to create an intelligent design [9, p. 131]. Combining this intelligent design with the concept of natural burials and the celebration of the biological life cycle, both human and product encapsulate a literal form of reincarnation, which perfectly embodies the commitment to "immortality" to which Smail refers [4]. Could embracing our place within the biological life cycle and immortalizing our loved ones in areas of natural beauty be a step towards a reconciliation of our ecological and social worlds?

At the core of the Leaf Cocoon and Capsule design is the concept of "natural burials" and the importance of embracing our place within the biological life cycle and a more natural return to the soil. The *Good Funeral Guide* defines a natural or green funeral as one that rejects cremation, uses a burial site that also serves a conservation purpose, and is not visually definable as a burial ground. The guide prohibits embalming, forbids demarcation of the grave with a permanent memorial, and forbids any tending of the grave. It also requires coffins or shrouds to be made from natural and, where possible, locally sourced, sustainable materials [53].

Capsula Mundi [45] describes the philosophy behind natural burials perfectly: "Capsula Mundi wants to emphasize that we are a part of nature's cycle of transformation. This universal concept goes beyond cultural and religious traditions. Only a tree, a symbol of the connection between the sky and the Earth, will mark the deceased resting place. As tree after tree is planted, the cemetery will become a forest, free of the architectural motifs that mark today's memorial grounds. The cemetery will be transformed into a place of nature, one where families can stroll and learn about the natural world, where communities will come together to tend and care for trees. In short, it will become a sacred forest."

Perhaps for some, the idea of having a burial site without a traditional memorial can be unsettling, especially in regions where the culture behind burials on consecrated land has been largely shaped by Christianity and the traditional demarcation of a grave using a headstone or plaque. Indeed, in many non-Christian cultures, memorial signs remain an important feature of burial. Others, however, like those who practice Hinduism, tend to cremate their corpses without leaving material memorials, though some traces are often left behind [54]. In the UK, where crematoriums are owned by public and private authorities (as opposed to the church), cremation is particularly popular among those who self-identify as atheist or agnostic, which could be due to the more "neutral ideological territory" on offer [55].

In keeping with this neutrality, (exclusively) natural burials are held on non-consecrated grounds and are accompanied by the planting of a natural memorial such as a tree, bush, hedgerow, or wildflowers [56]. Some burial grounds may permit the placement of benches or the marking of a grave with a wooden marker or plaque, but this is entirely dependent upon the terms and conditions of each burial ground. The scattering of ashes is also permitted. In keeping with the Leaf Cocoon standard, natural burial grounds are also characterized by their adaptability to suit local conditions and plant diversity [57]. They can be hybrid cemeteries, designated public spaces, an urban garden, private land, grazing areas for farm and wild animals, or part of re-wilding and planting woodland for wildlife [56]. For this reason, as well as being "sacred spaces" [58], cemeteries can also serve a broader societal function as "spatial vessels of civic identity, telling diverse histories of the city and representing intangible notions of the character of a given place" [59, p. 393]. In this light, the natural burial ground becomes an expression of a new narrative where users can reap the nonmaterial benefits of the cultural ecosystem services (spiritual, recreational, aesthetic, or educational) that it provides.

Interestingly, research suggests that hybrid cemeteries may have a much greater impact than their exclusively natural counterparts. Claydon et al. [60] suggest that hybrid cemeteries are reshaping the face of the traditional cemetery from its usual manicured lawn esthetic towards a more "habitat rich and spatially complex landscape with its own distinctive identity" [60, p. 1] (see Figs. 35.1 and 35.2).

Although some may feel uncomfortable with the idea of not being able to identify their loved one's grave, one would argue that this has to do with the way we perceive immortality. As the above quote from *Capsula Mundi* suggests, trees have long been considered a place of connecting with the ancestors and a symbol of

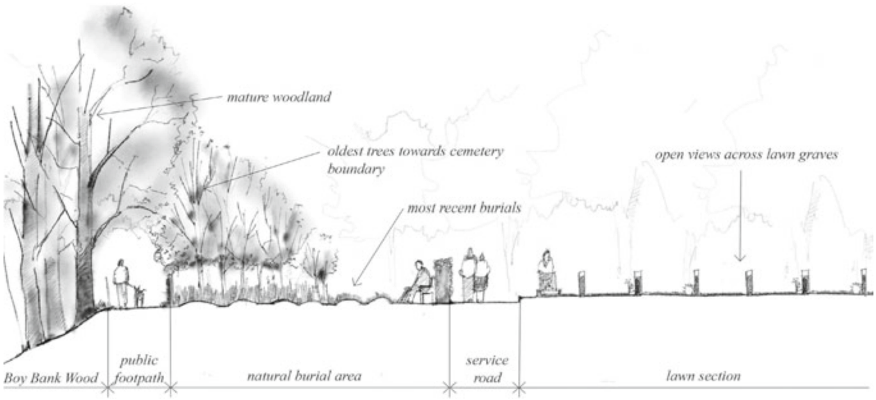

Fig. 35.2 Allerton Cemetery, Liverpool. The Natural Burial woodland forms a shelterbelt that divides this large cemetery into two halves (Adapted with permission from [60])

the meeting of two worlds: the heavens and the Earth [6]. Throughout history, tribes, ancient cultures, and those who have practiced nature religions have shrouded their dead before burial and, in some cases, elevated them high into the trees where they were thought to be closer to the realms of the gods [6]. For Hindus in India, to have their ashes scattered or to be placed in the Ganges River is considered sacred [56]. The deceased is passed over to the elements rather than having a static final resting place. Others may choose to immortalize a loved one in a more material fashion, in the form of named park benches, keepsake jewelry, pieces of art, or even ash-infused tattoos. Presently, online memorials are becoming more prominent, which contributes to a new type of immaterial memorial. What we find is that, generally, in many human beliefs, the dead are supposed to move into a world of immateriality or reincarnation. It is often the place (see [61] for examples of contemporary "sacred" spaces), the events that take place there [62–64], or the emblems, which represent the deceased (whether material or immaterial), that become sacred [65, pp. 47–51].

Discussion

In the introduction, eco-coffins were presented as a vessel to question our commitment to immortality and our relationship with the environment. Their use of locally sourced and safe materials, their low energy demands, and the fact that they have been designed to honor both the people and the natural systems in which they are produced make them exceptional examples of sustainable design. Conversely, eco-coffins provide us with practical examples of how a change towards regenerative production could trigger a greater philosophical and social shift in our relationship with the environment; the interdependency of man and nature that the C2C philosophy and Chief Seattle implore us to embrace.

This is not to suggest that we must go back to hunting and gathering or start erecting totems as they already exist in many contemporary forms: in our churches and temples, for example. Indeed, national flags, our "cathedrals of consumption" [66], and even our televisions can provide us with contemporary examples of totems. Much like our ancestors, we also attach meaning to the emblematic and often material representations of these totems; in the brand labels we buy and jewelry we wear, for example. "Sacred materialities" are already embedded in consumables and have social meanings that are deeply ingrained within our collective consciousness and heavily influence social action [67]. Seen in this light, a change in our relationship with the items we consume could also create new narratives that transform our relationship with the environment.

However, it is important to define our understanding of the term "Eco-Coffin" within a spectrum of "Eco" products that vary in their long-term sustainability. For example, some eco-coffins are made of imported materials such as a banana leaf, bamboo, or organic cotton, the growing of which requires large amounts of water and physical labor [68]. One must also raise questions about whether materials that are imported from tropical countries to those in the West fit into the C2C framework due to the air miles involved. Equally, while bamboo and banana fiber must be shipped, cardboard must be manufactured or go through a recycling process. The recycling process requires the use of extra materials and energy, which, according to the C2C framework, is an attempt to make the bad seem less bad [9, p. 67]. McDonough and Braungart lament the rise of our industrial society's monocultures and the fact that biodiversity is "typically treated as a hostile force and a threat to design goals" [9, pp. 32–35]. By contrast, the Leaf Cocoon's design naturally embraces diversity. Its two primary materials are naturally abundant worldwide in many different forms, which removes the need for the "brute force" or "one size fits all" approach and instead embraces regional identities and rituals. For example, wool can be sourced worldwide from sheep, llamas, alpacas, goats, yaks, camels, and even some species of rabbit. Decorative elements like flowers and foliage can be collected during the manufacturing process, ensuring a return of local nutrients to the soil. In contrast to the conventional coffin, shrouds such as the Leaf Cocoon are non-industrial and highly personalized works of art, meaning that manufacture can take place on a small scale and be made to suit individual needs. Unlike conventional coffins, which are generally mass-produced and delivered by large funeral companies, the Leaf Cocoon can fulfill the "waste makes food" principle of C2C production.

This implications of this study within the broader discussion on sustainability reach far beyond that of cleaner production and instill a more holistic understanding of our place on Earth. Aside from the philosophical and practical shift, natural burial grounds can also provide us with essential "ecosystem services" [69].

As natural burials prohibit the demarcation of gravesites with traditional headstones, they do not threaten traditional cemeteries' existing narratives or identities, nor do they require the same spatial consideration. On the contrary, natural burials can *improve* the existing narrative within a traditional cemetery by occupying the marginal spaces that would otherwise be unsuitable for traditional burial due to topography or natural landmark limitations. This is particularly significant with regards to urban cemeteries, such as the Waddington Road Cemetery shown in Fig. 35.2, where an introduction of natural burials has led to an increase in burial capacity [60], a commendable feat in an urban environment. In turn, while promoting contact with nature, these natural burials within urban landscapes provide regulating ecosystem services by introducing new vegetation, such as the woodland shelterbelt in Allerton Cemetery shown in Fig. 35.3, and local plant species that can attract pollinators, sequester carbon, purify water, stop soil erosion, and aid flood control, among other things, thereby enriches the cemetery landscape as a whole [60].

The practical implications of this study extend far beyond coffins to the design of life-long products. While designs that bypass built-in obsolescence are presently uncommon, as we write this article during the Coronavirus outbreak, questions regarding sustainability become more pressing. In a time of global pandemics, consumers realize that throw-away, poor quality products force them to shop more when movement is limited, products are growing scarce, factories are closing, and the economy collapses. Also, "when the lives of vulnerable social groups and the health of the larger community are under threat, larger philosophical and ethical questions about our relationship with nature emerge." This rings especially true at the time of writing, as evidence emerges that the Coronavirus outbreak was caused by the movement and consumption of bushmeat, and thousands of rodents, primates, and ancient anthropods [61] are experimented on and "disposed" of as we tirelessly search for a vaccine.

Therefore, Eco-Coffins and C2C production become an emblematic vessel through which society can redefine itself and its relationship with nature by introducing new and improving existing narratives. It is then through the rituals attached to the materialities and spaces that "gives the group consciousness of itself

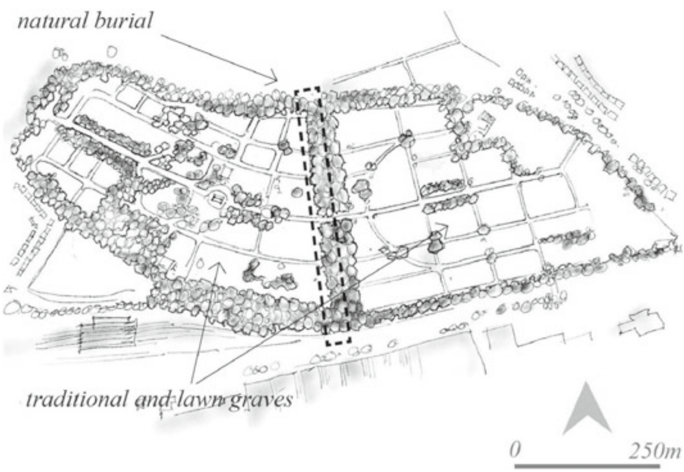

Fig. 35.3 Waddington Road Cemetery. A natural burial area connects the traditional cemetery with adjacent woodland while also creating shelter and privacy for the adjacent lawn section. Adapted with permission from [60]

[and its values] and consequently makes it exist" [64, p. 47]. This "collective consciousness" of our place within the biological life-cycle that Chief Seattle implored us to adopt as "whatever befalls the Earth befalls the sons of the Earth." To Seattle and his people, the fact that "Earth is our mother" must be taught, respected, and celebrated. And what better way to introduce a new narrative of circularity than by embracing our own place in the biological life cycle and returning to the cradle of the Earth from whence we came.

Conclusion

This chapter combines ethical and technical insights that have practical implications not just for burials and coffins (as material rituals and objects linking what is normally seen as binaries–life and death and man and nature) but for C2C production in general. Eco-coffins and natural burials fully encapsulate the biological cycle of the C2C philosophy. By using biodegradable and renewable materials and eliminating embalming fluids, the body can decompose naturally. The coffin and its occupant become fertilizer for the soil, returning to the Earth's cradle and becoming food for the beginning of a new cycle. If Eco-Coffins such as the Leaf Cocoon were to become commonplace, it would trigger a shift away from industrial, "brute force" designs that make our last interaction with the Earth a particularly violent one. Instead, it would celebrate cultural diversity in several ways; using local materials, customs, and rituals, and thereby breaking down taboos regarding death and the human life cycle. A step towards natural burials would encourage us to recognize our deep connection to the Earth in a peaceful and gentle manner. One that embraces diversity and encourages us to find our place in a greater life-cycle—a part of which our loved ones have become and that we shall one day become part of. So, let us teach our children that the Earth beneath them is the dwelling place of their ancestors. Perhaps then, we will cherish the land because we will know the Earth is rich with the lives of our kin.

Core Messages

- This chapter addresses dichotomous thinking about culture and nature.
- The cradle-to-cradle principles in application to eco-coffins are discussed.
- Eco-coffins provide an example of regeneration and a dismantling of dichotomous thinking.
- Eco-coffins offer a reconciliation of our ecological and social worlds.
- Burial procedures and coffin design remind us of our place within the biological life cycle.

Acknowledgements The original essay upon which this chapter is based is deposited in Leiden University archives as part of a student assignment written by the leading author during her master's degree. We confirm that it is not planned to be published elsewhere.

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Thinking 2050: Bioengineering of Science and Art

36

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"*It's not the problem that causes our suffering; it's our thinking about the problem*".

Byron Katie

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7_36

Summary

The authors of *THINKING: Bioengineering of Science and Art* were asked how they would see the future of their field 30 years later. This chapter presents the authors' views on the kind of world, thought force, cosmic dimension of thinking,

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engineering and systems thinking education, art and design, information theory, philosophy and social sciences education, curricula, musicology, humanities, economic thinking, engineering liveliness, environment and ecosystem, a new paradigm of thinking, and interdisciplinary science and thinking in 2050, along with fears and hopes for the 2050' human being who is thinking.

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THINKING: Bioengineering of Science and Art–Word cloud

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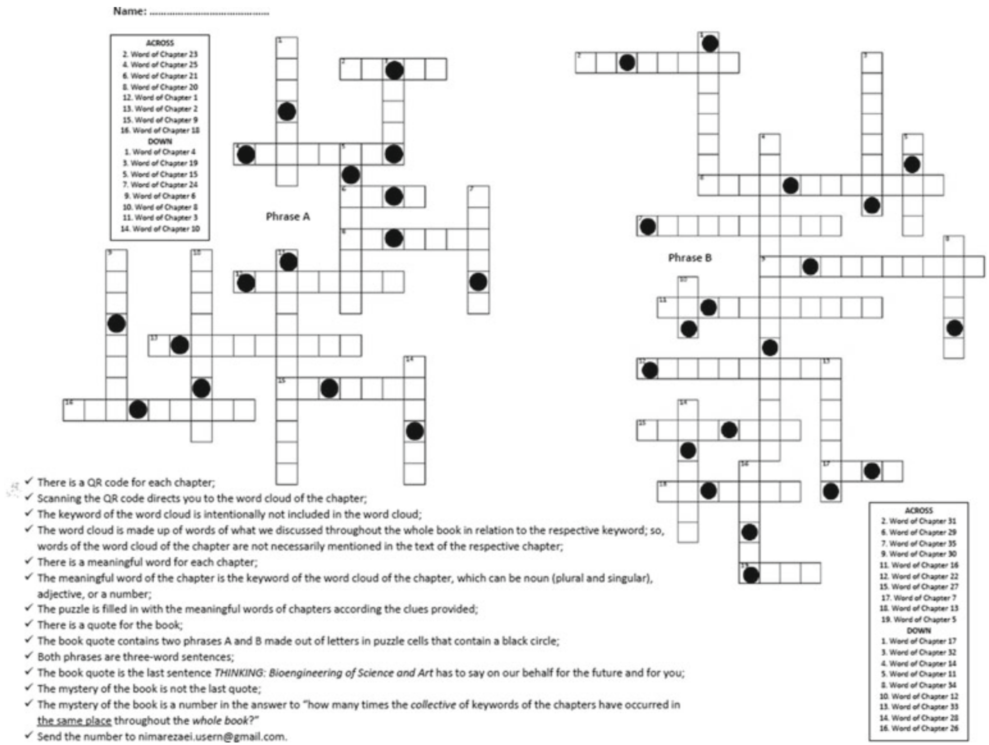

The puzzle of THINKING: Bioengineering of Science and Art

Keywords

Art · Bioengineering · Fear · Future · Generations · Science · Thinking

Introduction

THINKING: Bioengineering of Science and Art invited authors to present how thinkings at present are. Throughout the book, we see the authors set one or more points of time and space by which shortened the path from the past to present thoughts as well as thickened their journey along with well-known initiatives of present thoughts. For this last chapter, the authors were asked to set the present thoughts as the starting point of time to address how thinkings in the future are. Below, future thoughts are synthesized under different headings and subheadings. For further convenience, a few introductory sentences immediately appear after each heading before these future thoughts are outlined along with cross-reference (and occasionally a brief synopsis of present thoughts for clarification as they are) to the respective book chapters.

Discourses

These phenomena are a product of thinking, crucially critical thinking, as well as a type of communication. For this, some suggest putting discourses under the language of *thinking-as-communicating*. The frame of this language ensures the simple mechanism of holding a well-defined discourse that is working mainly using communication tools and logic, analytical, mathematical, or rational thinking. But the point is not to rely on these rules merely: we care about discourse participants' mental, behavioral, and phycological constructs [1]. Taking such meta-rules considerations into account, there is a lot of issues of discourses that different communities wrestle with. For this, discourse technologies and systems are emerging onto the discourse path that permits understanding the language of discourses at different levels [2], and therefore, extend a hand to different modes of thinking, such as sociocultural thinking [3], metaphoric thinking [4], reasoning and mechanistic thinking [5], and mathematical thinking [6], which are, in particular, pronounced with regards to scientific inquiry. We see, throughout the book, discourses about the human-nature dichotomies (Chap. 35), knowledge production and education (Chap. 32), taboos (Chap. 30), soul (Chap. 27), aesthetics (Chaps. 20 and 26), language (Chaps. 24), design (Chap. 22), model organism (Chap. 17), mind-matter (Chap. 8), biology and philosophy (Chaps. 2 and 5), theology (Chap. 2), and signals and symbolic messages (Chap. 3).

Discourses of Fears

Global fears are a subject of discourse. Climate change and global warming are terrible that in the discourses have a place to assume adjectives such as dangerous, catastrophic, extinct, and terrorful [7]. Fears are not new, but discourses surrounding these issues date back to the early modern era to the modern era to the contemporary era, which considers climate as judgment, pathology, and catastrophe, respectively. Climate change discourses have occupied about two-thirds of the body of the literature on discourses, with different themes, global or local, and points of focus, such as justice and security. They have led to developing a package of psychotherapy for both the individuals and communities to *control* and *master* their behavior [7]. Of most recent accomplishments are indicators that emerged to enable us to monitor global climate, but the problem is that the available data is not enough to be included in assessment analyses. It might take decades to collect the observations big appropriate for management decisions [8]. Moreover, the Global Climate Risk Index 2021 report stresses the climate change' impact worsened by the COVID-19 crisis [9]. We referred to climate as an example of long age to acknowledge that, though the catastrophe is still going into combat with us, how human fears in initiating discourses have been helpful to develop *thinkings* of *sufferings people are living with*. Though our thoughts are yet far from meaningful actions, we are still good, when even some fear and prevent themselves from falling behind discourses, but better than us are those who are in suffering, but are not busy with themselves, those who have found their focus of belongingness, *others*, and think along that.

Discourses of Hope

And the latter those of above are not only moving themselves but also have the hope to encourage other people to join their journey. Education is that through which they invest to create invitations at the scale as large as possible.

Public Discourse

In 2050, the main cultural spaces of public discourse will be controlled by various expert institutions. This practice will require the use of advanced artificial intelligence (AI) programs. This process will manifest itself in social media in attempts to automatically and algorithmically block content inconsistent with the prohibitions of various expert institutions securing the social activity of constructing mental worlds in accordance with their interests. The freedom of deduction and interpretation will cease. World public opinion will experience many language wars that will prove to be substitutes for standard wars fought with the use of tanks and rifles. As a result of these wars, the stochasticity of decision-making processes in the political space will increase. Hence, the demand for system programming specialists for aims of the deductive and hermeneutic prefabrication of mental worlds will increase. The importance of semantic and pragmatic engineering in the processes of democratic elections of authorities will increase disproportionately. Due to market needs, discourse processing theory will focus on the development of hermeneutic systems for the prefabrication of mental worlds. For this purpose, the mathematical theory of categories will be used. Hermeneutic inferences will be modeled as morphisms entangled in graph structures. Discourse research will also cover the ways of using such structures in profiling press news. It is possible that the algorithmic methods of formatting various types of fictional literature will be included in such research. Information technology engineering in literary art and in the press messages will become a fact (Wojciech Krysztofiak 2020).

Scientific Discourses

Since the middle of the last century, the status of philosophy has been severely weakened. On different fronts, both the increase in the authority of natural sciences, as the only recognized scientific paradigm, and deconstructionist criticism, as articulated in particular by French philosophers, have attacked philosophy in its traditional configuration. In recent years philosophy has thereby either found a place at the service of the sciences – within which the so-called analytical philosophy has converged—or has taken on the function of *consolatio vitae*. Within this scenario, the more traditional so-called continental philosophy has mainly turned into a history of philosophy. Our time, however, poses new questions to philosophy: environmental issues (e.g., the question of the Anthropocene), social inequalities (e.g., gender studies, subaltern studies), the criticism of objectivity, ethical problems related to the development of AI and robotics. These are the fields with which philosophy will have to deal in the next 30 years. This will be done by exposing the limits of a worldview based on the separation between different disciplines. Whereas in 1882, the philosopher Wilhelm Dilthey initiated the now traditional distinction between natural sciences (*Naturwissenschaften*) and the sciences of the spirit (*Geisteswissenschaften*), which led to a worldview that rigidly separates disciplines from one another, in the coming years, it will be up to philosophy, once again, to set itself up as a place for the overcoming of this distinction and the promoting of discourse capable of integrating different scientific discourses (Stefania Achella 2020).

Religious Discourses

In the last thirty years, there has been a revolution in history, both in its methodologies and in the way of theoretically approaching problems, which has not only made it possible to expand the repertoire of topics studied but also to propose novel explanations about matters that were alien to discipline such as emotions, eating practices or clothing. This has resulted in the strengthening of a discipline that has had the ability to incorporate the contributions of other disciplines into its own practice. In the particular case of the history of Christian religious thought, there are numerous studies that have sought to transcend the doctrinal part that sustains beliefs and has sought to show the socio-historical circumstance in which religious discourses were produced, as well as the political and cultural purposes that they pursued in the mythical construction of biblical characters. Although some religious sectors consider that any investigation of the sacred texts that do not use the tools of theology constitutes a challenge to the beliefs that have given ideological support to Western culture, the truth is that the studies that are undertaken in the future should pay attention, among other things, to the analysis of the construction of religious characters and the role they played in the Christian tradition; and the examination of aspects related to culture such as the importance of crying or the mechanisms that were used to instill fear among believers (Rogelio Jiménez Marce 2020).

Thinking of New World

Predictions of the future world are different, involving de-globalization [10], world communication network [11], tunnel networks [12], future pandemics [13], would population [14], distance learning spaces [15] and education systems [16], vehicles [17], energy [18], and climate. A substantial portion of predictions is about planetary urbanization, a kind of most intensive humanities' movement over the last two decades. Land degradation, the immediate aftermath of urbanization, has caused rural areas to face numerous challenges, worsening the effects of climate change, agricultural resources- and agricultural activities-diminishing effects, and therefore, health-limiting effects. Moreover, all these issues affect the food production and so food security is threatened at both rural and urban levels. From the management perspective, managers are thinking to design approaches that promise sustainable agriculture production [19]. From the social science perspective, there is a need to regenerate the community in the rural areas, by focusing on the recognition of potential resources that will help rural areas establish their own socioeconomic infrastructure and thereby develop relationships with urban areas [20]. Finally, some are, on the post-carbon world, predict that people will get back to their roots in the quest of the healthy lifestyles [21]. We are afraid that a community will gradually become victim to the other, while both are "must to exist" for the world to remain asymmetric, not lateralized to unidimensional mind, to enjoy thinking of all life, not a small part of that.

Moreover, there are many predictions about life-related indices, for example, life expectancy and disease-related outcomes. Physicians have shown they might not be as precise as they should be to care enough for their patients [22]. Such similarly occurs in prognostics work of philosophy discussing the dialectic of mind and matter (Chap. 8). Generally, based on a true priori and conditionals, philosophers conjecture about what possible is and what impossible is, and accordingly, they make justifications, judgments, and explanations that make the knowledge philosophy [23]. For the purpose of estimations in prognostics, they work, for example, with truth and “the life remaining.” With many attempts, estimations are still interpreted corresponding to a confidence interval that means “vulnerability to failure” [24]. The point is that life, though very short, is surrounded dynamically with variables related to our lifetime, and incorporation of all these looks a daunting task and yet impossible unless the parties take an integrated manner of thinking.

With Fear: The Changing World

Ten thousand years ago, where my family and I live in the North American state of Vermont, there was once a slowly melting sixteen-hundred-meter-high glacier. The Abenaki people lived their lives on the edge of this glacier, built their longhouses close to the edge of lakes and rivers, raised their families, grew their crops, hunted for animals in the forests, fished in deep lakes and rushing icy-cold rivers, and communicated with their neighboring communities in what is now Massachusetts, Connecticut, and New York. Just as they had little notion of what lay ahead of them generations beyond their lifetime, I cannot know for certain what kind of world my grandchildren will face, even thirty years in the future. Given what we know of the present disturbing conditions, it would be very easy to comment in a deeply dystopian way. The local, country, and worldwide events threaten to make each day sadder than the day before. The seemingly endless focus on individual suffering, disparate and desperate human conditions, the physical repercussions of climate change, the drastic reductions in the wide range of flora and fauna imposes a heavy burden on all of us to bear (Trevor J. Tebbs 2020).

With Hope: Thinking of Changing World

Each prediction, formulated in the moment of the lived present, is a projection into the future, a picture of the future, in which the objects are facts of the past. In this definition, the knowledge of the men is established why bound to the ideas of the world, the prediction of a philosopher must be different from the forecast of a physician, who can rely on the experiences which are really based on the facts of the matter, although these facts are also linked to the experiences of the mind. In the process of thinking about the things of the world, little new things have appeared in the well-known historia since Aristotle and, I think so, it will be remaining in the future. In 2050, the physician will be confronted with other experiences, new in their appearance, and the philosopher will have to pick up the old questions in order to answer anew – the what is open, not the how, but, being free, in the moment of the lived present every man knows enough to look to the future without sinking into the fear (Ulrich Richter 2020).

Thought Force

Looking into the origins of the universe, some believe that a single force and associated field has made the universe come to exist. Moreover, this force has its roots in the universe, and so, there has been a universal mind, universal consciousness, and universal thought, and these universals are to allow the origin to drive individual minds, individual consciousness, and individual thoughts and corresponding forces. These lines occur mainly in quantum physics research [25, 26], pseudo- and real-thinking, and thought force, as discussed in Chaps. 10–12.

With Fear: Human Being or Human-Like Being?

In the circumstances, it is difficult to close one's eyes to what is happening around us and take a utopian view of the future. However, as true as this may be, we should not disregard the human propensity to live in hope, embrace those we love, seek joy in our lives, and dedicate our time and energy to making a positive difference in the world - despite its problems - whether it be a world defined by our family or the world we can now wonder at from space. To my mind, this is crucial, and it underlines my hope in the new generation of individuals, who, to the degree they are prepared and enabled, are given the opportunity to apply their intellectual and creative strengths to finding and solving the problems that will, doubtless, continue to plague humanity. When I started searching thought force, I thought it was an interesting topic. I have realized over the years; many subjects are actually related to the force of thought. So, I believed the force of thought was an important discipline, a part of science. Then I built devices that measured the "immeasurable" force of thought and that could be controlled by thought force. Every force has its counterforce. Thought is actually a two-way communication phenomenon. Then I eventually realized that "thought force is not an interesting topic, it is not an important science, it is the most important question in the world. If today's scientists, journalists, and average people do not want to understand what thought force is, then I do not have to be a prophet to say what will happen in thirty years. The state (or private) thought force generator would send us thought forces. It will send us forces we accept as our "self-made" thoughts. People will live on the streets; they will have no need for money, housing, entertainment. The only thing that everyone will think of is the following: "I want to give you everything I have, dear, beloved 'Human Absolute.' Consider me your obedient slave. I myself want it this way." This last paragraph, by the way, is a serious critique of the absurdity of today's paid mainstreamers that deny accepting the existence of thought force. Thought force exists that is no question at all, and this is already not a scientific issue. It is about our future, about us. What will we be? Human beings with our own will or human-like beings without our own will? (Tamás Lajtner 2020).

With Hope: The Power of Thinking of Future–"Pull"

There is a concept called the "Futures Triangle" in Futures Studies. It explains that three forces, pull, push and weight, determine the future. Pull comes from the images of the future, the push is the ongoing trend in the present, and weight refers to what has been established, such as customs and traditions. In the midst of our fight against COVID-19, I have observed that the prevailing goal of this world seems to be the resuming of the conditions/state before the pandemic. This phenomenon signifies how much heavier the weight is compared to the pull and push. The weight is, however, not a physical, objective measure. It is composed of many kinds of assumptions as to how things ought to be. Quantum changes described in my chapter have removed those "ought" assumptions and have lightened the burden of quantum changers. As long as the current heaviness of weight continues, we will not see a future much better than the present. The further the idealized self (i.e., one's mask) is nurtured, the heavier the weight in the individual and society becomes. If we are able to figure out ways to decrease the weight and increase the power of the pull, we can become optimistic about our future. I believe that people become aware of the fact that they have lost touch with their real self and find the need to resume it is one of the ways toward a better future for our civilization (Ryota Ono 2020).

The Cosmic Scale of Thinking

This scale of thinking, in terms of time, space, and casualties, is visited when thinking where human thinking is posited in relation to the world. Two main discussions are those that compromise the scale of human thinking, for example, to that of an organism and those that stretch it to that of the universe. That these discussions have not reached an acceptable level of coherence has prohibited understanding what our true thinking scale is, also known as scalar collapse, and therefore, our actions and behaviors are not only mismatched with, but also reveal extensive damage to the environment, ecosystem, and the world such that climate change and other global catastrophes are not at all surprising events. Some authors write [27], as throughout the book discussed (Chaps. 2, 3, 5, 7, 14, 16, 18, 24, 25, 28, 29, 31, 32, 34, and 35), about Western thought and European Enlightenment tradition to explain what behind this scalar collapse are, through which they highlight, for example, that from these perspectives: (i) human thinking has to do with a single scale for his identity to remain stable. Indeed, they see the stable line of human identity propagating into unstable states when human thinking transits to extended scale (or even multi-scale); (ii) the human mind has a habit of interpreting other objects of the world in relation to himself, and at the heart of this interpretation is to define to the scale of other objects while his scale remains free, and this freedom is, of course, not pleased when it does allow you to understand other objects' scales before self-scalar understanding is achieved; and iii, and this lack of self-scalar understanding is that has paved the way for traditions, like Enlightenment, to allows themselves to *disintegrate* our thinking scale.

With Fear: Thinking is Disappearing

Today all forecasts about thinking as well as anything else must take into account the global situation, which becomes more and more eschatological that is loaded with growing risks of a global catastrophe. According to my analysis (see Sergey Horujy. Settling-down in the Eschaton? In *Diogenes' Lantern*, 2020, No 5. InRussian), there are five principal eschatological scenarios, and prospects of thinking are different in each of them. Two scenarios correspond to the self-annihilation of humankind and hence to the disappearance of thinking (Sergey Horujy 2020). Two others describe the non-military self-destruction of personality and society due to the virtualization and loss of ethics and truth. In the last case, the detachment of thinking from truth implies radical changes of epistemology and gives birth to peculiar perverted and degraded modes of thinking cultivated mostly in media and the Web. Finally, there is the scenario of the post-human and the trans-humanism, and in this case, the main trend is the convergence and fusion of human thinking and computer technologies into a certain kind of synthetic connectionist network architecture.

With Hope: Thinking Has a Mission to Accomplish–being Re-Integrated

If mankind succeeds in overcoming eschatological threats, harmonious scenarios become possible. They will involve not only the Earth but also the cosmos because human practices strive to reach extraterrestrial, interplanetary, and even galactic limits. Thus, human thinking and activity will develop a new cosmic dimension, in which they actualize the *cosmic mission of humanity*. The realization of this mission demands a new model of our relationship with the environment that is a new type of ecology; it is already emerging now and is called *integral ecology*. On the other hand, this mission was always the subject of religious thought, so that dialogue with ancient spiritual traditions is possible on this ground. One scenario of such a dialogue based on the Eastern-Christian paradigm of 'cosmic liturgy' is presented in my works (see Sergey Horujy. Cosmic Liturgy, Orthodox theology, and integral ecological expertise. In: Christopher C. Knight and Alexei V. Nesteruk, eds, *Eastern Orthodox Christianity and the Sciences: Theological, Philosophical and Scientific Aspects of the Dialogue (*Brepols, Turnhout. 2020, inpress). In this scenario, individual thinking is to be united with ontological and theological one (in some new forms, perhaps) as well as with thinking of animals into universal cosmic connectionist architecture (Sergey Horujy 2020).

In 30 years from now, thinking of the future challenges the man to consider his presence in the world—as part of an ecosystem on a planetary scale. It is about understanding a process that does not only remit to a sense of survival but of existing in the most human way possible. Indeed, knowledge is still limited; however, the activity of thinking with others interdisciplinarily affects the deployment of science and technology. On the other hand, if man, as far as he knows himself *nosce te ipsum* and advances scientifically, may attain great achievements to benefit the "self" itself. The different pieces of knowledge can help this search. So, thinking, doubting *cogito ergo sum,* is an unwaivable exercise whose goal is to give a constant account of the understanding of the self, cosmos, and God (Eva Reyes Gacitúa 2020).

Engineering and Systems Thinking Education

Twenty years ago, 13 engineering educators and researchers [28] did a job as we are doing, making predictions of the future of engineering education. The concepts they mainly included were:

- changing economy and demographics, technologies and their impact on the learning spaces and education systems, competitive world, engineering and science pipeline problem, engineering enrollment trends, objectives of engineering education;
- changing university;
- the relationship among engineering, art, and science, technologies, overspecialization;
- stimulating positive changes via hiring graduates, organizing a better accreditation process, improving research fundings, and improving the reward system;
- considering a higher level of education;
- moving along with education research trends and providing support through research application opportunities and outcomes assessments; and
- the emphasis to integrate engineering, art, and science.

So, here let to express our deep happiness and kind appreciation of all authors to do this project at the heart and brain of which is integrated bioengineering, science, and art possible. Here, unfortunately, we cannot refer to the specific chapters, as it, for all interested readers, remains a journey to explore in the expanded area of all chapters' discussions at least an educational and learning aspect of thinking, though the words "education" and "learning" are not directly mentioned there!

Then, looking into the most recent of engineering in addition to that of the changing world of complex problems, there is an increasing need for engineers, while the engineering education setting mainly suffers from inadequacies with regards to professional, soft, and computing skills. More precisely, the word needs engineers to think and act as distinguished: those who can use these skills to solve problems, learn, lead, effectively join teams and participate in teamwork, communicate, and all of these, of course, in parallel with knowing the principles of different science areas [29–31]. Notably, the systems thinking (ST) approach to engineering education is sustainable as it offers a way of learning, the so-called experiential learning, so competent to represent interdisciplinary opportunities for practicing engineering [32]; thereby, learners acquire the capacity to work collaboratively [33]. Such an approach, in particular, applies to civil engineering education, where the dynamic complexity of socioeconomic problems makes it difficult to manage [34].

But what our responsibilities with regards to the cultivated engineership are? How can we prepare their school-that is, the curriculum, teaching, and learning spaces?

With Fear: Ambiguities and Uncertainties

It is as impossible to predict the future of education in 2050 as it is reasonable to invent *possible futures* with better education today. In order for engineers of future generations to meet the increasingly complex demands for non-routine interpersonal and analytical skills, it is necessary to start working holistically on the development of cognitive and metacognitive skills in higher education. Therefore, higher education should focus on the explicit inclusion of disciplines that strengthen critical thinking, creative thinking, and -given the hyper-connectivity of today's world—the knowledge and understanding of other cultures. Colleges and universities should also consider in their curricula the development of other soft skills, such as social and emotional skills, which have been relegated by the impressive thrust of hard skills: the management of emerging technologies and the digital transformation. Definitely, by developing students' self-awareness in their own learning, we will enable tomorrow's engineers to successfully confront the ghosts of volatility, ambiguity, and uncertainty that overwhelm us, the engineers of today (Patricia Caratozzolo 2020).

With Hope

Integrated Engineering and Liberal Arts

The complexity of engineered systems and the amount of information that users and engineers will handle will likely only increase in the next 30 years. We believe that intuition, aesthetics, and emotion will become essential elements of engineering curriculum and practice. We hope for an education system in which requiring a few liberal arts courses as part of engineering programs becomes obsolete. Instead, artistic and creative thinking should be embedded in engineering courses. Solving a problem should be no longer the result of applying analytical skills only, but it should also be based on elegantly framing and problem and conceptualizing the solution. Similarly, critical thinking ceases to be associated only with open discussions in liberal art classes. Instead, data analytics, mathematics, formal modeling, and engineering are employed to enhance and put to the test critical thinking.

While we still see art and engineering as two distinct disciplines 30 years from now, we certainly see their overlapping growing, particularly in those areas where one can benefit from the other one. They both pursue, through complementary tools and approaches, the design of good forms (Luca Iandoli, Alejandro Salado, Giuseppe Zollo, 2020).

Embedded Systems Thinking for Education

We must harness our collective potential in creating a new paradigm in education that fosters innovation and creativity in imaging a new human ecology that aligns with our Earth's ecosystem. By adopting an ecological worldview through an ST approach to education, we help mitigate the multitude of global crises we currently face. Furthermore, by embedding systems thinking (ST) through organismic biology within education, we are more likely to solve the complex problems we face and promote social justice, human dignity, and the common good. Therefore, it is imperative that we dispense with our anthropomorphic mindset in education in favor of a more ecocentric one through ST, as this promotes and recognizes our Earth as an organism. We can also benefit from lessons learned from Indigenous cultures to inform further education curriculum and modeling (Stephen Spain 2020).

Philosophy, Social Sciences, and Thinking Education

Philosophy is a knowledge connected with social sciences [35], and on the other hand, is the activity of practice with the practice of education [36]; so, the integration of these three, i.e., philosophy, social sciences, and education, is not an idea at all, but a necessity of their identities in relation to each other. Just to begin with, it is the philosophical reasoning that branches out educational knowledge into distinct forms as we see in distinguished curricula, e.g., empirical, scientific, deductive, mathematical, and ethical knowledge. Yet, it is critical to treat intersections between philosophy and education as multiple or plural [37]. It is, however, clear—an evaluation system is that we need to apply to this context, which not only are humanities and social sciences inseparable from but they are deep inside, for making a measurable image over past, present, future, to make sense if we are progressing [38].

With Fear: Educational Problems Have Roots in the Philosophy of Practices

My field is the philosophy of education. As I see it, there will not be many changes in thirty years since the main issues of philosophy have been practically the same since Heraclitus and Parmenides, who lived 2,600 years ago. The separation proposed by the great Parmenides between the sensible and intelligible worlds remains until today, under different terminologies: body and soul, language and thinking, word and thing, sign and meaning, and so on. The metaphor of Heraclitus's river, which expresses the fluidity of knowledge and denies the existence of absolute certainties, continues to clarify several metaphysical problems, enabling intermediate positions between the above two giants of philosophy, as we see in the work of the contemporary philosopher Ludwig Wittgenstein, whose ideas have guided my research in education. What we have seen throughout this long period is that philosophical questions reappear at all times due to new contexts and demands, requiring solutions that make sense in the new forms of life in which they appear. Particularly in education, the subject of the formation of human beings has questioned the already existing pedagogical practices, looking only at methodological and empirical issues (new computers, remote teaching technologies, reform of physical spaces), to the detriment of ethical and epistemological issues that guide our action and thinking. In my view, a significant part of educational problems could be faced if we looked at the philosophical foundations of these practices, which are still far from happening (Cristiane M. C. Gottschalk 2020).

With Hope

Universal Science and Education

The future of philosophy and social science will depend on how much they will engage with constructing and inventing a better and fairer world. Philosophy and social sciences should work to overcome disciplinary boundaries and allow a complete understanding of humanity. Similarly, cooperation between humanities, social, and natural science would bring a new era of creativity and discoveries while assuring an ethical, unbiased development of sciences. Of course, this implies that every discipline and science should go out of its "comfort zone," that every scientist should be willing and able to communicate with different fields, and that new interdisciplinary expertise should be developed. That is how an integrated science will develop. Moreover, scientists should abandon their "ivory tower": science is a social, communal enterprise, then scientists should engage in building a society in which ideas could freely circulate. Ideas are the most powerful asset of humanity: creating a universal science and education should rest upon a free and respectful circulation of ideas (Mauro Scalercio 2020).

Social Sciences and Philosophy Education for the Next Generations

Education, particularly social science and philosophy education, will be increasingly relevant in the next three decades. As of the time of writing, we are sending robotic explorers to Mars, stopping a global pandemic, extinguishing forest fires, opposing authoritarian regimes, allowing nature to recover, waging wars, and celebrating rights, diversities, expressions, and humanity. However, all these things will be for nothing without the next generations gaining an understanding of their meaning. This shall be the purpose of social science and philosophy education in the decades to come. Social science and philosophy education, which is not only meant to relay information, will be at the forefront of reflexivity and reflection. Conflicts will inevitably arise as this seem to be an indispensable part of humanity. However, alongside this, I believe that there will be pockets of reasonableness, dialogue, empathy, and collaboration – all thanks to multidimensional thinking education. As education guides the next generations to understand the present, it will look back to the score years that have gone by in order to endow inquisitive minds with vital lessons of the past. In the same way, education shall also continually look towards the future, as we are doing right now, in an attempt to learn where our dreams, ideals, and aspirations will lead us. These lessons shall guide our young into forging a better future for humanity. One that will, hopefully, be brighter, better, and safer. In the end, social science and philosophy education will perform its time-honored duty to give meaning to humanity's progress (Leander Penaso Marquez 2020).

Curricula

Humanities integration is discussed under interdisciplinary learning and education programs in different sciences. This integration is, for example, possible to move medicine towards science that is more aesthetic [39], empathic, and ethical. In engineering, this integration is no doubt important to be incorporated in education; thereby, engineers develop communication and social skills, which tend, otherwise, remain poor, and would prevent them from passing dutifully [40]. Moreover, humanities-integrated programs are, in learners' eyes, enjoyable learning, encouraging them to attach the knowledge acquisition [41]. Language [42], particularly ideological language [41] and art media, might help mediate this integration. Through communication play [43], we see how a better generation of sciences can grow in scientific environments. Schools, universities, and faculties need to attain a certain level of awareness of interdisciplinary programs [43].

With Fear: Education as Commerce–Humanities Are Slowly Dying

The new university model of 'education as commerce' necessarily weans out those programs that are not economically viable and encourages students to see themselves as consumers of education (and given the exorbitant cost of tuition in America, for example, I find it hard to blame them sometimes). Professors become little more than shopkeepers, adding items to a shelf or removing them at the whims of students and administration alike. Interdisciplinary models and methods may invigorate the humanities in new ways. But it should not stand that entire disciplines—the former cores of what a liberal education was supposed to mean—must be given a cash value in the university's economic system. Rather than merely grumble here, I offer three solutions (of many possible avenues of action). First, the sciences must defend the humanities at the university and administrative levels. This is, of course, more difficult in practice, but it is worth mentioning. Second, programs in the humanities must expand their curricula to include healthy doses of scientific study. A student should not graduate without some literacy in a broad swath of knowledge. Third, there need to be more books, special issues and collaborations like the present one. While I cannot say where the humanities will be in 30 years, I know that without the humanities, university life (and thus society generally) will become more staid, less playful, and ultimately less democratic (Dustin Hellberg 2020).

With Hope: Art-Integrated curriculum–A Room for Dialogical Thinking

Working in Modern Languages (German) within the specialist field of poetics, my vision needs optimism to see a future at all. Currently, departments in my field are closed, and finances for the humanities are drastically reduced. However, I am convinced of the importance of literary, cultural, and language studies, and so I am sure societies will see reason, and things will change again for the better. I imagine, however, that all literary and cultural studies will be assembled in one large department with some core courses for everybody but also various pathways within which students can choose quite freely to tailor their studies according to personal interests, combining languages, visual arts, film, probably also philosophy, history and international relations/political science. This tendency is already visible in very popular new liberal arts programs in the UK. I envision that language learning will be obligatory and that this will be done to foster thinking language. Poetic thinking is, of course, an overarching approach for all these fields: it would be a positive and welcome development if curricula could be designed so that all students somehow encounter some of it. I remain hopeful that dialogical thought will indeed be the philosophy of that future (Marko Pajević 2020).

Design

Design thinking is a humanistic, problem-solving approach [44, 45]. It offers high potentiality both in terms of the formation of new products (plans) and re-formation of current ones but remains less translated into the practice, calling a process of familiarization, through, for example, a tour, course, or programs, for managers and organizations to pull! them to decipher the meaning of the design thinking and how it is simply humanistic as well as, through a combination of physical artifacts, specific enough to effectively manage complex problems and projects making us appreciate its power [46], and this appreciation is pertaining signal for emotions. Moreover, at the brain of the designer is think, practice, more think, practice, and more and more think and practice to reach out and catch the product that is innovative; the manner that diminishes cognitive biases [47], making designers good candidates for leadership [48]. Therefore, design thinking is thinking that promises to meet our mental constructs [49], such as reflection, as described in Chap. 22.

Again, let us come back to the 2000s when design-aided tools emerged. At that time, the use of such tools seemed unpleasant in terms of the style of interaction, in terms of the processing of product formulation, and etc., with which the designer was almost totally alien. Next, attempts moved towards more designer-friendly systems that could engage designers from the early stages of the design process, and therefore, design thinking could enter into an improved interaction with the tool. The architecture of such a system can be found in [50], which, in summary, involves different knowledge systems that work with sketching, gesturing, and verbal inputs.

Nowadays, the discipline of design is changing as its tools, methods, processes, and knowledge become more transferrable to all other fields of study. As the problems requiring design intervention grow in complexity, design will be positioned at the forefront and continue to make contributions to interdisciplinary practice through its specific ways of thinking, reflecting, and knowing. Design has, for decades, borrowed theories from its neighboring disciplines to provide structure to its often intuitive and skills-based abilities. This calls for more design researchers to translate practice into theory, developing and establishing core theories that are epistemologically and ontologically rooted in the domain of design (Harah Chon 2020). For this purpose, experimental studies and large-scale analyses of design data are necessary to bridge the gap between empirical and practical knowledge design and establish cognitive design; thereby, they can help create the culture of design—that is, experiential learning, organization-level environment, and tools [44, 51]. Another interesting avenue design thinking is opening is pertaining to classroom education for children to promote learning through media and hands-on activities; therefore, cultivating creative, constructive, and collaborative thinking [52].

Art

Making artwork is the process of creativity, imitation, and inspiration [53]. Even when the artist copies others' artwork, there is again a demand for creativity and inspiration to make an original artwork or reproduce others' artwork. Artwork creativity, in turn, results from different cognitive mechanisms as being integrated, mainly computational thinking, memory (both long-term memory and working memory), and activities (exploration, reflection, analysis) [54]. From a functional viewpoint, the artwork creativity corresponds to a balanced activation of the default mode network (DMN) and executive network (EN), which individually apply to idea generation and idea selection [55]. That professional artists display greater connectivity between these two brain networks reveals this connectivity as a function of art expertise, that is, artistic creativity. Chapter 16 provides a perspective on the bioengineering of art. In Chap. 19, that art and media intersect with each other in the mind of an artist, we see a great ground made of thinking, perception, and emotions.

With Fear: Loss of Inspiration, Creativity, and Contemplation

Contemporary artists are no less technically skillful than previous generations of artists, quite the opposite, for they have a wider heritage to learn from than previous generations did. However, the current paradigm of contemporary art is based on reactions and ignores the role of contemplation and inspiration (Amine Harbi 2020).

"In the future, the only artwork that will survive will have no gravity at all," maintained Nam June Paik, the father of video art, in 1980. I think that new media art will be increasingly virtual and digital; at the same time, art will maintain a very strong relation with corporality and matter as they will always be viscerally linked to the creative act (Paola Lopreiato 2020).

With Hope: Integrated Art and Science

Thirty years from now, by God's will, a renewed interest in philosophy as seeking wisdom will burst from the multidisciplinary approaches to reality that we are witnessing. Studying how previous civilizations and traditions approached beauty and nature is important in forging a paradigm of nature in which humans seek harmony with nature rather than mere utility, commodity, and consumption. Artists in this realm have an important role to play, for they are constantly working on beauty as a vital element in life. The ecological crisis cannot be overcome without the contribution of artists in making people rediscover the beauty of nature as more important than subjective whims that are at the roots of the consumerist lifestyle that is harming nature (both human nature and nature at large). If integrated science and multidisciplinary studies will overcome the narrowed specialties inherited from the scientist era by being encouraged in education, artists will reconnect with the spiritual dimension of art that is universal, objective beauty, and this will definitely reinitiate a harmonious equilibrium between humans and nature (Amine Harbi 2020).

Biology

Dualisms with regards to "life," an entity that is "living," and an entity that is "non-living," have long been the subject of biology, philosophy, and epistemology. This discussion includes all "living" beings who possess the body, the mind, and the soul (Chap. 6). Among "living" beings, human beings and non-human beings also hold hot dualisms. Synthetic biology is an interdisciplinary science that emerged to understand the origins, development, functions, and behaviors of non-living and living entities [56]. Bioengineering from this leads to different products that are valuable for instrument acquisition for modeling complex systems and structures, from cells, tissues, and organisms to life and evolution, in practice. Planning for such an inclusive purpose, different disciplines need to integrate knowledge and conceptual tools in order to precisely execute a systems biology analysis; so, it reveals to us a pleasant realization of what is real [57]. Chapter 17 includes dialogues that occurred between an artist who did programming bacteria (E. coli) and a philosopher, followed by philosophical accounts of bioengineering organisms in Chap. 18. There are challenges, for example, regarding biological issues [58]; however, the field tracks appear well-suited to direct towards a noticeably advanced state, via, e.g., automation, industrialization, deep learning-based approaches for DNA design, while-cell simulations, biosensing detectors, evolutionary controllers in real-time, multicellular systems, systemic genomes, artificial cells, and engineering living materials [59].

With Fear

The Distinction Between Mind and Body

Current research in the field of the epistemology of biology is addressing the problem of the emergence of teleological structures in the living, paying particular attention to the issue of the ontological consistency of the "possible." In agreement with Kauffman, for example, the Adjacent Possibles are real ontological possibilities that arise from the mixture of classical physics, quantum physics, and unpredictability of selection. The processes of natural evolution involve Adjacent possible that are not only classical deterministic physics but that contain quantum elements for the most part indeterminate. These analyses, however, in an attempt to solve the very serious philosophical problem of how to describe a system in which there are different levels of activity connected by both bottom-up and top-down relations, are not able to break away from Cartesian dualism, proposing, in fact, a dual ontology of quantum matrix that risks proposing all the absurdities arising from the mind–body dualism implicitly. Unfortunately, the problem is far from being solved in a definitive way (Mirko Di Bernardo 2020).

The Distinction Between Organism and Non-living Being

Currently, it is close to impossible to predict the future developments in the discipline with any degree of confidence; however, we submit that the basic conceptual distinction between organism and non-living being is unlikely to be overthrown in the near future. This means that even in 2050, the engineering of living beings will remain elusive. As for philosophy, no progress is to be achieved beyond keeping vigil and critical company with scientific and social developments—and the dreams and nightmares within them (Reto Gubelmann, Marco Toscano 2020).

With Hope

An Integrated Information Theory

The concepts on which Kauffman has been working for many years, such as Enablement, Adjacent Possibles, and Poised Realm allow important steps forward towards the solution (allowing an extension compared to the classical version of complexity theory) but require in the mathematical sense of the term further considerable technical efforts. In other words, in current scientific thought, we are waiting for a new Newton capable of making the physical–mathematical sciences take a similar but far more far-reaching leap to what the great English scholar made physics and mathematics do at the beginning of modernity. In particular, we are waiting for an adequate information theory for physical systems that do not fall within the paradigm of classical mechanics systems—statistical mechanics included—which are the non-linear dynamic systems stable out of equilibrium (chaotic systems); therefore, an information theory that is adequate (true) also for all biological and cognitive systems. The hope is that decisive steps in this direction can be taken by 2050 (Mirko Di Bernardo 2020).

Art-Integrated Engineering Liveliness

I consider myself to be an artist, although, in the context of this project, my work has been art that engages with biological material. My hope for the future, therefore, is that our understanding of the properties of physical material will include consideration of its liveliness. The study of lively material in this sense therefore, is understood in two distinct ways. Firstly, that all material—biological or otherwise—is capable of being extracted, appropriated, and manipulated by humanity and secondly, that all material has a capacity to act in relation to its environment and that this capacity has consequences on the environment in both the present and the future to come. Perhaps through this understanding, we will seek to find ways in which we can be both respectful of and considerate towards the plasticity of the lively material which constitutes both our planet and our physical bodies (Louise Mackenzie and María Antonia González Valerio 2020).

Environment and Ecosystems

An ecosystem is defined as healthy if it can remain in its position, in terms of both structural and functional features, in a stressed state [60]. Indeed, a healthy ecosystem is resilient when external stress, from either natural or anthropogenic sources, applies to it. Ecosystem retrogression is the removal or reduction of nutrients in the system resulting from the biological and ecological processes that affect, for example, soil fertility and organismic traits. These processes correspond with long-term consequences, and so studying this correspondence, short-term prosses and long-term effects, is of theoretical potential to intervene in them for rejuvenation to occur. There is a wide variety of patterns, processes, mechanisms, and consequences of ecosystem retrogression, and so studying them requires an interdisciplinary panel of experts in ecology, biogeochemistry, geology, and pedology [61]. Moreover, the core of such a study is to assess ecosystem health quantitatively over time, as this assessment is helpful for tracking the health status of the ecosystem of interest, but also for the health management of similar systems. Developing indicators of ecosystem health has been an active line of research in technology and innovation management. Efforts are of three main themes: industrial ecology, business ecosystem and platform management, and multi-actor network that, correspondingly, focus on industrial levels, organizational levels, and social network dynamics. Recent research stresses the need to integrate these themes into a practical model to coherently and systematically define, assess, and manage ecosystem health [62].

Ecosystem functioning forms a close correspondence with human cognitive functioning. Biodiversity is, for example, an aspect of ecosystem functioning. Species loss, among both animals and plants, changes the ecosystem diversity and its functioning [63]. As mentioned above, such loss results from natural or anthropogenic effects and is so crucial that we know it as ecosystem collapse [64]. Forests are an important source of biodiversity and in direct relation to services and functions, the ecosystem can offer [65]. Moreover, ecosystem services contribute to human health, both in terms of physical and mental health, well-being [66], and economics [67]. Despite these well-known facts, predictions are not promising, with more than one-fifth of surface land estimated to cross one or more of the functioning thresholds [68]. Altogether, ecosystem services management needs to be tuned to the sustainability of human well-being, and some keys to fine-tuning entail societal transformation [67].

With Fear

Apathy in Specialized and Non-socialized Science

My academic background is based in sociology, anthropology, and the fields of permaculture and regenerative design. While I study environmental change and how it impacts social dynamics, my work aims to reconnect people to their natural environments through citizen science programs, outdoor education, and community engagement. Through work, I have come to learn that the sciences appear so specialized and introspective to those outside of academia that they have become seemingly inaccessible, resulting in apathy and lack of engagement. Social science is a discipline that likes to ask uncomfortable questions and challenge the status quo. With an in-depth understanding of social dynamics, practitioners are well equipped with the tools to analyze, inform and effect change within our communities. However, if steps to democratize knowledge and bridge gaps in communication are not made, reconnecting with the wider public may be difficult.

Distinction Between Human and Animal Life–Extinction and World End

In 30 years, the philosophical field of human/animal studies will find itself at the center of growing tensions, perhaps even in a dramatic way. Transformative processes on a global scale will make scholars impossible to erect ivory towers or lock themselves up in textual specialism or philology. On the one hand, this will be due to widespread social needs for greater justice in the treatment of non-human animals and, on the other, to the increasing (scientific *and* ethical) awareness of the unsustainability of the traditional models of action and thought. Human/animal studies will therefore be faced with two key tasks. First, they shall help social aspirations for interspecific justice (which are often unaware of the thought patterns they are based on) to take on a critical form and an overall coherence—to pass, in other words, from the status of expectations to that of projects. Second, human/animal studies shall stimulate scholars of all fields to pool their skills together in order to give concrete indications of action to the human species in this crucial phase of its relationship with non-human forms of life. Scholars interested in animal cognition – be they scientists, philosophers of the mind, bio-semioticians, or others—will have a delicate but essential task: to make people understand that the extinction of an animal species involves the disappearance of an unrepeatable point of view on reality. In this sense, when a species becomes extinct, an entire world comes to an end (Carlo Brentari 2020).

Consequences of Failure in Assessment—The Permanent Effects of Climate Change on the Environment and Ecosystems

The research field related to the analysis of multifactorial interactions that bring about dynamic behaviors, thus impacting the environment and ecosystems, is fundamental for the understanding and assessment of their state (Chap. 34). This will support the decision-making process to select adequate environmental management actions, which aim to improve the current environmental state. Human activities and the events related to climate change will permanently affect environmental and ecological states, and developing countries will be the most vulnerable. Therefore, the research field related to the studies of environmental and ecological systems will represent urgent and necessary support to reduce and/or mitigate the impacts on ecosystems that provide services for the benefit of human wellbeing. This research field should be reinforced and extended to cover the vulnerability of ecosystems to climate change. In addition, it requires the permanent participation of multiple disciplines to find insight into new knowledge to reinforce the understanding and the assessment of ecosystem states by taking into account socioeconomic, sociopolitical, technological, demography, and cultural factors. Otherwise, the studies related to environmental and ecosystems will always be incomplete and lack objectivity (Fernando Ramos-Quintana, Ana Itzel Casarrubias-Jaimez 2020).

Lack of a Systemic Approach–The Cause of Ecological Problems

My field is actually architecture. My excursion into brain science is the result of recognizing that our thinking "Within the Box" is the actual cause of the problems I, as an architect, but also we, as a society, are facing, where leading scientists have said we only have about ten years to resolve them. Architecture has made real progress in the past 20 or so years internalizing the basics of green buildings. However, most work only at the checklist level, where the industry is cost-conscious and traditional. Only a few recognize the need for a systemic approach and a regenerative focus (Christopher A. Haines 2020).

With Hope

Transdisciplinary, Social Ecology–Regeneration of the Environment, Human Life, and Non-human Life

To make scientific knowledge more inclusive, we will need to create opportunities for transdisciplinary research and information sharing that goes beyond academia to bring theory and practical application together, thus involving all stakeholders (from artists to policymakers) who play a crucial role in imagining alternative futures and shaping collective solutions that are beneficial to both human and non-human worlds. We cannot fix our problems with the same thinking that was used to create them (Grace Anywar, Helen Kopnina, Kim Poldner 2020). We will need a drastic paradigm change to avoid ecological collapse in the next 50 years. This will necessitate a shift from industrial to regenerative production, linear to circular economies, individual to collective thought, and from anthropocentrism towards a social ecology that recognizes environmental ethics and the intrinsic value of non-human lives. The social sciences will need to create new narratives, and our chapter (Chap. 35) is just one example of how re-examining our methods could enable both philosophical and systemic change (Grace Anywar, Helen Kopnina, Kim Poldner 2020).

Paradigm Shift–Biodiversity and Architectural Regeneration

We must raise the bar on these issues, but identifying the actual cause of our ecological problems is a required step. The Heat Planet thesis documents biodiversity loss and replacement, not just carbon gain as the cause, providing opportunities for very rapid improvements. If the profession hears and embraces these paradigm shifts, then vast improvements could be made in 30 years. The change would drastically reshape the field to embrace biodiversity into architecture and expand the knowledge base of architects significantly. However, from recent experience, architects are unprepared for and somewhat dismissive of this paradigm shift, so the verdict is not in yet (Christopher A. Haines 2020).

Integrated Science

This last heading has already been the subject of the first volume of the *Integrated Science* book series [69], which embraced the integration of different sciences to manage complex real-world problems of the changing world and sustainability [70].

With Fear

The Division Between Science and Religion–The Root of Cognitive Biases in Private and Public Life

The divide between science and religion manifests itself in crucial areas of both private and public life. Privately, individuals develop attitudes, habits, and characters defensive of their respective positions but often biased against others based on these two areas of social life. In public life, this division influences the practical implementation of public policy, education curricula, and socialization processes in different institutions. Sometimes these distinctions impact global business as well. The divide is often so deep that no compromises are ever thought possible (Jude Likori 2020).

Absence of Supportive Educational Environments for Teaching "thinking on thinking"

My field of research is philosophy, whose focus is "thinking on thinking." Albeit appearances, this feature is endowed with both practical and interpersonal relevance. It is thanks to philosophy's reflective effort that we can understand the world, achieve self-awareness and improve our behavior, or enquire into the qualities of meaningful relationships. Thinking does not develop automatically but requires time, education, effort, and courage. Developing the ability to think goes hand in hand with acquiring an interdisciplinary and future-oriented perspective and fostering tolerance and open-mindedness. For sure, these are the tough challenges we will have to face in the next 30 years (Roberto Franzini Tibaldeo 2020).

Absence of Economic Humanities and Abundance of Labor–The Root of Irrationality in Economic Thinking in Developing Countries

Economic thinking, in our opinion, until 2050 will proceed in two ways. The first way is, as always, for developed countries, and the second for developing countries. For developed countries, rationality, safety, and economy in economic thinking will be the most important. Because in developed countries, the transition to a knowledge economy is already prevailing. And as we know, the knowledge economy is innovation and knowledge that develop according to the scenario of rationality, safety, and economy. They require from humanity only a mental approach, which means economic thinking. The second way is for developing countries. In developing countries, physical labor predominates, which hinders the development of rational economic thinking. Irrationality in economic thinking does not allow the knowledge economy to develop fully and freely. In these countries, financial-economic thinking will always prevail. The population always decides for financial reasons. From this, he will not break the habit (Khasankhonova Nodira Isametdinovna 2020).

With Hope

A New Paradigm of Thinking for Old Problems in Philosophy, Cognitive Neuroscience, and Physics

In the last 50 years, there have been great unsolved problems in philosophy, cognitive neuroscience, and physics (Gabriel Vacariu, Mihai Vacariu 2020). A new paradigm of thinking will replace the old framework of thinking in which illusory problems have been created by humans' minds (Gabriel Vacariu, Mihai Vacariu 2020).

Integrated arts, humanities, and natural sciences

From the beginning of human history, knowledge has gradually advanced from unity to specialization. The present growth and division of knowledge into many compartments has led our thinkers and scientists to believe that infinite progress is possible within separated 'boxes,' with no need for contact or exchange among them. That worldview is just an illusion. We have forgotten that the human being, like the universe, is a system whose components work in mutual dependence. Fortunately, in recent decades, the brightest thinkers from different disciplines have begun to re-admit the vision of reality as a unit where each component contributes to the general good. In the years to come, I dream about the growth of human consciousness and accepting that the different areas of knowledge cannot work in isolation. Natural sciences, social sciences, and arts cannot work individually anymore: instead, they cooperate in developing humankind based on reality. In the hope of that dream coming true and acknowledging the advantages of collaborative work among different sciences, I encourage interdisciplinary work. I am positive about the idea of a new way to approach knowledge. In thirty years, I envision a world where arts and humanities will offer new solutions to scientific questions that we can better answer from a joint perspective (Julio Juan Ruiz 2020).

Transdisciplinary Musicology

Musicology as a discipline has a recent disciplinary history. It started as an academic discipline around the second half of the nineteenth century with a historical, systematic, and comparative musicology subdivision. The systematic approach was conceived originally as a joint discipline that comprised both systematic and comparative aspects to study the organization of musical structures in a transdisciplinary and cross-cultural approach. Despite this original width of scope, the historical and systematic branches evolved quickly in different directions, due partly to their different methodology, which can be termed distinctly as being either

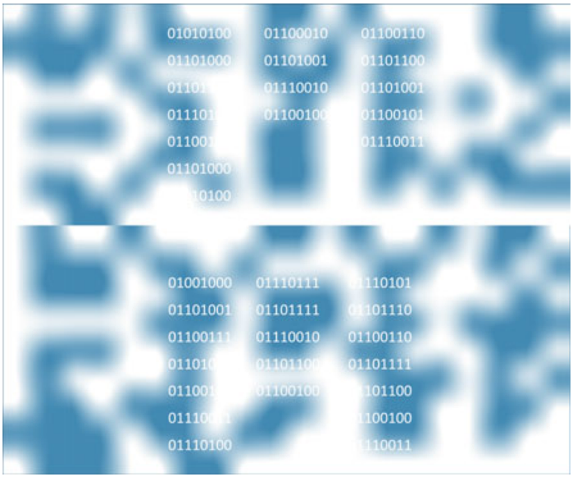

Fig. 36.1 THINKING: bioengineering of science and art–quote

historical-philological-hermeneutic or scientific-experimental-comparative. Since these early days, musicology has continued to evolve with multiple attempts to broaden its scope with new fields such as cognitive musicology, computational musicology, empirical musicology, and many others. However, many of these attempts have taken a rather disembodied and detached stance towards music so that a new field of research has emerged over the past decades, which proposes an approach that takes the listener and his body as a starting point. As such, embodied and enactive models have emerged for the study of the way how listeners cope with music as it sounds. Much is to be expected here from the exploding field of music and brain studies with their search for the neural correlates of music listening, both in an objective-descriptive as well as a subjective-experiential way (Mark Reybrouck 2020).

Integrated science–a Factor of Success

Integrated science 2050 will be a key success factor for enabling research findings and innovation in 30 years. Unlike today where cross-discipline (academia) and cross-company (practice) collaborations are already pursued, there will be a change in quantity and quality. On the one hand, such clusters will emerge at a much larger scale. On the other, they will prove to be a game-changer so that no longer individual and separate disciplines or companies or industries will dominate their field, but ecosystems. Still, I wish to end with a note of warning which systemics has continuously raised: If past predictions are any indication, the only thing we know today about tomorrow's science and its applications is that they will be radically different than whatever we predict they will be like (Christian Hugo Hoffmann 2020).

USERN–An Initiative of Integrated Science and Thinking

The initiative for a holistic appreciation of nature and the role of science pursued by the Universal Scientific Education and Research Network (USERN) is the unavoidable mission of scholars of our time. Bio-engineering of science and art premised on human thinking abilities will not only clarify the differences and, therefore, the possible complementarity of the two, it will also champion attitudes of tolerance that transform them into effective instruments of human wellbeing. My active involvement in this endeavor will not only empower my instrumentality in this process it will also train me on the ways and means of bringing this reality to my background and institution. I foresee fruits of collaboration in research bearing influence on educational curricula and public policy to facilitate peaceful co-existence at different levels of public life. I look forward to valuable mentorship from experienced colleagues for my active membership in USERN (Jude Likori 2020).

Conclusion

Box 1 THINKING: Bioengineering of Science and Art–Fears and Hopes

FEAR	HOPE
The world is changing	
	Think of the changing world
What would happen to a human? Human being or human-like being?	
	The power of thinking of future—"pull"—saves human being
Thinking is disappearing	
	Thinking has a mission to accomplish—being re-integrated
Ambiguities in engineering science are difficult to comprehend	
	Integrated engineering and liberal arts are comprehensible
What about uncertainties? Sometimes, I ask why I should study at all?	
	Embedded systems thinking for education would teach you how to live with uncertainties
Educational problems are due to a lack of philosophical understanding. Is there any way to understand this?	
	That understanding is the principle of universal science and education
How late? Is it for us?	
	Social sciences and philosophy education would happen for the next generations
So, humanities are slowly dying	
	The art-integrated curriculum makes room for dialogical thinking
But art has no longer inspiration, creativity, and contemplation	
	Integrated art and science would rescue both art and science
Mind and body are still two	

	An integrated information theory would make them united as exactly as the time they born
Organism and non-living beings are far from being friends	
	Art-integrated engineering liveliness is progressing
Science is specialized and apathetic to humanities and the environment	
	Transdisciplinary, social ecology would regenerate the environment, human life, and non-human life
Humans do activities that are determinantal to non-human life and even might cause species extinction	
	The paradigm shift would improve biodiversity and regeneration
Are the effects of climate change on the environment and ecosystems permanent?	
	A systemic approach for assessment would help monitor the ecosystem health
The division between science and religion has caused cognitive biases in human life	
	Integrated science would bridge the science-society gap
Supportive educational environments for "thinking on thinking" are not available	
	Integrated science would improve awareness and open-mindedness

The abundance of labor has made people irrational in economic thinking in developing countries	
	Integrated economic humanities would ease physical labor and financial issues globally
Old problems in philosophy, cognitive neuroscience, and physics remain unresolved	
	A new, integrated paradigm of thinking would simply solve them
Scientists think for themselves	
	Integrated arts, humanities, and natural sciences think for the universe
I love music. Is it a science?	
	Musicology is both an art and a science
Quantitative and qualitative research are distinct	
	Integrated science would help both succeed
Was I bad?	
	No, dear. You haven't done a bad job.
So, why are you dying?	
	…
…	
	After my death, go.
… Why don't I have your arm in my arm?	
	We make a better life later
When?	
	Now
How?	
	Think.

We moved between our fears and hopes for thinking future. We are not wolf who does not have any fears. Not only are we human being who has killed the wolf of existence, but also, we have watered to cultivate its inversion; there is a continuous *flow* in ourselves; we have fears about our children and their suffering. This flow is nothing more than tears of that *flower* we cultivated in ourselves, the flower of further hope for future, for that we came here to devote ourselves to think how to educate our children beyond time–space, for that day may we leave them, and we are not present in their time–space that we cannot take care of our children arm in arm, but we will, through our education, be *perfect being* closer to them than ever, *thought in thought* (Fig. 36.1).

Core Messages

- Future science, religion, and politics discourses benefit from integrated science and AI.
- Isolated thinking of the changing world is sad, but some sort of good is the vulnerability of isolated thinking to failure.
- Thought force and the cosmic dimensions of thought speak the same: we are ourselves the scalars of thinking.
- Eduction in engineering can be improved by systems thinking approach and arts integration.
- Social sciences and philosophy education and integrated curricula can mitigate current generations' educational problems.
- Integrated science and art is a path directing creativity and innovation in art and science and resolving old dualisms in science.
- Social ecology would regenerate the environment, human life, and non-human life.

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N. Rezaei and A. Saghazadeh (eds.), *Thinking*, Integrated Science 7,
https://doi.org/10.1007/978-3-031-04075-7

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