Understanding Complex Systems

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Àngels Massip-Bonet
Albert Bastardas-Boada *Editors*

Complexity Perspectives on Language, Communication and Society

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Understanding Complex Systems

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Understanding Complex Systems

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Springer Complexity

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Àngels Massip-Bonet
and Albert Bastardas-Boada (Eds.)

Complexity Perspectives on Language, Communication and Society

Springer

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1 Introduction

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Over the past thirty years, the use of the term *complexity* has grown exponentially in parallel across several scientific disciplines. As with other innovative labels, however, this term has not always been understood in the same way by its many users. Nor has it been applied in the same way to different aspects of reality. For this reason, the title of this book makes use of the plural word *perspectives* in reference to complexity, leaving no doubt that there is more than one perspective at work. Our intention, however, is not to suggest that the term *complexity*, in its various scientific uses, does not share points in common which contribute toward building a coherent approach. A look over the authors gathered here will show that, despite their differing fields and countries, they share similar concerns and questions, which have led them to formulate new concepts and test new theoretical approaches and methodologies in their pursuit of knowledge.

Behind most uses of the term *complexity*, we find a strong interest in lines of thought that aim to deepen our understanding of phenomena that involve several agents held in networks of mutual inter-retro-actions within given contexts. Through their coevolution, these agents spark the emergence of new realities, with properties and characteristics that are different from their original components. It is hard to gain an understanding of these types of complex phenomena if we use only the conceptual strategies and classic methodologies of the reductionist approach. Dynamic networks of processes interweaving their component parts and their emergent totalities force us to change concepts, images and strategies, producing a shift that poses a weighty challenge for contemporary thought. As a result, *complexity* has gained increasing acceptance as the most fitting "umbrella" label for the convergence of a large number of contributions, some of which extend earlier advances made in cybernetics, systems theory, traditional ecological approaches, and figurational sociology, while others emerging in recent decades include CAS (complex adaptive systems), network theory, computational modelling, cellular automata, and Edgar Morin's work on human complexity.

Of late, the growth in lines that can directly be called *complex* has received a huge boost from the spirited addition of scientists in the fields of physics, mathematics and computing, who are contributing sound new models and conceptual tools to the advancement of our understanding of physical, chemical and biological systems. At the same time, however, these advances reveal shortcomings in our understanding of phenomena that are more strictly social and human in nature. The highly diverse agents in play are not merely cognitive and/or cultural, but also emotional and behavioural in their specificity. And one of the

most characteristic of these phenomena is the "language-communication-society" triangle, whose unique traits defy traditional approaches. Clearly, this is a phenomenon that calls for an integration of complex, transdisciplinary approaches, if we are to make any progress in understanding how it works. Indeed, the effort may require building a theoretical and methodological body of knowledge that can effectively convey the characteristic properties of phenomena in human terms, capturing their cognitive/emotional *socio*complexity.

The present work grows out of this conviction. It invites the reader to enter into conversation with an array of authors who tackle these issues from several angles, but all under the overarching view of complexity. Most of the texts are the product of three international events – two courses and an academic conference – and this explains the stylistic diversity of the texts, with some resembling lectures or talks and others closer to classic academic papers. The first of the two courses, entitled *A Living Being Called Language: Complexity and Word*, took place over a number of weeks in 2009 at the CosmoCaixa science museum in Barcelona, while the second course, entitled *Communication and the Cognitive Sciences*, was held in July 2011 at the Universitat de Barcelona. The third event was a colloquium on *Language and Complexity*, also hosted by the Universitat de Barcelona, in June 2010. The order of the texts reflects the diversity of their origins. In the earlier pieces (Chs. 1-9, and also the final annex 15) the reader will encounter contributions intended for the courses, while the later pieces (Chs. 10-14) were primarily prepared for the colloquium.

Thematically, the pieces fall into four groups: the first features the texts mostly directly concerned with the elaboration of broad *complexic* perspectives and concepts (Gershenson, Munné, Heylighen); the second group develops these approaches and applies them to linguistic phenomena (Bastardas, Massip, Mufwene, Terborg & García); the third group is devoted to cognition and communication (Puig, Martorell, Vilarroya), and the fourth group offers reflections on aspects more closely tied to socialization and education (Darder, Albero). The final chapter includes extracts about ethics and society from a talk given by Federico Mayor-Zaragoza. Bearing in mind the spirit embodied in our view of complexity, though, the texts are in no way "isolationist" or fragmentary in their approaches, but rather wide-ranging, cutting across disciplines, and characterized by contributions of real value in the joint effort now underway to build a paradigm of complexity for science and, especially, for the social and human sciences.

2 Facing Complexity: Prediction vs. Adaptation

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Abstract. One of the presuppositions of science since the times of Galileo, Newton, Laplace, and Descartes has been the predictability of the world. This idea has strongly influenced scientific and technological models. However, in recent decades, chaos and complexity have shown that not every phenomenon is predictable, even if it is deterministic. If a problem space is predictable, in theory we can find a solution via optimization. Nevertheless, if a problem space is not predictable, or it changes too fast, very probably optimization will offer obsolete solutions. This occurs often when the immediate solution affects the problem itself. An alternative is found in adaptation. An adaptive system will be able to find by itself new solutions for unforeseen situations.

1 Introduction

The scientific method, since the epoch of Galileo, Newton, Laplace and Descartes, has contributed considerably to the increase of human knowledge and to technological development. Still, its success does not imply that it cannot or should not be criticized, especially considering the differences between the context in which it was proposed and the present context.

The traditional scientific method isolates and simplifies a problem to proceed to mathematical formalization as a tool to finding a solution. This method is useful for several problems, such as building traditional bridges, automobiles, and computers, since there are relatively few variables to be considered and these do not affect each other too much, i.e. they can be treated in isolation. Moreover, the specifications of these problems do not change: gravity, combustion, electrical properties, etc. are constant.

There are two ways in which the traditional method becomes inadequate. On the one hand, if there are many variables that determine a system, their combinatory explosion prevents the finding of a solution via analysis or exhaustive search. Optimization techniques can be useful to find adequate solutions. On the other hand, if the problem itself changes, the solution will probably be obsolete. If the problem changes faster than it can be optimized, a different approach is required. This is because it is not possible to predict the future of the problem and traditional techniques become inadequate. The traditional method requires the complete prespecification of a problem to find solutions (from initial and boundary conditions) (Gershenson 2011a). However, we often encounter problems that cannot be prespecified, especially when solutions themselves change the problem.

2 The Limits of Prediction

Since at least the late nineteenth century, the scientific presupposition concerning the predictability of the world was questioned (Morin 2007), starting with the three-body problem studied by Poincaré. Nevertheless, today many a scientist still assumes that the world is and must be predictable.

The predictability presupposition was proven mistaken with the study of deterministic chaos. It is logical to think that a deterministic system is predictable, which led Laplace to propose his famous "daemon". Laplace hypothesized that if a superior intelligence could have access to all of the positions and momentums of all particles in the universe, Newton's laws (which are deterministic and reversible) could be used to know all past and future events in the universe. There are several problems with the worldview exemplified by Laplace's daemon:

1. Even with a complete description of all elementary particles of the universe (whatever these may be), phenomena at different scales cannot be predicted from this description of the universe. Life, mind, dreams, imagination, Rachmaninov's 2nd piano concerto, money, a Murakami novel, a revolution. All of these phenomena are *real* and have a causal effect on the physical world, but cannot be described in terms of the laws of elementary particles. The universe is not *reducible*.
2. A complete model of the universe must contain the model itself. This leads to a paradox, similar to Russell's. If the model contains the universe, but is a part of the universe, it has to contain itself infinitely.
3. Irreversibility in thermodynamics showed that it is not possible to deduce all past events. For example, if there are two states that lead to the same third state, once being in the third state it is not possible to determine which of the two states led to it.
4. Determinism does not imply predictability. Predictability is limited in *chaotic* systems which are "sensitive to initial conditions". In chaotic systems, very similar initial states can lead to very different future states. For example, a variable with an initial value of 3.3333333333 can lead to a final value of 0.25, while an initial value of 3.3333333334 can lead to a final value of -1.6793. Independently of how much precision is considered, very small differences will lead to very large differences, since trajectories diverge exponentially (this can be formally measured with Lyapunov exponents). This sensitivity to initial conditions is a characteristic of *deterministic chaos* (Elert 1995; Gershenson 2002a). Lacking an infinite precision, even with complete information about a state and functioning of a system, its predictability can be limited.

A classical example of chaos is found in weather forecast. This is limited not because atmospheric dynamics are unknown to meteorologists, but because of the inherent chaos present in the atmospheric dynamics. Even if precision is increased, predictions cannot be made with a high confidence more than a few days in advance.

Another example of a system with a limited predictability is road traffic. Vehicle dynamics can be described with classical mechanics. However, there are many additional factors that affect vehicle movement, such as driving conditions (wet floor,

poor visibility, road works), the state of the driver (distracted, tense, in a hurry, texting, sleepy, under the effects of certain substances), pedestrians (children playing, jaywalkers, street merchants), etc. It is possible to attempt to predict the future position of a vehicle, but it will be limited to not much more than two minutes. Minimal changes in the predicted trajectory of a vehicle can lead to major effects in the traffic of a whole city. This is due to the large amount of interactions between each vehicle and its environment: other vehicles, pedestrians, traffic lights, etc. (Gershenson 2005; 2007). These relevant interactions are one of the main characteristics of *complex systems* (Bar-Yam 1997; Gershenson & Heylighen 2005).

3 Complexity

It is difficult to define complexity precisely, since it can be found everywhere. Etymologically, complexity comes from the Latin *plexus*, which means interwoven. In other words, a complex system is difficult to separate. This separation is difficult because the *interactions* between the components of the system are relevant, as the future of each element depends on the state of other elements. Since interactions generate novel information, which is not present in initial nor in boundary conditions, the future of complex systems cannot be *reduced* to the isolated dynamics of its components. Traditional science attempts precisely this, to simplify and isolate in order to predict, reducing the behavior of a system to that of its components. But a (reductionist) model that does not take into account relevant interactions will not be useful, as predictions will probably be mistaken. Moreover, the behavior of the system will be difficult to understand if this is reduced to the behavior of the parts, precisely because relevant interactions are not considered.

Examples of complex systems are everywhere: cells, brains, cities, Internet, stock markets, insect colonies, ecosystems, biospheres. All of these systems consist of elements that interact to produce a system behavior that depends on the elements and their interactions. For example, cells are made by molecules. Cells are living, while molecules are not. Where do life and its organization come from? These come precisely from the *interactions* between molecules. A similar example: brains are composed by neurons and molecules. Brains are capable of reasoning, imagination, consciousness, etc. These properties are not present in the components. Where do they come from? From the interactions. It is because of the relevance of interactions that the behavior of a system cannot be reduced to the behavior of its parts. Interactions generate novel information that is not present in the parts but is essential for their behavior, and thus for the system.

A classic example of complexity can be seen with Conway's "Game of Life" (Berlekamp et al. 1982). This consists of a lattice, in which each "cell" can take one of two values: 1 ("alive") or 0 ("dead"). The state of each cell depends on its eight closest neighbors: if there are less than two neighbors around a living cell, this dies out of "loneliness". If there are more than three, it also dies, because of "overpopulation". If there are two or three living neighbors, the cell will remain alive. If around a dead cell there are precisely three living cells, a new cell is "born". These simple rules produce an impressive complexity (see Figure 2.1). There are certain stable structures that can emerge from random initial conditions. There are also oscillatory structures that repeat a dynamical pattern with a specific period. There are also moving structures, which travel across the lattice, until they encounter other structures,

with which they interact. There are oscillatory structures that produce moving structures. There is a richness of dynamical patterns that has yet to be exhausted. Moreover, it is possible to implement a universal Turing machine (capable of computing any computable function) in the Game of Life. Could all of this richness be predicted from the rules of the game? Simple rules produce complex behaviors and patterns through local interactions. The large scale properties cannot be known a priori, since these are *computationally irreducible* (Wolfram 2002).

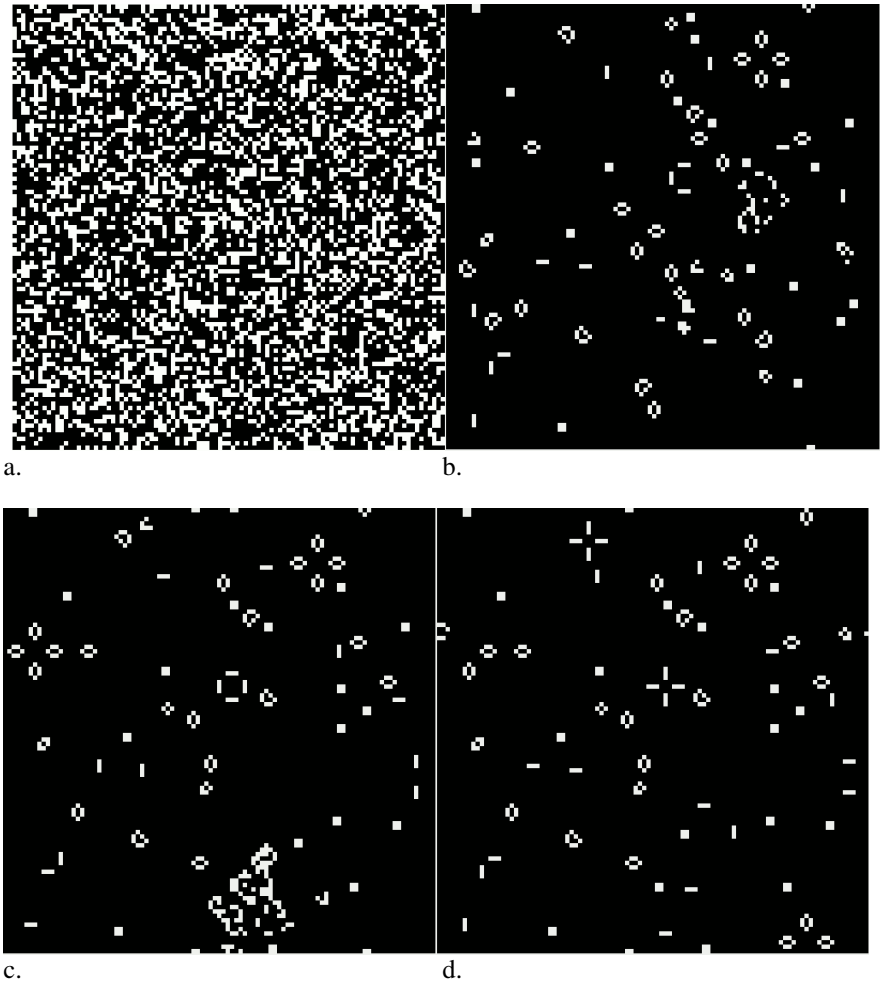


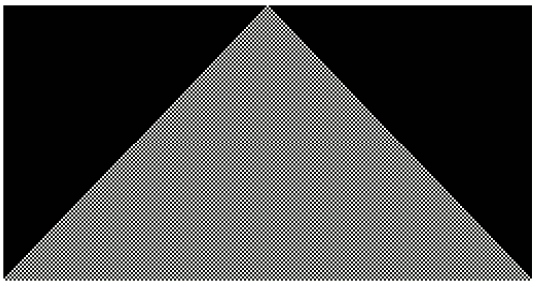
Fig. 2.1 Evolution of the Game of Life from a random initial condition (a), where white cells are "alive" and black cells are "dead". After 410 steps (b), certain stable structures have been formed, but there are still some active zones. After 861 steps (c), some structures have been destroyed and some new ones have been created. Activity continues in the lower part of the lattice. After 1416 steps (d), the dynamics is periodic, with stable and oscillatory structures. Images created with NetLogo (Wilensky 1999).

Another example of the relevance of interactions can be seen with elementary cellular automata (Wolfram 1986; 2002; Wuensche & Lesser 1992). The Game of Life is a two-dimensional cellular automaton, since cells are arranged on a plane. Elementary cellular automata are unidimensional. They consist of an array of cells, each of which can take one of two values: zero or one. The state of each cell depends on its previous state and on the previous state of its two closest neighbors. This is determined by a lookup table, which consists of the eight possible combinations of zeroes and ones on three cells (111, 110, 101, 100, 011, 010, 001, 000), and an assigned value (zero or one) for each combination. Having eight combinations and two possible values, there are 2^8=256 different "rules" (11111111, 11111110, 11111101, ..., 00000000).

Transforming these strings to base ten, these can be referred with a number, e.g. rule 10101010 corresponds to $2^7+2^5+2^3+2^1$=128+32+8+2=170. While there are 256 rules, many of them are equivalent, so there are only 88 "clusters" with different dynamics. There are rules that produce simple, repetitive patterns (e.g. rules 254, 250). Other rules produce nested structures (e.g. rules 90, 22). There are also rules that produce pseudorandom patterns (e.g. rules 30, 45). Finally, there are also rules that produce localized structures (e.g. rule 110). These cases are illustrated in Figure 2.2. Rule 110 is an interesting case. Similarly to the Game of Life, there are structures that persist in time and glide in space. When structures collide, they interact and may be transformed. It should be noted that there are interactions at different scales: between cells and between structures. It has been shown that rule 110 can also implement a universal Turing machine. Being such a simple system composed only by zeroes and ones and determined by eight bits, it has an immense potential. Where does this complexity come from? From *interactions*.

Complexity carries with it a lack of predictability different to that of chaotic systems i.e. sensitivity to initial conditions. In the case of complexity, the lack of predictability is due to relevant interactions and novel information created by them. This novel information can also consist of new variables. Since precise interactions and novel variables cannot be prespecified, solutions to complex problems cannot be found *a priori*. For example, the future state of a system as "simple" as rule 110 cannot be known without actually running it. The emergent structures of the Game of Life cannot be predicted from its simple rules if the system has not been run. Also, when a problem changes the solution that had been found for it becomes obsolete. Then the problem space can be called *non-stationary* (Gershenson 2007). Almost all problems fall within this category, since all systems in the real world are *open*. In other words, systems interact with their environment. They are not completely isolated. Thus, systems become unpredictable on the long run. This is because an open environment lacks predictability, and an open system is affected eventually by the unpredictable changes of its environment.

What can be done to solve problems with a non-stationary space? A good starting point is to take inspiration in nature, since living systems are constantly solving a non-stationary problem: survival.



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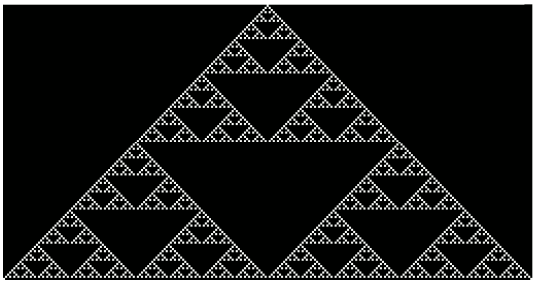

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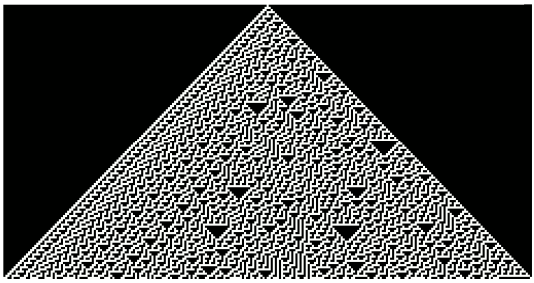

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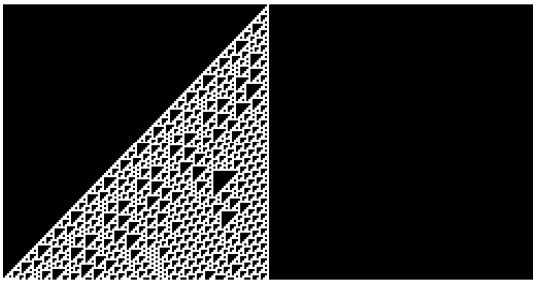

d.

Fig. 2.2 Examples of different classes of elementary cellular automata, with an initial state of a single active cell on the top row, time flows downwards. Rule 250 (a) produces regular patterns (class I). Rule 90 (b) produces nested patterns. Rule 30 (c) produces pseudorandomness (class III). Rule 110 (d) produces localized structures (class IV). Images created with NetLogo (Wilensky 1999).

4 Adaptation

Adaptation (Holland 1995) is the ability of a system to change its behavior when facing a perturbation. Living systems have to adapt constantly to changes in their environment, so they are a source of inspiration for building biomimetic adaptive systems.

The difference between adaptation and prediction is that the latter tries to act before a perturbation affects the expected behavior of a system. Certainly, it is desirable to predict perturbations, since these can affect negatively or even destroy a system. However, as it has been shown, it is not possible to predict all future interactions of a system. This is why it becomes necessary to build systems that are able to adapt, since there will be unexpected situations. An adaptive system will be able to respond to the unexpected, to a certain degree, without the need of human intervention.

It can be said that adaptation is a type of creativity (Kauffman 2008). Adaptive systems can create novel solutions. This is necessary if systems are expected to face a complex and unpredictable environment.

There are several techniques to build adaptive systems. One of them is to use the concept of self-organization (Gershenson 2007).

5 Self-organization

A system can be described as self-organizing if its elements interact so that the behavior of the system is a product mainly of these interactions, not from a single element or from an external source. All of the examples mentioned previously about complex systems can be also seen as self-organizing systems. Whether a system is considered as self-organizing does not depend only on the system, but also on the observer (Gershenson & Heylighen 2003). There are several advantages in using the concept of self-organization in system design. While designing self-organizing systems, the designers focus on the behavior of the components and their interactions, so that through their dynamics, together they perform the system function without directly designing it. Since components interact constantly, it can be said that they are constantly searching for solutions. When a problem changes, the system adapts to the new situation, modifying its functionality.

An example of adaptation through self-organization has been proposed for traffic light coordination (Gershenson 2005; Cools et al. 2007; Gershenson & Rosenblueth 2012). Instead of trying to blindly predict when an average flow of vehicles should arrive at intersections, each traffic light gives preference to the streets with higher demand. In this way, vehicles on streets with lower demands will wait a bit longer, increasing the probability that more vehicles will join those that are waiting. This leads to the formation of vehicle "platoons". Once platoons reach a certain size, they will be able to trigger a green light before reaching an intersection, thus preventing platoons from stopping, unless other platoons or pedestrians are crossing at that moment. This platoon formation also leaves free spaces

between platoons, allowing other platoons to flow with little interference. With simple local rules and without a direct communication between traffic lights, an adaptive synchronization is promoted, which adjusts itself to the immediate traffic conditions. The system adapts at the same *scale* at which the problem changes. The self-organizing method brings considerable improvements, reducing waiting times by more than 50%, saving not only time but also money, fuel, and pollution.

Another example of the benefits of self-organization can be seen in a recent proposal to regulate public transportation systems (Gershenson 2011b). An algorithm that responds locally to passenger demand and vehicular intervals is able to perform even better than the theoretical optimum.

6 Language

One of the main obstacles to adopt a novel scientific paradigm is our language. The way in which we speak, write, and describe things determines how we understand them. Newtonian dogmas find their roots in Platonic and Aristotelian language.

In the Greco-Latin worldview, which has dominated "western" cultures, *one* absolute truth is assumed. From this perspective, the mission of science is to "discover" the truths of the world. This presupposition becomes evident in classical logic, which includes the principle of the excluded middle (something is true or false, but not something else) and the principle of non-contradiction (something cannot be true and false at the same time). Classical logic, as well as traditional science, has been very useful, especially in closed systems.

Nevertheless, the truth of any proposition depends on its *context* (Gershenson 2002b). This fact can be generalized from Gödel's (1931) incompleteness theorem. Gödel proved that in any formal system, such as mathematics, there are statements that cannot be proven. The root of this "problem" lies in the fact that axioms of a formal system cannot be proven from within that system, precisely because axioms are presupposed. This is relevant, because if axioms change, statements can change their truth value. For example, the statement "parallel lines never intersect" is true within Euclidean geometry. In fact, this is one of its axioms. However, there are other geometries, which do not consider this axiom, in which the statement is false, since parallel lines do intersect at the infinite. This can be visualized projecting the plane on a (Riemann's) sphere: if two parallel lines are projected on a sphere, these intersect on the opposite side of the sphere. This condition of formal systems leads to the "silly theorem problem": for any silly theorem (e.g. 1+1=10), there are infinite sets of axioms for which the silly theorem is true (e.g. use base 2). However, in practice this problem is trivial, because experience tells us which axioms are *useful*. Nonetheless, it should be noted that there is no set of "true" axioms. There are axiom sets over which formal theories can be based. Depending on the uses of the formal theory, others can be chosen. For example, Boolean algebra can be based on a single axiom (Wolfram 2002). Still, proving theorems based on a single axiom can be more complicated that with other axiomatic systems.

Another example can be seen with Newton's laws, which were considered absolute truths, rulers of the universe. Still, at very small or very large scales, they do not apply. It is not that they are "wrong". Newton's laws apply to a certain context, and their common usage demonstrates their efficacy.

Within language, people have attempted to expel ambiguity by formalization, e. g. Tarski (1944). However, language is by nature ambiguous. It is better to understand contradictions (Priest & Tanaka 1996; Gershenson 1999) than ignoring them.

The limits of our descriptions can be illustrated with the following example. Assume there is a sphere, half white and half black. If the sphere can be seen only from one perspective, actually a circle will be perceived. Of which color is the circle? The answer will depend on the perspective from which the sphere is observed. The circle might be white, black, half and half, 10% white and 90% black, etc. (See Figure 2.3).

Of which color *is* the circle? The "right" answer will change depending on the perspective of the observer. Averaging answers will not be closer to the "truth", since it is highly probable that there are more observers from certain perspectives and less from others. In this case, we know beforehand that we are describing a sphere, not a circle, and that the sphere can be rotated and examined from a multitude of perspectives. However, all phenomena that we describe can have more and more features and dimensions. One can never state that a phenomenon has been described completely, since our perceptions and descriptions are limited and finite. But one can always encounter in natural phenomena novel properties, interactions, relations, and dimensions. Just like with the sphere, we cannot describe completely any phenomenon, since our descriptions are limited and phenomena are not.

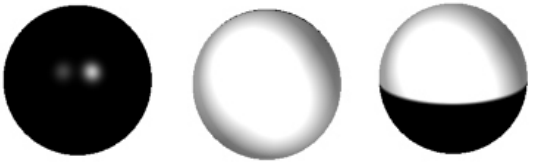

Fig. 2.3 What *is* the color of the circle? It depends on the perspective from which the sphere is observed.

Does this imply that all hope of understanding the world should be abandoned? Certainly not. But we should be aware that our descriptions, if they are "correct", they would be so only within a determined context. There is no risk of "wild subjectivism", since our contexts are socially constructed. In other words, we reach agreements. What should be accepted is that there are no absolute truths, that the world changes, that our descriptions of the world also change, and that these changes have a limited predictability. We should take advantage of this dynamism instead of ignoring it or hopelessly trying to get rid of it.

Another example can be seen with colors. The color of an object can change depending on the illumination under which it is observed. In darkness, all objects are black. Behind rosy lenses, all objects are of a rose hue. Again, there is no risk

of "radical relativism", because even when there might be more than one description for the same phenomenon, we can agree on the context under which the phenomenon is described and decide over its properties under a *shared context*. This leads us to reflect over the difference between the model and the modeled.

7 The Model and the Modeled

Plato's myth of the cavern illustrates the presuppositions and aspirations of classical science, which are embedded in our language as well. Plato describes a cavern, where people are chained and can only see a wall. Behind them, different objects are found, which project their shadow on the wall. People can only see shadows. Plato writes that these people fool themselves, since they do not perceive reality. Philosophy (and later science) is the method to discover *the* truth. Philosophers can break their chains and see the reality in full color outside the cave, not only shadows.

Before going further, a distinction between the model and the modeled should be made. Models are *descriptions* of modeled phenomena. As such, models depend on the observer. Since there are no observations independent of observers, nor descriptions independent of a describer, there cannot be a "direct" access to phenomena. Just by tagging them with a name, we are simplifying them to a description, a generalization, a model. This implies that even "breaking the chains", what people will see outside Plato's cave will not be *the* reality. It will be a *different description* of reality. It cannot be proven that this or any other description is the "correct" one, since the usefulness of descriptions depends on the purpose for which they are used. In other words, the only we can perceive is "shadows".

Humanity has always aspired for perfection. In science, this translates into seeking absolute truths. In engineering, this translates into faultless systems. We should admit our limits, our lack of perfection, and that our engineered systems are also limited and imperfect. These limits are natural and inherent, not a defect, since infinite potentialities cannot be contained within our finitude.

8 Conclusions

We have illustrated how adaptation is essential to solve problems with non-stationary spaces. However, this does not imply that prediction should be neglected, as it is useful and desirable. Nevertheless, prediction should be complemented with adaptation and used with caution, considering its limits carefully. One of the accomplishments of the scientific study of complex systems is to show that the perfect control of open systems is utopic. If there are interactions, there will be a certain degree of unpredictability. This demands modesty and consideration when building systems and solving complex problems. The implication is that there will always be novel problems. The best we can do is to be prepared and expect the unexpected. It is not only desirable to have robust systems, so that they do not "break" because of perturbations. We should also give our systems a certain degree of creativity to be prepared to face the unknown.

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3 Sociolinguistics: Towards a Complex Ecological View*

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Abstract. As the sociologist Norbert Elias pointed out, there is a need of new procedural models to get to grasp the complex functioning of human-beings-in-society. An ecological complexity approach could be useful to advance our knowledge. How can we think of a sociolinguistic "ecosystem"? What elements do we need to put in such an ecosystem and what analogies could be applied? The (bio)ecological inspiration is a metaphorical exercise to proceed toward a more holistic approach in dynamic sociolinguistics. However, a language is not a species and, therefore, we need to make our complex ecology socio-cognitive and multidimensional. We need to create theories and represent to ourselves how language behaviour is woven together with its contexts in order to maintain language diversity and, at the same time, foster general human intercommunication on a planetary scale.

1 Introduction

It is worth beginning with a mention of the German-Jewish sociologist Norbert Elias, now already died. Elias, a man ahead of his time, is a person in need of rediscovery. When he gave his sociology classes, he began by showing his students a section of a human brain. I find it extraordinary that a person "doing sociology" should start in this way, introducing the class to the element central to any attempt at understanding reality: the human brain. Certainly, the approach was revolutionary in his period, within the field of sociology. Elias had studied philosophy and medicine. Finding himself between these two poles is what led him to devote himself to sociology, which he believed would be the best path toward understanding the human phenomenon as a whole. Certainly he has left us a sociology that is original and enormously useful and up-to-date.

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A quotation from one of his books – translated into Spanish – that might serve to frame today's talk goes: "The fact that the human-social plane of the universe is made up of people, of us, leads us easily to forget that its development, its structures and its modes of operation, as well as its explanation, are for us, for human beings, something that is, in principle, no less unknown than the development, structures, modes of operation and explanations of the physical-chemical and biological planes and they must be, to no small extent, something that is discovered slowly. Our everyday experience of ourselves easily conceals the fact that, at present, we ourselves are still, and to a much greater extent, a relatively unexplored region, a white spot on the map of human knowledge less well-known than the poles of the Earth or the surfaces of the moon[1]." We must be mindful of how difficult it is for us as human beings to see ourselves, to represent ourselves and gain distance on our everyday actions. So far, we have been able to gain such distance with respect to the physical and chemical world. However, with the respect to the human plane, this remains an unrealised conquest.

Therefore, we, like Elias, face the same challenge in trying to move forward, to understand the world better, in this "third culture", this intersection between the "arts and humanities" and the "sciences", drawing on the best of each of these two broad areas. This is the perspective that I will be applying to that part of reality to which I have devoted my work in recent years, namely sociolinguistic phenomena. Today, my aim is to consider both elements of the term "socio/linguistics", i.e., the social and the linguistics aspects. And because we want to see the idea in its entirety as well, I will apply the perspective in an integrated fashion at both levels.

2 The Perspective of Complexity

How did I personally come to be able to speak from the perspective of "complexity"? If we wish to gain an understanding of sociolinguistic phenomena, that is, an understanding of language as a subset interrelated with the rest of society, then we clearly face a challenge. How can we build an interdisciplinary paradigm if none exists? Those of us who work in sciences that are at the edge of university departments always fall between the cracks. We find ourselves in no man's land. Therefore, it was highly satisfying to us to encounter theories of physics, ecology and anthropology that signalled the way forward (Bastardas i Boada 1996). They confirmed that we were headed in the right direction, that it was of no consequence whether we were at the periphery, that this was the path we needed to go down to build an understanding of the world that better fit reality, which certainly is complex. It is one thing that academic disciplines cut up reality for operational convenience, but it is another to think that the world itself is also cut up into pieces. This is the great problem before us. And the great danger. Thinking that the world is fragmentary, disconnected, with no interrelationships between its elements.

The way we in the universities have divided up the work into separate and distinct bundles, for example, leads many linguists to speak rarely with people in psychology, sociology or anthropology. And they do not speak with us either.

[1] Elias, Norbert, 1982, p. 36.

Where are the bridges? Where is the unity of the human being, which is plain to see? As Edgar Morin (1991, 1992, 1994, 2001) puts it, we need to make an important change in our thinking. We have to reunite what we have wrongfully divided. Of course, we need to distinguish, but not to separate and smash. We need to make operational distinctions, but not by fragmenting that which is obviously an indivisible, united and complex reality. Blending disciplines, blending views, working metaphorically—this is the path. We won't see many numbers or calculations. But we will see the world of metaphor applied to distinct disciplines and we will see the productivity of analogy. At least, that is the proposal before us.

I propose to you that you think of those images that have more than one interpretation. Probably all of you have seen them. Recall that if you looked a little carefully, you could see one thing at times and a second thing at other times. The *same* image can be interpreted in two ways. That is an example of the fact that the physical outlines of perception constitute one aspect of reality, while what we interpret from what we see constitutes another. We see what we think we see. We always *interpret* the outlines of perception. Reality is not given directly to us. Between, there is always the interpretation of reality. We might go decades without seeing certain aspects of the reality we are looking at, because we have not evolved our interpretation, we have not adapted our ability to interpret our perceptions in this way. First, it must be said clearly that we ourselves create images of reality, we ourselves create the ideas of things, conceptual landscapes. Perceptions come to us from reality, but we assemble the perceptions according to the interpretation that we think we see. We cognitively construct reality, we "make" it, and it is precisely for this reason, building on this awareness, that we take on the challenge to see whether we can construct better, more complex, more fitting images in light of the intricate and interwoven dynamism of reality. This is our commitment by adopting a "complex view": knowing that we ourselves are the "creators" of reality, we try to see whether the images by which we have so far sustained our representation of the world are the most suitable ones.

But how can a view be complex? A complex view is a gaze that builds in the fact that reality is self-constructed and that these elements exist within one another. For example, in this moment, in this room you are in some sense both outside me *and* within me at the same time. And I am too: I am outside *and* within you. But, despite being highly scientific, we have viewed the world in recent centuries through a fragmented, partitioned gaze that can uncover the interpenetrations and interweavings of reality only with difficulty. We were unable to think our way toward creating new images of self-co-construction and interdependence of reality. But this, after all, is exactly where we need to be headed, if we are to understand human linguistic and cognitive phenomena, which have properties that are not the same as the properties of matter. For example, a stone is plainly here, the spot it occupies cannot be occupied by something else. Yet socio-cognitive phenomena do not possess exactly these properties. A collective human identity is not a stone whose effect is to prevent another identity from occupying the same spot. It does not have these properties. The same thing occurs with languages: knowing a language does not signify that you cannot learn other languages. A language does not occupy a spot that necessarily precludes the entrance of another into your brain/mind.

Therefore, when we think of socio-human, socio-cognitive facts, we must in all likelihood abandon many of the typical scientific properties that we tend to employ in our everyday thinking. In fact, we are simply doing what our friends the physicists did in their revolutions of the twentieth century when they shifted paradigms, found that particles were waves and waves were particles – so what were they, in fact? – and found that the observer influenced reality. These elements clearly aid us in gaining a much greater understanding of the socio-human level. Then, briefly, based on my experience in the field of sociolinguistics, what characteristics could we now say typify a complex view? What are its basic features?

3 The Main Aspects of an Ecological Complexity: A Proposal

a): The centrality of the mind. There is no science without an observer. While this statement may seem obvious now, it was very unclear for many years. We have spoken of the world and its elements from a supposedly objective and neutral viewpoint. We have reified concepts. They had their own existence. It was as if we ourselves had not created the concepts. But *we* create representations and concepts. As the physicist David Bohm put it, "science is not about reality, but rather about *our* knowledge of reality" (1987). Bearing this fact in mind is very important to being able to change our way of thinking. We have no direct access to the world. There are always conceptual lenses that enable (or hinder) our access to it.

b): Not only the centrality of the mind is a central principle, but also a broad conception of the mind. A conception of the mind that seeks to recoup the entirety of cognitive and emotional reality. We are fundamentally cognitive *and* emotional beings. The emotions have been banished from scientific discourse until recent decades and this is a terrible mistake. How can we understand human behaviour without the emotions, the feelings? Comprehension would be impossible. Clearly, we must rethink the so-called classical foundations from the ground up.

c): I believe that a complex view must see the world in terms of "and/both", not "either/or". In other words, it must unite seeming opposites. Why is "nature" different from "culture"? We can distinguish, but not separate. Nature *and* culture: this is how we will gain a much better understanding of the world. How many hours have been lost on debates teasing out the issue of Chomskian nativism, for example? But it is impossible to unpick this union. A well-formed brain lacking exposure to a social context in which language is used will never develop into a mind capable of communicating through language. And a malformed brain, even with exposure to a social context, will struggle to develop into what we consider a fully human mind. Therefore, elements *and* contexts, objects-processes *and* and *in* their environments. That is what languages are.

How do we need to understand "languages"? As isolated elements, as objects? A language is *in* society, *in* people, who are *in* the language. Isn't this how the world is? This type of circular thinking *à la Morin* is wonderful. I recall first

encountering this great French thinker and reading these extraordinary phrases. How can we spend so many years squabbling over whether it is one thing or the other? That is absurd. Therefore, objects *in* their context, a language *in* its context. The context *in* the language. The world is in language, which is in the world.

d): This leads us to a systemic vision. We have spent many years in which linguistic elements have been described not outwardly, but rather inwardly and in isolation. How many years have we prioritised the phonetic-morphological-syntactic element without connecting it to the rest of the living environments that ultimately give rise to the existence and changes of languages. What we need now, therefore, is to develop open systems, not closed ones. We need to bring matters up to date by appropriating systems theory and adopting a comprehensive, multi-layered perspective. We need to see how, for example, the phonetic subsystem of a language is related to the social subsystem.

Take, for example, the case of Catalonia, or any other society with a great number of immigrants. Such massive immigration will probably cause changes to existing linguistic systems, as for example the introduction of aspirated sounds in Catalan, a strange fact in this language. This is clearly produced as a result of a phenomenon of contact, because there are people who come from other phonic systems –from southern Spanish, for instance- and project their own constitutive rules as they begin to speak Catalan. Therefore, as you can see, a phonetic element must be explained by a social element. A linguistics closed within itself, an inward system, cannot take account of such elements.

e): Reality is dynamic and fluid. Events and processes. That is, a clear awareness of the temporality of phenomena. Time is inescapable, and everything occurs in a temporal dimension. Norbert Elias (1991) addresses this matter, asking, How can we understand specific elements that can only be explained historically and dynamically if we think of the world statically? How can we understand the phenomena of language in society if we cannot situate them in the flow of multidimensional historical dynamics? If you are familiar with linguistics, recall that some universities still teach Saussure's 'synchronics' and 'diachronics', parts of an undoubtedly very important theory. However, Saussure still spoke of "closed" systems – a great step forward, certainly – but today we can see that what is required is a conception of "open" systems. Saussure drew a distinction between synchronics and diachronics, with synchronics to analyse language from the current, contemporary viewpoint and diachronics from a temporal viewpoint. But the problem in our thinking about humans is thinking that distinct terms are opposites. They are not opposites. That is, synchronics is *in* diachronics, which is *in* synchronics. Languages live temporally, synchronically and in time. Therefore, linguistic change is change in the contemporary system, which is evolving, in flux, in a process. It is much better not to think in terms of dichotomies. It is much more fruitful to think in terms of continuities, not opposed polarities.

f): This reasoning argues in favour of circular, retroactive and recursive causation, that is, of non-linear causation, as they say in other sciences. We will also adopt

the non-linear dynamic, because our facts are non-linear. How can we understand a conversation if not from the viewpoint of circular, retroactive causation? If you listen to someone speaking on the telephone, you can hear only one part of the conversation and it may sound incomprehensible. You may try to determine what it is about. But you cannot get a very good sense of what is happening, because the conversation is a dance between two people.

If you have attended courses in ballroom dancing, you know what happens. You wind up stepping on your partner's toes, if you plant your foot where your partner still has his or her foot. These phenomena, these *figurations* – as Norbert Elias called them – are circular, retroactive causations and we cannot really see them in any other way. This is recursive in the sense that what is produced also produces. We as individuals produce the society that produces us. This is the idea of recursion. We are producer and product at the same time. This notion is important not only in the field of linguistics but also in other disciplines.

g): Lastly, *implicated* order. The physicist David Bohm (1987) is the creator of the concept of "implicated order" versus "explicated order". This idea is based on the hologram, which contains information about the whole at every point. Implicated order builds on the idea that the whole is contained within the part. For us social scientists, this idea is extraordinary. The individual contains within himself the whole of society. To a great extent, I am a product of my society and I contain it. If I speak now in a certain way, it is because I have lived among certain human beings. Everyone here in the audience is taking part in a ceremony that we call a "talk" or a "class". You are quietly listening, I am speaking, each of us is in his place, we follow norms, a representation of the situation, because we have been educated in this type of culture. In other cultures, by contrast, this would be unthinkable. In other words, we have the society that has us. We possess the ideas that possess us, as Morin said. In an implicated order, a hologram-like order, the parts contain information about the whole and the whole is in the part that is in the whole. Therefore, we need to reject the fragmentation and separation of elements. For us, everything is contained within everything else.

In my view, these are elements that can help each of us in our fields to gain an idea of how to look upon sociocultural phenomena with a complex perspective. I do not know exactly which image of complexity we should find. But, no matter what, we need to think from the perspective of a world that is not simple or linear, but rather that challenges us to construct a complex way of thinking to understand phenomena that are otherwise incomprehensible. Particularly in the social and human sciences we have no other way forward. Perhaps in the physical-chemical and biological worlds, to a certain degree, it is possible to think from simpler perspectives, but we cannot do so.

4 Sociolinguistic Complexity

The principles that I have introduced here could be taken as general principles, but what we need is to understand social complexity, a set of phenomena that we must probably learn to retheorise and rethink. We really need to take care with the most

apparently clear-cut terms. "Society", for example. What is "society"? Now we can distrust terms that appear so clear. Everything that seems clear may be said to obscure an important complexity. Certainly, the most commonly used labels need to be reviewed and given their due complexity – in a word, *complexified*. This is probably because they do not bring us sufficiently close to the reality that is there. Therefore, the challenge is to understand the phenomena that *emerge* from the multitude of existing human beings. A clear example is our current economic crisis. The problem is not only understanding it, but also in some sense controlling what we have collectively built, which is slipping out of our grasp and out of the grasp of social agents. This example concerns economics, which many want to distil into mathematics, but which remains a science of people and environments. Many economists today still work with mathematical formulations that seem to explain reality to them, but we now see how difficult forecasting is. The problem is not about the economy; the problem is of human beings and what we have built collectively.

Therefore, we return to the brain/mind to attempt to see how we could explain and articulate a better understanding of linguistic and sociolinguistic phenomena in general by taking a complex approach. In my 1996 book, entitled *Ecologia de les llengües*, I based my thinking not only on the work of ecologists (Margalef 1991), but also on the work of physicists and anthropologists adopting a complex gaze, such as Edgar Morin, in order to see how we could articulate an ecology of languages that was socio-cognitive in nature. What are the elements of a sociocultural ecosystem that could account for socio-cognitive or linguistic/cognitive phenomena? I believe that fundamentally we need to start by bearing in mind that the brain/mind has linguistic, cultural and cognitive competences to represent reality and that this is fundamental to any theory. Chomsky deserves kudos for being the one who dared to build an extraordinary critique at behaviourism, a psychology that ignored the mind, and therefore to connect linguistics with psychology. Now we have gone farther. Chomsky spoke of an ideal speaker-listener. But obviously no ideal speaker-listener exists. In any case, if there is one, then there are many ideal speaker-listeners, in plural.

Nobody has developed a language on his own, nor could anybody have been socialised on his own. There must be human connection. We need to construct a theoretical perspective that can enable us to understand the self-organising, autopoietic co-construction of minds. What makes possible the learning of human cognitive content, which is always developed in a plurality of individuals? This is where Norbert Elias put a great deal of emphasis. He always criticised the act of thinking of human beings individually. He believed that it was an extraordinary mistake. Humans always exist in numbers, in groups. Therefore, how do we live together? How is it possible to reach a mutual understanding in conversational interactions? What happens in our heads for people to make sense of the noise that others make?

"Communication" is an old critical label. "Communication" needs to be complexified. What lies behind communication? At present, the term is abused. It is excessive. It is polysemic. We do not know what it is, what is there. To understand communication, first we must understand cognition and the possibility

of mutual interpretation. That is something that is clearly seen in linguistics in the metaphor of the container. For many years, many people have believed that words are what have meaning. Words do not have meaning, *we* give them meaning. That noise we make means nothing on its own. We bestow our perceptions with meaning. Therefore, communication is an action, it is an inter-action between two minds that have the elements needed to interpret the signifying intention of each other adequately. However, if the necessary elements are not present, we can make all the sounds we want and they will produce no cognitive activity in another individual. If we speak to one another in a language that we do not know, we will certainly try to guess what each other is saying. But there is no guarantee that our guesses will be good enough. I think, therefore, that we need to build a linguistics that *simultaneously* takes account of phonetic spectrograms and the human beings who produce them. It needs to connect the sounds with the society, the sounds with cognitions and with constructions of reality. This is where, in my view, the perspective of complexity can be of great help to us.

Our challenge is to understand the social level. As I said, Norbert Elias has proposed the term *figurations* to understand the constructions that we make jointly as humans. His complaint was that what we have not studied yet are exactly those properties that emerge from human interaction and relation. What kinds of constrictions occur when two people relate to one another? We cannot think of the matter as though it involved the force of Newtonian gravity. We need to think differently. We do not yet have a clear way of saying it, but we must build adequate concepts. We humans make figurations that are interpersonal, in groups; we establish States that control us and which we, in part, control in turn. The State is in us and we are in the State. It is not only the State in us – particularly in the democracies. We also have an influence on the States. We must see the interdependencies. But what type of figuration generates this relation? We are also in the economic world that is in us. What kinds of properties are created here? What types of constrictions and mutual dependencies are there? This is what we still must work out. Society is not an object. It is an idea that we possess in order to think about collective reality. But, in the end, there is no object that is society.

We should also think about language transversally, multidimensionally. The transversality of different simultaneous levels of existence is where the linguistic phenomenon happens. It does not happen in a single dimension of these levels, but in all dimensions and at the same time. We need to make use of systems theory, look at individuals and groups, look at how the phenomena interpenetrate one another. We need to try to see how things are contained with one another. I postulate the development of a complex linguistics that aims to embrace all elements; that tries to think in terms of networks and from the viewpoint of an orchestral polyphonic metaphor. (One of the problems we face is coming up with adequate images and formal notations to enable us to think about human complexity.) What systems are available to us to represent this complex linguistics? An orchestral notation is interesting as one way to express complexity. That is, the orchestral score has the advantage of being synchronic and diachronic at the same time; it is sequential and temporal. Melody is sequential, yet polyphony comprises different voices and instruments. If, for example, you have

had the experience of singing in a chorus or playing in an orchestra, you can grasp the "complexity" – to put it that way – of the part you are performing. Apart from the dominant melody, all the accompaniment – whether voices or instruments – is constructed in function of the harmonic *totality*, of the perceptual whole. The instruments' notes that make up the whole are determined by their role in the group, in close and indissoluble interrelationship with the other voices or instruments. Each element, therefore, becomes comprehensible in function of the *whole*. If it is not framed within the whole, there is no possibility of understanding what justifies the sounds it conveys.

The image of the musical score shows us the importance of temporality: if the sounds of each and every instrument are not executed continually, the piece of music does not exist as such a phenomenon. If each sound is conveyed with a great temporal separation, the intended musical work cannot be produced. Time is inescapable and forms an intrinsic part of existence. The image of the orchestra also enables us to take account of temporal changes and/or continuities, as well as of the evolutions of the diverse levels of sociocultural phenomena. In this way, we can represent this dynamism and make a procedural perspective possible. The "harmonic" idea also enables us to represent "disharmonies" that in the social and/or linguistic plane can be produced by divergences that evolve between the different levels of reality. Specifically, if changes occur in any dimension, it is highly likely that such changes will force successive instabilities and adaptive changes in other dimensions, potentially leading existing social or linguistic structures to unexpected de-re-organisations and evolutions that are frequently hard to foresee.

Using the musical image, we can also see whether it is possible to broaden the number of staves in the ordinary score of traditional linguistics and add others to correspond better to an "external" perspective of the code. By doing so, we could take account, as illustrated earlier, of linguistic phenomena that clearly cannot be explained by the interior, but only by the exterior of the structure of a language, using classical terminology. Our interrelational, group, sociodemographic, ideological and socio-significant staves could be added to complement the planes distinguished and considered canonical in linguistics to date.

5 The (Bio)ecological Perspective as a Metaphor

If we now focus our attention more on what we typically think of as sociolinguistic aspects, we shall apply a complex perspective. To some extent, this involves taking the perspective I called "socioecological" in 1996 and applying it to the existence of linguistic forms in contact situations. A (bio)ecological perspective can be used as a metaphor to illuminate our thinking and push forward our creative understanding of sociolinguistic phenomena (Bastardas-Boada 2002, 2002b). How can we think of a sociolinguistic "ecosystem"? What elements do we need to put in such an ecosystem and what metaphors and analogies should be applied?

To begin, I need to act with a certain degree of calm when we resort to analogy and also warn against stretching it farther than warranted, because some schools of thought have already reached positions along these lines that seem to me excessively radical in given applications of metaphor. First, a language is not a species. We can make the analogy, but that does not make a language a species. Therefore, the conservation, the life, the changes of languages can be studied analogically, but we must take care. For example, if we come to postulate that the maintenance of languages must oblige us to create "reserves" of speakers, then I think that may be an exaggeration. One reason, for example, is that buffaloes cannot express an opinion on whether they wish to be protected, while humans can. This sort of problem leads us to debates in anthropology, because anthropologists in favour of maintaining a language can sometimes come into conflict with a language's own speakers, who may have no interest in maintaining the language – something which can happen. This is why I issue my warning that the (bio)ecological inspiration is a metaphorical exercise for seeing how we can use advances made in another discipline to proceed toward an environmental linguistics, but that we need to take care not to confuse planes or lose the distinctions between their elements.

Comparing the fields may inspire us, for example, to want to know how linguistic diversity came about by studying the production of biological diversity. How have species arisen? This is clearly an important line of research. How has the extraordinary diversification of human languages come about? People who study the genetics of populations have compared their data to language families and found that there are clearly important relationships. This is a field of research that has received little attention and needs greater understanding. How does language *speciation* occur? How does this process continue? There is death, but also creation – not only in languages that innovate internally, but also, for example, through blending that gives rise to new languages. Pidgin and Creole languages are examples of such blending. Creativity does not stop. How is such a degree of diversification possible? Clearly, diversification is related to the diaspora of our species over the planet.

Now that we are in a new *glocal* era in which we may perceive ourselves as a planetary unit, we may also wonder whether processes of language reunification are at work (Bastardas i Boada 2007). For the first time, we humans have global languages that enable us to be understood by people from many different places. Without the need for anyone to dictate this explicitly, we begin to have shared instruments of communication. English, for example, takes on this role. But nobody has assigned this role to it. Humanity as such has not debated the matter, not even in Europe, because the subject is taboo, in some sense. Which language would we choose as a code for intercommunication? Will the language that is selected come to be seen as superior to the others? Will this cause the mass extinction of languages? These problems lead to a certain degree of fear among our political leadership. Europe's problem is very clear. Governments do not wish to say how they want Europe organised linguistically from the point of view of intercommunication. But looking inwardly, what are these governments doing? Everyone is opting for English and teaching English as a first "foreign" language

in their educational systems. They do not say as much, but everyone is doing it domestically in order not to stir up problems that we may call "identitary" in nature. Many people believe that English is an "imperialistic" language. In practice, however, it is not the American empire that is telling countries to teach English. Each country is making this decision because it seems the best way to promote technological and economic development. At present, English cannot be called a "killer language" outside of the territories where it was resident before globalisation (Mufwene 2001). It may overlay existing languages as a "hypercentral" language, but it is not currently replacing them in the big majority functions of human language groups. The case, however, is that humanity cannot wait for a decision from shared world organisations on what should be the language of general intercommunication. The need exists and English is clearly the language best placed to serve this function. We do not know whether that is how the situation will remain or whether other languages will come – such as Chinese or some other language – that can also take on this function of general human intercommunication. At present, it is impossible to foresee.

Be that as it may, language diversification has occurred. Speciation has occurred. But perhaps at this time we can see that we are on the path – a very long path – of language reunification for the species or, in any case, toward the facilitation of intercomprehension. Therefore speciation is a line of research that we need to pursue.

Another subject of study for ecologists is the *continuity* of ecosystems: how do ecological niches – constructions in which a species takes part in order to safeguard its survival – actually come about? Can such a species contribute to make an adequate niche, a favourable ecosystem, a suitable climate, the nutrients, etc? How must this be done to safeguard the continuity of human language diversity? What ecological niches do we need, if we are to prevent humanity from abandoning the languages we have been creating? This is an enormous question of social, political and linguistic dimensions.

States – their policies, their ideologies and their flags – have a big role to play. States have been the first to pursue policies that denigrate language diversity. Many States, as we know from experience, have been hostile in the face of their own internal language diversity. If our aim is positively to conserve language diversity, then such hostile policies are clearly not the way. We do not need to be fearful of humans becoming polyglot. We can hold several languages in our brains. We are created for polyglotism. The only safeguard we need to give human groups is that we reserve important, pre-eminent functions for their own languages. Therefore, we must never confuse social multilingualism with personal or individual multilingualism (Mackey 1994). How can adequate ecological niches be created for the world's languages?

In my view, if we asked the peoples of the world whether they would be happier all speaking a shared language and abandoning their own language or would rather know both languages, they would choose the second option. In this way, it would be possible to communicate with everyone and yet also maintain our uniqueness in groups. This, I think, is the path we need to take. The mass polyglotism currently underway, however, clearly represents a shift in the

orchestral score image of the language ecosystem. Then, how can this ecosystem be appropriately organised to allow its survival and, at the same time, permit intercommunication? These are vital questions for us. Is such a new organisation even possible? Clear cases of sustainable multilingualism exist. Luxembourg offers one example. This tiny country is clearly an example of how a population can be polyglot and yet experience no abandonment of its own language codes. Countries in Northern Europe traditionally pursue bilingualism in English starting early in school, but they do not abandon their own national languages. Nobody thinks that one thing must lead to the other. We can live peacefully in the complexity of "and/both". We need to see how we can make the ecological niche for a sustainable language continuity (Bastardas-Boada 2007b).

Another object of study for many ecologists is *contact* and *change*. What happens when there is contact between species? Here, environmental biology has developed the notion of predator species, species that consume other species. In the field of human language ecology, we can also see predator species that extend beyond their natural territory and consume other species. The reduction of diversity is tied to the growth of many colonial empires, which produce mass extinction of languages. The denigration of the native language and negativising discourses are only two examples of approaches that frequently lead distinct colonised groups to abandon their own languages (Mühlhäusler 1996).

Dawkins illustrates this case well when he says: "The fox runs for his dinner, the hare runs for his life". Major languages run because they wish to get bigger, while minor languages run in order to stay alive. Certainly, we live in a world in conflict. We may find harmony or we may find conflict and it depends on how we manage matters. In this sense, too, we can glean ideas from environmental biology.

Extinction: How is the extinction of biological species possible; and how is it possible for linguistic species to go extinct? How does species extinction arise? There are people who, when you talk to them about language extinction and they are speakers of a normal language, find it impossible to imagine that a day may come when they could abandon their code. However, as many cases show, it is perfectly possible. It does not happen overnight. It is an intergenerational phenomenon that requires a bilingual population that has a mastery of two languages and that, at a given point in time, abandons the original language of the group to adopt what was initially the foreign language. The pattern unfolds over three generations. Circumstances arise in which populations, according to the contexts in which they live, come to generate a representation of their own group that is negative and stigmatised. When a language becomes extinct, the process is not simply of a fish eating another fish. It happens in situations of subordination that are typically political and economic and it is characterised by a negativising discourse that leads people to take the dominant language group as their point of reference. This is how they see themselves and in order not to shame their children, they try not to pass onto them the stigma of the language, which they now view negatively, influenced by the pressures of the situation and the dominant groups with which they have contact. This explains how humanity, in a situation of ecolinguistic peril, can come to abandon its own codes. From one generation to the next, little by little, a language is let fall into disuse.

To try to provide a solution to this issue, ecologists have created *ecological restoration*. How can we maintain biodiversity? What is lacking for species to have continuity? The question, therefore, is this: what did the context contribute before and now does not? What did the context contribute to stabilise a species in its ecosystem and now is missing? What did the context do to enable the species to survive? If some disturbance or disorganisation has occurred, how can we step in to help this human or biological entity to persist? What essential elements do we need to contribute to enable the species – or the language – to survive? If nutrients are lacking, for example, we can add nutrients. If a protected habitat needs to be created in a reserve, we can create it. We can do whatever is necessary. Therefore, if that is what takes place on the biological plane, we can also speak of a restoration ecology of languages in the linguistic plane. What should we do to stop humanity's language groups now abandoning their codes from ceasing to use them? What should we do to enable them to live happily and fully in their diversity?

The first action must address the context and the mind simultaneously, from a complex and holistic point of view, addressing the socioeconomic and political context, but also and especially the discourses. How do they see the world? How do they see themselves in relation to others? (We are always among others.) Why do they believe that they need to abandon their code? Why is their code unworthy? This work concerns awareness and assertiveness. The Native Peoples of Canada, for example, largely switched to French or English, but are now greatly interested in maintaining their languages. They take the view that their abandonment was a mistake, and wish to regain pride in their language. Complementary to this change, Canadians of European origin – as is also the case with Australians – are ashamed of past policies clearly pursued against the interests of maintaining diversity. There is a need for restoration ecologies to help European Canadians redress their sense of guilt and help other peoples try to reclaim the social uses of their codes. However, despite achieving dignity for a language, once you have adopted the major language and abandoned the minor one, it is much more difficult to create an everyday context in which to reclaim the language in retreat. Nearer home, for instance, we have the case of Irish Gaelic. Political independence came, but the language had reached a point at which the percentage of speakers in the population was already low across the demolinguistic whole. Despite government support for Irish Gaelic, the population had largely adopted English and abandoned Gaelic in daily life and it became difficult to gain speakers in everyday functions that are, indeed, the ones that maintain languages. Schools and the public administration are important, but the most important aspect is the individuals, the people, who, must keep the language in movement.

Prigogine, a Nobel prizewinning physicist, has said: " ... [W]hat is needed [he is referring to Physics] is to find exactly which precise conditions of disequilibrium can be stable" (1996). In other words, disequilibrium will be the case, because everything will be in disequilibrium in a world of contact and interpenetration. So we need to see which conditions can allow a certain continuity of equilibrium that is clearly in dynamic disequilibrium (Bastardas 2002c).

6 Towards a Socio-emo-cognitive Language Ecology

Lastly, I want to talk about the limits of the (bio)ecology metaphor. If we turn from the ecology metaphor to human reality, all of these concepts give us fields, lines of research, parallelisms; however, a language is not a species and, therefore, we need to make our ecology *socio-emo-cognitive*. Human ecology is complex and multidimensional. *Complexus* is that which is woven together. Therefore, we need to discover and create theories and represent to ourselves how language behaviour is woven together in order to maintain language diversity and, at the same time, foster general human intercommunication on a planetary scale. One of our problems is that we want to substantivise something which is dynamic. We objectify, say "language" and see an object. But there is no object. Or rather there is a complex emerging and dynamic object. But it does not exist as an object among us. More than "language", what there is is "languaging" – ceaseless human communicative activity. In this vein, Morin says that it would be good to view languages as living in three simultaneous dimensions, which should be borne in mind when analysing such phenomena. Language is in the *psychosphere* of individuals. It is also in the *sociosphere* among individuals (*within* and *between*). And it is in the *noosphere*, an environment of complex cognitive systems in the sense of an analysable system. Ideas, for example, live *within* us, *among* us, and can be studied as specific *objects* that are *cognitive* in nature. Language is in the *interrelationship*, in the intersection between these three spheres. The *locus* of language – whether language was in the individual or in society – has caused rivers of ink to spill in the history of thought about language. But that time is past. Let us not waste one more minute on it. Language is *within* and *between* individuals. It is "and/both".

Now I would like you to picture a shape like the upside-down pyramid at the Louvre Museum in Paris as a way to illustrate the multidimensional, transversal ecology that we have been talking about. The image of an upside-down pyramid with several layers enables us to put *human brains-minds* at the basis. At each level, new things emerge. A mind, when it relates to another mind, gives rise to new phenomena, phenomena that were not present before. When I interact with another, there are I, the other, and the organisation of the *interaction*. If we enter into a *group*, more new elements emerge. As individuals forming groups, we constitute new phenomena. We are not simply John or Maria. We are set X, set Y. I am X, the other is Y. We identify ourselves in terms of suprapersonal categories that oblige us to behave as members of these social categories. If I am such and such, I need to behave in such-and-such a manner, because that is what is expected of me by the group. This always occurs in the context of a transversal relationship, in terms of interconnected levels. If we join *organisations* – economic ones, for example – further new elements emerge. And if we are also members of *States*, the same process is once again at work. Therefore, if your aim is to study the language behaviour of an individual, you need to imagine the upside-down pyramid. This is the most pared-down image we can have from a complex point of view. In a conversation, for example, we need to imagine ourselves as two individuals with an inverted pyramid above each of us, because that is where important things happen.

To understand the phenomenon of language, we must understand it by using an image that is dynamic and also able to capture the interrelationship of the different dimensions. Language exists in multidimensionality, transversally, dynamically.

That brings us back round to the metaphor of music, of the orchestral score or polyphony, which make it possible for us to explain all these interrelationships. In our *first stave* we will have the brain/mind level. In terms of understanding linguistic behaviour, there are two main interrelated functions of the brain/mind complex that would appear to be of particular relevance: language development and representation of reality, and control over behaviour. It is in the brain/mind complex where we construct and sustain ideas and emotions about the reality that we experience, and from where we activate our motor organs to carry out specific actions – determined in accordance with the representations and interpretations of the reality that we make. And this we can do either from the conscience or the "sub-conscience". We can hold certain definitions of reality without being conscious of so doing, and similarly we can undertake certain actions without having been conscious before, or at the time, of having done so.

At the heart, however, of this conception of the human being as a cognitive-interpretative being is, as maintained by the perspective of symbolic interactionism, that *the meaning does not emanate from the intrinsic structure of the thing that it possesses but rather from and through the defining activities of individuals as they interact* (Blumer 1982:4). Contrary, therefore, to long held beliefs, things do not have meaning on their own; rather, it is human beings that attribute meaning to things, be they physical objects, words, language varieties, or actions, through the cognitive processing of apprehended information and internalised interpretative procedures. Indeed, we might say, to modify slightly a well-known saying of Gregory Bateson, that we *cannot avoid interpreting*.

The fact, therefore, of the 'meaning' of reality is central to human existence. No explanation of the experience of individuals or societies can ignore it. The way the individual represents his world, his place in that world, the values and aims of his existence and that of other beings, his personal and social experiences, etc. will have a profound influence on the individual's motivations, sentiments and emotions and, therefore, on his behaviour.

The second function – control over behaviour – has, it should be stressed, a very close link with the first function. Thus, human action always occurs in the framework of a universe of senses which determines it and makes it intelligible. And the action that I think I am carrying out is the fruit of the indications that I have given myself in accordance with the interpretative schema that I have internalised in my depository of knowledge and which are the fruit of my prior experiences (Blumer 1982). In order to understand the action – as Max Weber reminded us some time ago – it is necessary to understand the interpretation that the subject gives of his own actions. Many of the daily, repetitive actions are directed from the human sub-conscience drawing on an individual's experience accumulated in his cognitive depository: if things work in such a way, he will act in such and such a way. If the internalised routines of behaviour are successful they become habitual 'recipes' of behaviour.

The social interaction of brain/minds is the *second line* of our orchestral score. As in systems theory, we propose that new properties emerge from the social interaction of minds that cannot be derived directly from the first level of the subsystem under analysis. While this new level retains all the significant elements originating in the mind, the emphasis shifts to how human interaction is organised. It takes into account that interaction occurs within a much broader social context in which relationships of power and social inequality play an enormous role.

Speech, therefore, is not an isolated, independent behaviour without a setting. To the contrary, it is a fully integrated subset of social life that registers the same socio-cultural influences, meanings and constraints as, for example, rules for what to wear or how to eat. The use and selection of a language form or variety are strongly affected at an interactional level. Just as other elements of social interaction are organised and structured, speech is also organised and structured. The selection of language forms used by human beings depends on how these forms are related to the elements in the interactional setting. Just as it is not the same to speak to a person with an informal or formal *tu/vostè* in Catalan or *tu/vous* in French, the use of one language or another cannot be neutral. Language variation, too, is regulated.

The forms, scripts and rituals used and followed by individuals in their interactions are obviously not universal, but differ according to the culture diversity of the human species, organized as a 'groups' or communities. This is our *third level* of the score. A gesture of greeting in one culture may be seen as a sign of aggression in another; a normal volume of voice in one country may be considered inappropriate or raucous in another; words and other linguistic elements may have negative or taboo connotations in a given society, while they are quite normal and have no connotations in another. Culture is convention. It is an arbitrary agreement that is socially established in diverse human communities. We make it signify what we want it to signify.

The reality of groups is undeniable. From the smallest collectives of two, three, four or more people to vast socio-economic organisations or ethnic-linguistic groupings, human beings have typically organised into defined socio-cultural groups or networks. To a greater or less extent depending on the circumstances, these groups or networks give rise to a sense of belonging and emotional identification with specific cultural traits. An essential characterisation of such groups, particularly in the smallest ones, is the high degree of internal interaction that sustains them and the norms that emerge over time and become established as the collective's own norms and, therefore, as expectations that must be followed by members of the collective or that, if established customs and ideas are not adhered to, may trigger sanctioning mechanisms.

Social groups or networks fulfil the intrinsic needs of individuals for emotional connection and solidarity, and this gives them a degree of influence that should not be underestimated. Within themselves and through their socio-cognitive exchanges, individuals elaborate their interpretation of reality and forms of conduct which, in turn, tend to attract greater support and confirmation and even to foster a quality of emotional attachment as they gain greater support and confirmation within the group. However, the strong emotional attachment of

individuals to their groups may equally become a mechanism for change. A group may be influenced by its most listened-to leaders or respond to a significant subgroup's change of opinion and then decide to adopt a new interpretation of reality or a new pattern of behaviour. When changing the forms assumed by the collective, the individual must also consider his own decision and assess the consequences that may arise from not changing. In this way, many initially reticent individuals eventually change with the group, ensuring their peers' continued support and their own socio-affective stability. Language behaviour is clearly affected by the influence of social groups and networks.

The macrosocial order shows us the common reality of inequality and asymmetry among human groups. The causes may be economic, cultural or demographic – or political-military, as we will shortly see. The disparity between the resources and opportunities of each human group ineluctably gives rise to socially dominant and socially subordinate groups. While the category of "social class" is more strictly socio-economic in origin and less directly refers to the psychosocial properties of the concept of "group", the existence of collectives usually called "minority groups" seems to be an undeniable, conceptualisable reality.

Asymmetry usually accompanies socio-cultural change. Individuals want to get closer to the forms and values of more powerful groups or change their unequal situation. If the perception of the situation held by the minority group is that the system of inequality is stable, i.e., no cognitive alternatives exist, or that it is legitimate, or both stable and legitimate at once, its actions will tend toward conformity and at least some adaptation to the dominant collective. If, however, objections to this reality emerge from within the group, the situation can develop differently.

The political power could be the *forth level*. "A State -says Weber- is a human community that successfully assumes a monopoly on the legitimate use of physical force within a given territory" and "the right to exercise physical force is specifically assigned to other institutions or individuals only to the extent that the State permits it" (1985:10). As a social institution, the State appears to wield an extraordinary ability to influence the lives of human beings. Its regulations must be fulfilled and disobedience calls into play a system of punishments that can, as we know, extend even as far as loss of life for some lawbreakers.

Since the nineteenth century, many States have tended in particular to adopt ideologies of "national" unification, i.e. linguistic and symbolic unification. Using all the means at their disposal, they have promoted language uniformity amid actual diversity and fostered "state patriotism" against traditional group loyalties. This patriotism is associated with given symbolic forms – the flag, anthem, institutions – as well as the State's instrument of communication, the official language variety, which is, in most cases, singular and exclusive of other varieties within the same State. The category "State" – often masked under banners like "patria" or "nation" – is the basis for a new and in many cases effective group categorisation and identification. Regardless of their wishes, human beings are assigned to the state institutions that have spread over the planet. Side by side with the widespread dissemination of the official definition of the categorisation of

reality, elements such as wars, sporting competitions and territorial conflicts foster identification with the State in the area of sovereignty in which they live their lives, and these elements can generate hatred or sympathy toward other people according to the unfolding relations between respective State institutions.

This extraordinary increase in the direct and indirect influence of political power on language can, at least to a large extent, explain many of the ethnic-linguistic conflicts that have emerged across the planet in the last century. Given that the vast majority of today's States have populations with significant language differences, the equation "one State = one language" has become a potential source of serious civil conflict that may be difficult to resolve in some cases. These situations of conflict can be particularly violent when the ethnic-linguistic composition features a group that is demographically much larger than the others. Even with democratic forms, the majority group can patrimonialise the State and use it consciously or unconsciously to expand its domain, provoking a sensation of subordination from which there is no way out for smaller demolinguistic groups.

7 Time and Co-evolution in Sociolinguistics

Inevitably, all of these phenomena of interrelation, equilibrium and/or evolution take place within the context of a variable that is inherent in human existence: time. Just as music is unthinkable without the succession of different notes receiving their "significance" in relation to the syntagmatic and paradigmatic axes, in Saussurian terms, so reality does not exist without movement and sequence and in the dynamic mutual influence of all its elements. Seen as an ecosystem, reality – and particularly language – is at once dynamic, in equilibrium and changing. Permanence and change occur simultaneously. They are entwined and indivisible. Although it may seem a paradox, one can only be understood with the other and vice versa.

Just as a work of music does not exist without its instruments, the socio-cultural reality does not exist without the entirety of its components. The mind does not exist independently of the social context in which individuals live. Nor is this social context possible without minds. The different levels of the score shape one another and exist in interrelation. That is, in a general sense, existing language behaviours are the result of these mutual influences. Their maintenance and their continuity depend on the persistence of the structure of contexts that produce their existence. Excessively radical changes in this structure may well cause the destruction or modification of behaviour, leading to another configuration by means of stages characterised by unstable equilibria.

The mind, as the foremost control centre for behaviour, appears to register the influence of two beats that are harmonised to differing extents depending on the case. On the one hand, it initially receives direct stimuli from the levels of interactions and groups and, particularly in contemporary developed societies, only shortly later, also the levels located beneath the direct or indirect control of political power. For example, while an individual is socialised in a specific way of speaking within the family and within the group, he or she can encounter another way of speaking in nursery school, the rest of the official educational system, the

media or advertising. Moreover, these may also appear in written form. At the core of the issue is how reality is given meaningful categorisation, and particularly, the *sociosignificances* given to the concurrent language forms or varieties in the contact situation .

The phenomena of socio-cultural permanence and change are closely tied to the properties of human beings. The duration and penetration of early socio-mental imprinting at the level of representations of reality, norms of behaviour and competences are highly likely to contribute to cultural continuity, unless significant events throw into question their appropriateness to the context. On the level of language behaviour, for example, enormous groups of human beings have maintained general norms and forms for centuries. Yet, despite their gradual evolution, these norms and forms can be identified as a single fundamental system. Generation after generation, individuals socialised within the same socio-cultural framework have basically reproduced the traits of a culture perfectly adapted to the essential environment of their existence.

Despite the pronounced correspondence between mind and context, however, humanity has collectively made changes in many basic aspects. The stability of existing socio-mental structures have been shaken by military, political, economic, technological, demographic, environmental, ideological and cultural events. Against the strong conservative tendency of human groups, these events have led to new configurations never before envisioned or imagined.

Within the context of their socio-cultural ecosystem, the permanence or change of the norms followed by individuals in their language behaviour will determine whether a specific sociolinguistic situation is durable and stable or, by contrast, it undergoes significant change. The phenomenon of language contact, precisely because it is a new element in a dynamically functional reality, will frequently activate the attention of individuals and define them amid the reality facing them. However small or great, language contact is a factor in the changes that occur in communication forms and/or behaviours. In whichever group or code, the resulting situation will not be same as it was before. As a result, the structures that support the persistence of behaviours can start to fracture and the behaviours can begin to evolve toward initially unforeseen states.

Imagine, for example, a stable, “harmonised” population that is nonetheless integrated politically within a State where another group dominates. In all likelihood, this situation will “disharmonise” the historical equilibrium and lead to sociolinguistic readaptations. Now imagine that new populations also arrive and they are linguistically different. Add new staves to the score, staves that relate differently to the already existing ones. This leads to new phases of disequilibrium as the various staves (re)adjust to new realities.

The usefulness of the orchestral score is as notation: it enables us to picture a complex, multidimensional and dynamic reality. Down this road is the way we need to go, generating new images and new tools for complex thought because, as Elias said, “One of the essential duties of human beings is to find out how things are interlinked, if they want to organise their life better than it is today” (1991:63).

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4 Language as a Complex Adaptive System: Towards an Integrative Linguistics*

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Abstract. The author justifies the title of this chapter by offering a general approach to the perspective of complexity and introducing the wide range of language used in connection with complexity. There is an introduction to terminology as redefined within the framework of complexity because we think that agreement on the terminology of the main concepts will provide a basis of common language for all the chapters of this book. The objective of the chapter is to promote progress in the formulation and dissemination of transdisciplinary knowledge from the perspective of complexity, with special regard to its application in the field of language, the tool used to convey both thought and method. For this to happen, it is necessary to rethink science, including the human sciences, by means of an approach that cross-cuts disciplines and takes into account all those aspects which will allow us to find a shared language. This is because human phenomena require a way of thinking that is able to account for the interrelated and systematic nature of its internal and external dynamics. The development of a complex perspective will drive us toward a deeper understanding of human phenomena in general since they may well be the most complex in existence. This chapter also aims to set out guidelines for developing a vision of linguistics guided by the perspective of complexity.

1 Shared Assumptions

This section sets out the shared assumptions common to the writers of the various chapters of this book. It also examines the terminology of complexity and any vocabulary given a specific use in this context. Throughout the book, these terms will reappear and the aim of this section is to offer a brief introduction for the reader (see Massip 2006: 15-16).

The properties of complex systems in one discipline have a great deal in common with the properties of complex systems in other disciplines. As a result,

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one feature of this approach is its transdisciplinary nature. For instance, complex systems can range from the social level to the neurological level or from astronomy to biology. Complexity enables us to address objects of study by exploring their processes, changes and continuities.

When we speak of complexity theory, we draw on a) Maturana and Varela's systemic theory of cognition (in which cognition includes perception, emotion and action, the entire process of living), b) the ideas of the physicist Prigogine, c) the philosophical thought of Morin (set forth in his book *La Méthode* and especially in his reflections on the knowledge of knowledge), and d) the new contributions of groups working on complexity research all over the world.

Let me comment briefly on five pillars that we consider central to the articulation of an approach focusing on complexity.

1. The importance given to our cognitive instrument (the brain in interaction with the body), cognition (understood as perception, emotion and action, the entire process of living), and, especially, metacognition (the knowing of knowledge).

2. When we refer to complexity we do not mean simply acknowledging that there are complex things – some more so than others, of course – but also that we require a method of knowledge suitable for this object of knowledge. In other words, complex thought; a way of thinking that can account for the multidimensionality of things, their interdependence and paradox as well. Therefore, the method needs to be dialogic: we have to try to make room for concepts that seem antithetical in order to think about organizing and creative processes in the complex world of life (including human life, which cannot be isolated from life on this planet in general) and in the complex course of human history. We also need a tool, language, to convey both thought and method.

3. The sum of partial studies of given systems cannot account for the behaviour of their whole. Conversely, the parts can have qualities that are inhibited in the organization (or vision) of a set. An emergent structure is a new formation (with new information) that is created from the connections and relations of the parts.

4. We take ecosystems as a frame and as a limit.

5. As for the methodological treatment, the functional transversality among subjects, conveyed always through language, is indispensable.

2 Main Vocabulary

2.1 Concept

What is the theory of complexity? The aim of the theory is to account for how the parts interacting in a complex system give rise to collective behaviour and how, in turn, this system interacts with its environment. What is meant by interaction is that an action affects another action, which also affects the former action.

Complexity studies complex systems and is applied to them (see vocabulary). Complex systems possess features shared by different fields addressed by various branches of science and other disciplines. The theory of complexity is transdisciplinary and can be applied at many different levels.

2.2 Measures of Complexity

Three dimensions have been proposed to measure the complexity of an object or process (Lloyd 2001):

- difficulty of description
- difficulty of creation
- degree of organization

Lloyd produced a list of 40 measures of complexity proposed by various authors. Each measure addresses one of the dimensions listed above, drawing on the concepts of dynamic systems, thermodynamics, information theory and computational theory. Mentioned here are a few that I regard as useful in reflections on language and complexity (Mitchell 2009: 96).

1. *Length.* While length may be one of the parameters, it is not definitive. For instance, a mustard plant (Arabidopsis) has approximately the same number of genes as a human being. In this case, therefore, the size of the genome is not a good measure of complexity. Human complexity must originate from something deeper.

2. *Entropy*. Entropy is the average information content or amount of surprise that a message source has for a receiver. Shannon's entropy does not capture our intuitive concept of complexity. One of the things that make human beings complex (to our intuitive way of thinking) is precisely that our genomes are not random but have evolved over time to encode genes useful for survival, such as the genes that control the development of eyes and muscles.

3. *Algorithmic information content*. The shortest length of a computer program that can generate a complete description of an object (Kolmogorov …) or, according to Gell-Mann, the algorithmic information content of the set of regularities. We can determine which set of regularities best suits an entity by using a test called Occam's razor. This determines the smallest configuration of features that describes the entity and simultaneously minimizes the remaining random components of the entity.

4. *Logical depth* (introduced by the mathematician Bennett) is a measure of how difficult an object is to construct. In Bennett's words, "logically deep objects ... contain internal evidence of having been the result of a long computation or slow-to-simulate dynamical process, and could not plausibly have originated otherwise".

5. *Thermodynamic depth* (Lloyd and Pagels) establishes "the most plausible scientifically determined sequence of events that lead to the thing itself" and measures "the total amount of thermodynamic and informational resources required by the physical construction process". Problems also arise in practical application. For example, what is an event? Should a genetic mutation be regarded

as an event or a group of millions of events "involving all the interactions between atoms and subatomic particles that cause the molecular-level event to occur"? (Mitchell 2009: 101)

6. *Computational complexity* (Wolfram). Systems are complex if their computational abilities are equivalent to the abilities of a universal Turing machine. This machine alone is not complex, but it does create complex behaviour together with machine and input code that produce sophisticated computation. In other words, we should measure the complexity of a system's behaviour coupled with its inputs.

7. *Statistical complexity* (Crutchfield and Young) measures the minimum amount of information on the past behaviour of a system needed to make optimal predictions of the statistical behaviour of the system in the future. Measurements have been taken of the statistical complexity of real-world phenomena, such as the atomic structure of complicated crystals and models of neuron activation.

8. *Fractal dimension*. The French mathematician Benoit Mandelbrot was one of the earliest to discover that the world is full of fractals, objects that have a strongly self-similar structure (e.g., coastlines, snowflakes, trees). In general, a fractal is a geometric shape that has a fine structure at every scale.

The fractal dimension quantifies the number of copies of a self-similar object that exist at each level of magnification of that object. Similarly, the fractal dimension quantifies how an object's total size (e.g. its area or volume) will change when the level of magnification changes. For example, if we measure the length of the Koch curve each time the rule is applied, we will find each time that the length has increased by 4/3. Only perfect fractals – fractals in which the level of magnification extends to infinity – have a specific fractal dimension. Fractals have interesting details at every level and the fractal dimension in this sense quantifies how interesting each detail is in function of how much magnification is increased at each level in order to see it.

9. *Degree of hierarchy*. H. Simon (*The Architecture of Complexity*) argues that the most important properties of complex systems are hierarchy and near-decomposibility. For instance, systems like the body, which is composed of organs, which are in turn composed of cells, which are themselves composed of cellular subsystems. The term "near-decomposibility" refers to the fact that hierarchical complex systems contain much more intense interactions within a subsystem than between subsystems.

These measures and many others (Lloyd) have theoretical and practical limitations. They are rarely useful to characterize any real-world system. The diversity of measures indicates that notions of complexity have so many different interacting dimensions that they cannot be captured by a simple measurement scale.

The introductory reflections above are aimed at situating us within the overall context of complexity, not because we find it necessary to justify the complexity of language systems and languages.

2.3 Systems

A system is the product of a set of components that interact in a particular way to produce a state or form in a given moment. Systems differ from other sets, collections and so forth in the sense that belonging to the system affects the properties of the components and the components form a connected whole.

In simple systems, we know the rules obeyed by the elements as they interact. As a result, the future state of the system can be predicted. *Complex* systems have many different kinds of elements or agents (or processes); they are heterogeneous and the future state of the system is difficult to predict (Massip 2007a).

Non-linearity is a mathematics term that refers to a change that is not proportional to some input. Complexity arises from the nonlinear nature of connections or interactions among the components of a dynamic system. In a non-linear system, the elements or agents are not independent and the relations or interactions among them are not fixed, but rather can change. The vocabulary of a second language is learnt slowly at first and later more rapidly. At a certain point, when a student seems to have the necessary words, the rate of learning new lexis slows again.

An *open* system (as opposed to a closed system) exchanges energy and matter with the outside world. While an isolated system in equilibrium is associated with structures *in equilibrium* (e.g., a crystal), an open system "out of equilibrium" will be associated with so-called *dissipative* structures, which are associated with an "order through fluctuations". Such structures are generated and maintained thanks to exchanges of energy with the outside world, in a state of instability. For this reason, they are called dissipative structures.

Brain waves (and also metabolic reactions) can be analyzed in terms of temporal dissipative structures. Language has come to be regarded as the "noblest" fluctuations of our brain (Lézine 1971).

Being open can make it possible for a system *far from equilibrium* to continue adapting and maintain stability.

Systems can be *static* or *dynamic*. Dynamic systems in which everything always changes can be *linear* or *nonlinear*. In nonlinear dynamic systems, the elements have an intrinsic mutability. Change can be continuous or discrete. Discrete change occurs in steps or phases. Continuous change does not proceed in steps, but rather never stops.

Dynamic systems can also be *stable* or *unstable*. Stable dynamic systems (Prigogine 1997c:32-33) feature small modifications to the initial conditions that produce small effects. For an extremely vast class of dynamic systems, these modifications become amplified over time. *Chaotic systems* are an extreme example of unstable system. In chaotic systems, the trajectories corresponding to the closest possible initial conditions diverge exponentially over time. We also speak of "sensitivity to initial conditions", illustrated by the well-known parabola

of the "butterfly effect", which says, for example, that the fluttering of a butterfly's wings in China can affect weather patterns in New York City.

Complex systems can be *adaptive* (e.g., human societies) or *non-adaptive* (e.g., the turbulent flow in a liquid, according to Lewin 1995: 28). In adaptive systems, the change in one area of the system leads to a change in the system as a whole.

Complex adaptive systems are systems that learn or evolve in the same manner as living beings. They seek patterns. They interact with the environment, they "learn" from experience and, as a result, they adapt. They contain information on the environment; in a special sense, they "know" it. The common trait of complex adaptive systems is that they all process information in some way.

Suddenly we can see that shared characteristics exist in complex adaptive systems implicated in processes as diverse as the origin of life, biological evolution, the dynamics of ecosystems, the immune system of mammals, learning and the mental processes of animals (including human beings) and the evolution of human societies. Comparing these shared characteristics offers us keys to enhancing our understanding of the system that is our object of study.

A language system is a complex adaptive system. When speaking of a language system, we do not refer only to a language, but also to the communicative exchange, to language as a shaper of cognition, to language as an expression of our nature (see the difference between I-Lang and E-Lang further on p.33).

It is also interesting to see similarities across the patterns of dynamic systems that can emerge from systems that differ greatly from one another in their composition or nature. The important properties of complex systems do not reside in their composition, but rather in the relation of parts and the dynamic organization of the whole, in their relational order (Goodwin 1998: 101-133). All complex systems share certain properties: nonlinearity, a flow of energy through the system that distances it from thermodynamic equilibrium and also feedback mechanisms that create circuits in which outputs return to the system as inputs.

2.4 Context

One of the initial implications of the complex perspective is the realization that understanding a system and its behaviour requires understanding how the different parts of the system interact with one another and how the system interacts with its context.

Context is not separate from the system, but rather a part of the system and of its complexity. For example, the psychological system of each human and their family and cultural context have collaborated to constitute a system that is affected by other factors as well, e.g. genetic and educational factors.

A system undergoes a *phase change* when its behaviour changes suddenly to a radically new mode. Sudden changes are called phase transitions or *bifurcations*. The *state space* is the set of all possible states. The *phase space* is the state space in which at least one dimension reflects change over time. A system's state space is a visual display of all the possible states in which a system can be. The phase space represents the landscape of a system's possibilities and it changes and adapts over time: the system moves through this landscape.

2.5 Organisms

To this discussion of systems, let us now add organisms, the biological term for living systems (Massip 2003).

In what sense can language be seen as more similar to an integrated organism than to a series of separate features evolving relatively independently? (Christiansen & Chater 2008: 491) Language is highly systematic. It is so systematic that much of linguistic theory is concerned with tracing the systematic relations among different aspects of language structure.

The nature of an organism is defined today in terms of the properties of the species to which it belongs and its form is one of its most distinctive properties. Two aspects of its form can be distinguished (Goodwin 1998: 240): its spatial aspect, i.e., the configuration of parts that define the organism's morphology (e.g., the silhouette of an elm or a salamander) and its temporal aspect, i.e., the rules of activity that define the organism's behaviour (e.g., the courtship ritual of the fruit fly or the flight of the nuthatch).

A member of a species can be recognized by these two formal components. They are qualitative characteristics, the expression of an integrated whole. Organisms can be said to express their nature through the qualitative spatial and temporal characteristics of their own form.

Quantitative studies provide extremely important information on the dynamic nature of organization at the molecular level, but they are not sufficient to describe the rate and spatial patterns that emerge during an organism's development and translate into the morphology and behaviour that identify the organism as a member of a specific species.

3 Change in Complex Systems

3.1 Irreversibility, Self-organization and Emergence

Non-equilibrium physics regards non-equilibrium as a source of order, of coherence (a very general principle that physicists can now formulate) with the emergence of correlations among units. General relativity leads to an extraordinary synthesis in relating space to time and matter. However, it continues the tradition of classical dynamics because it does not assign a privileged direction to time.

The spectacular development of non-equilibrium physics and the dynamics of unstable dynamic systems associated with the idea of chaos force us to revise the notion of time as it has been formulated since Galileo. The new physics of non-equilibrium processes has given rise to new concepts such as self-organization and dissipative structures. Non-equilibrium physics studies dissipative processes characterized by unidirectional time and thereby gives a new meaning to irreversibility. Before, the arrow of time was associated with very simple processes, such as diffusion, friction, viscosity. It was possible to conclude that these processes were intelligible with the sole aid of the laws of dynamics.

Today this is not the case: irreversibility is at the root of myriad new phenomena, such as the formation of whirlpools, chemical oscillations and laser radiation, phenomena that exemplify the fundamental constructive role of the arrow of time. Irreversibility is an essential condition of coherent behaviours in populations of billions and billions of molecules. Without the coherence of irreversible non-equilibrium processes, the appearance of life on Earth would be inconceivable.

Irreversibility is not a universal property (Prigogine & Stengers 1997: 33). However, the world as a whole seems to belong to these intrinsically random complex systems for which irreversibility is significant, and this is the category of systems that break with temporal symmetries. This is the category to which living phenomena belong, including human existence.

Instead of deterministic and reversible laws of nature, the theory of chaos offers up a pluralistic vision of the world (Shepherd 1993: 131).

Among particles emerge particular states of union. A kind of mutual influence exists by virtue of which they remain intimately connected. No matter how great the spatial distance between the particles, certain properties like spin or polarization remain correlated. The causality at work here is an expression of intrinsic powers in the particle fields that cause the entire systems to behave as a unit. The particles are not affected by outside forces. Rather they are themselves aspects of a single process that is distributed in space and that changes over time according to defined rules (the rules of quantum mechanics). This is the same with communication: what emerges is affected mutually by the participating members.

All interaction among particles, cells and so forth exerts an influence on the interacting elements and generates a creative relation emerging from the interaction.

This leads us to think of the remote order relations that exist in the sequences of nucleotides in DNA or between the words of a language.

In this respect, I find that it is a good approach to analyze lexical elements as elements that carry their combinatory abilities integrated, i.e., that each element carries conditions of syntactic presentation and, at the same time, conditions that have been acquired precisely from use in these syntactic presentations (Massip 2007a).

Matter again becomes active in a non-equilibrium world. Activity is an internal property and not an element imposed from outside. Some metaphors that I find applicable to linguistics and that convey a more flexible vision of change processes include, firstly, resonance (Prigogine 1997c: 42). Resonance occurs when two frequencies – the frequencies of a spring and of an outside force – correspond to a simple numerical relation. Then the amplitude of the vibration of a pendulum increases considerably. In music, the same phenomenon occurs. When we play a note on an instrument, we hear harmonics. Resonance couples the sounds together.

An example in the field of linguistic variation occurs in the case of the Peninsular Catalan word for “more”, *més*, and its Northern Catalan (or Rossellonese) counterpart, *pus*. Both forms existed in an ancient language. In the current language, however, each area has selected one of the two options for

reasons of resonance with its corresponding official language of contact: *más* in Spanish and *plus* in French.

Another useful metaphor is diffusive motion in phase space (Prigogine 1997c: 45-46). A single point p^0 in this space is associated not with a point p^t, which could be predicted with certainty as the state of the system after a given time of evolution t, but rather with a field D within which each point has a non-zero probability of representing the system.

The systematic variations in the several varieties of a language arise within predictable and determined limits for each "phase space" considered. For instance, in Catalan today, the pronunciations of the word *germà* (brother, in English) have an initial [ʒ], [dʒ] or [tʃ] phoneme. No other initial palatal sound is predicted. (Clearly, these results must relate to the word's Latin etymology and to the initial sounds DJ, GJ, GE, and I, which define an earlier phase space).

3.2 Attractors

An attractor is a model of self-reinforcement that leads to the evolution of a system over a certain period of time and gives rise to its resulting organization. An attractor is the region of a system's *state space* (*phase space*) towards which the system tends to move (Larsen-Freeman & Cameron 2008: 50)

Researchers have demonstrated the tendency of dynamic complex systems to reach an ordered state without any pressure of selection. They argue that evolution is not only the result of random mutations followed by natural selection, but that it also involves a combination of natural selection and spontaneous order. Models of self-reinforcement (known as attractors; Shepherd 1993:134) are formed only if enough diversity exists in a system. By contrast with the language of hierarchy, which speaks of domination and control, the language of the theory of chaos speaks of organization created by attractors. In linguistics, this term could be applied to sociolinguistics (in which case, we would speak of dynamic attractors), contact between languages, the relations of dialects to a standard language, language ideologies and so forth. In historical linguistics, the term could be applied to languages of origin, while in the linguistics of variation, it could be applied to the most frequent or most productive models (which have traditionally been called analogies).

According to Larsen-Freeman & Cameron (2008: 56) there are three types of attractors:

1. Fixed point attractors are the simplest type of attractors. They represent a system that moves toward an already preferred stable state and stays there.

2. Limit cycle or torus cycle attractors represent a system that moves periodically between different attractor states.

3. Strange and chaotic attractors are regions of state space in which behaviour becomes wild and unstable. The theory of chaos is the study of systems that move by means of chaotic attractors. The theory of complexity is the study of chaotic situations (incorporating the theory of chaos) and also non-chaotic situations.

3.3 On the Edge of Chaos

Self-organization and emergence are alternative ways of referring to the source of phase changes in the behaviour of complex systems. Self-organization sometimes leads to new phenomena at different levels or scales, a process known as emergence.

Emergence: New properties that appear as a product of interactions in a complex system. In other words, emergence is the appearance in a complex system of a new state at a higher level of organization than the previous state. The emergent behaviour has a "completeness" (integrity) that is recognizable.

Self-organization: Property that explains why a complex system emerges and varies until it becomes strongly stabilized by what we call an *attractor*. This is successfully achieved by virtue of a series of positive and negative feedbacks that inhibit any modification caused by the exterior. To a certain extent, the system could be said to react against external *aggressions*. This ability is maintained only through a constant supply of energy. Another name of this property is *autopoiesis*.

3.4 Co-adaptation

Co-adaptation of two or more systems involves the interaction of two or more complex systems which each change in response to the other(s). Contextual factors are not external to the system but form part of it. Language develops in a context and its use in context shapes linguistic resources. Language is applied in a context as the context selects the linguistic action that must be activated. Language is adapted according to the context as the experience of past language use is fitted to the here and now.

4 Characteristics of the Language System as a CAS (Complex Adaptive System)

Language, regarded as a CAS of dynamic use and acquired experience, has the following key features (Beckner et al. 2009:14-18):

a. The system consists of multiple agents (speakers in a speaking community) who interact among themselves.

b. The system is adaptive, the behaviour of the speakers is based on past interactions, and past and present interactions together feed into future behaviour.

c. The behaviour of a speaker is the consequence of competing factors, ranging from the mechanics of human perception to social motivations.

d. Language structures emerge from interrelated models of experience, social interaction and cognitive processes.

The advantage of seeing language as a CAS is that it enables us to provide a unified vision of apparently unrelated linguistic phenomena, ranging from variation at all levels of language organization, the probabilistic nature of language behaviour and constant change among agents and through communities of speakers, to the emergence of grammatical regularities out of the interaction of agents using a language and the stage-like transitions (of organization) arising from underlying non-linear processes. The CAS approach uncovers aspects shared across many areas of linguistics research, cognitive linguistics, sociolinguistics, first and second-language acquisition, psycholinguistics, historical linguistics and evolutionary linguistics. The approach opens up new avenues for research, drawing on evidence converging from multiple methods, including corpus analysis, comparisons among languages, anthropological studies and the history of grammaticalization, experiments in psychology and the neurosciences, and computational modelling.

The principal characteristics of language as a CAS are consistent with studies in language change, language use, language acquisition and language modelling of these aspects.

4.1 Distributed Control and Collective Emergence

An idiolect emerges from the language use of an individual through social interaction with other individuals in a shared language, from which a shared language emerges as a result of the interaction of idiolects. Distinction and connection between these two levels is a common feature in a CAS. Models at the collective level (e.g., economies and flocks of birds in flight) cannot be attributed to an overall coordination among individuals. The current process of language change is complicated and interwoven with many other factors. Computer modelling makes it possible to look inside the emerging dynamic (Christiansen & Chater 2008).

4.2 Intrinsic Diversity

Each idiolect is the product of the individual's unique exposure and experiences of language use (Bybee 2006). Universals emerge from the interactions of representations at the lowest level (e.g., the interactions described in grammars based in constructions) and general cognitive abilities (e.g., sociability, imitation, the deriving of models) that form the basis of language universals.

4.3 Perpetual Dynamics

Shared language and ideology are always changing and reorganizing. Languages are in a state of constant flux. At the individual level, each instance of language use changes the internal organization of an idiolect. Like other complex adaptive systems, it has a nature that is fundamentally far from equilibrium.

4.4 Adaptation through Factors of Amplification and Competition

Complex adaptive systems generally consist of multiple interacting elements that can amplify or compete with the effects of one another. Language can change in the give-and-take of conflicting interests among speakers and listeners. Speakers prefer economical production, which encourages brevity and phonological reduction, while listeners want perceptual prominence, explicitness and clarity, which require elaboration.

Language can evolve to share information and social coordination altruistically or to compete for importance and status among coalitions.

4.5 Non-linearity and Phase Transitions

In complex systems, small quantitative differences in some parameters often lead to phase transitions (i.e. qualitative differences). Gell-Mann (2005) notes that multiple small phenotypic differences between human beings and other primates (e.g., degree of sociability, shared attention, memory, control of the vocal tract) can in combination result in profound consequences, enabling means of communication that are totally different in nature. Also, even when there is no change in the parameters, the behaviour of a constantly dynamic system can undergo dramatic change at a certain point, moving toward a phase transition. The S-curve dynamic of language change is a kind of phase transition. Another example of such phase transitions may well be grammaticalization as a result of language use in which lexical items become grammatical items.

4.6 Sensitive Dependence on Network Structure

Real-world networks are not random. The internal structure and connectivity of a system can have a profound impact on the dynamics of the system. Language interactions do not occur through random contacts but are constrained by social networks.

5 Language Change

5.1 Complexity and Change

Complex systems are always changing. They can change slowly or radically.

When complex systems occur at or near attractors, they show stability and variability.

Complex systems can show self-organization by means of phase changes that produce emergent behaviour or phenomena at a higher level of organization.

Two or more complex systems can change in response to one another, in a process of co-adaptation.

Complexity emerges in systems by means of incremental changes that do not originate in a deliberate movement toward an objective.

In the context of complex systems, language is seen as an extension of numerous domain-general cognitive abilities such as: shared attention, imitation, sequential learning, fragmentation and categorization. Language emerges from continuous human social interaction and the structure is fundamentally shaped by existing cognitive abilities, by processing idiosyncrasies and limitations/abilities and by the network of circuitry in the human brain.

5.2 Language Change and Variation

Processes of language change operate to make languages easier to learn and more effective in communication. However, these changes do not operate through design processes or deliberate adoption on the part of speakers. In line with Darwin, the origin of adaptive complexity in language is analogous to the origin of adaptive complexity in biology (Christiansen & Chater 2008: 505).

According to this view, the adaptive complexity of language resembles that of biology in that it emerges from random language variation "sifted" by selection pressures that concern learning and processing.

Sometimes there are deliberate innovations, but they must be distinguished from the unconscious operation that occurs in basic learning and in the mental processing tendencies that have given rise to certain phonological, syntactical and semantic regularities.

When a system or one of its parts changes from one relatively stable attractor state to another in a process of phase transition, the transition point may be marked by increasing *variability* of behaviour (see subsection 3.2 of this chapter). When passing through a phase transition, systems engage in self-organization and the organization that emerges may be new and qualitatively different from the various prior organizations of the systems or their parts (see subsection 3.3 of this chapter). The natural state of a language system can be defined as a dynamic adaptation to a specific context.

In addition, when human beings adapt their language resources to new contexts, they change a language. A language system and its use are, therefore, mutually constitutive.

Human language has been shaped by selection pressures from thousands of generations of language users and learners. Pressures from an increase in use or pressures that minimize memory load, such as regularity and brevity, can favour language variants that are easier to learn, understand and use or language variants that are more economical, more expressive and generally more effective in communication and persuasion, as well as language variants that may indicate status or social group.

5.3 Parallels between Biological and Language Systems

The idiolect of an individual speaker is analogous to an individual organism; a language resembles a species. A language *genotype*[1] corresponds to a neural representation of an idiolect invoked and insisted on by a series of mental "constructions" that are analogous here to genes and give rise to language behaviour – the language *phenotype*[2] – characterized by a set of statements and interpretations (Christiansen & Chater 2008: 499).

Language is shaped by cognitive abilities such as categorization, sequential processing and planning. Language is used in human social interactions, and its origins, specific productions and abilities depend on the role that it plays in our social life. To understand the evolution of language and its observable properties today, we need to look at the combined effects of many limitations/many abilities, such as the structure of thought processes, the constraints/abilities of perception and motor skills, cognitive limitations/abilities and sociopragmatic factors[3].

As a historical parallel, Pinker & Bloom 1990: 709 (cited by Christiansen & Chater 2008: 498) indicate that natural selection is the only scientific explanation of adaptive complexity. Adaptive complexity describes a system composed of many interacting parts in which the details of structure and the organization of parts suggests the existence of a design intended to satisfy some function.

While qualifying Pinker and Bloom's statement with regard to the functional aspects of language, Christiansen and Chater put forward the view that biological adaptations may have produced improvements in the cognitive systems that support language (increased capacity of memory, ability to learn words, skill at hierarchically complex sequential learning), but they see this adaptation in terms more of enhancing cognitive abilities than of improving language.

6 Language Evolution and Language Change

Grammaticalization processes appear gradually and follow historical models, suggesting that systematic selection processes operate on language change.

Understanding the cognitive and communicative foundations of the direction of grammaticalization and related processes is a challenge for linguistics. However, at the same time, the suggestion that this type of observable, historical change may turn out to be on a continuum with language evolution opens up the possibility that research into the origins of language could cease to be an isolated area or speculative theory.

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[1] The **genotype** of a human being is the **total of all factors** (visible and invisible characteristics of the organism) that comprise the **genetic makeup** of the individual.

[2] The **phenotype** of a human being is the composite of his or her observable **physical characteristics** that make it impossible to mistake one human being with another, that is, the visible traits (that physically reveal our genetic information).

[3] The slash in the middle of *limitations/abilities* indicates that there is no dichotomy here. The reach of one word's meaning cannot be grasped without the other.

7 Language and Thought: Grammar

The structure of a given language has an influence on how its speakers think and conceptualize (Slobin 1996). Language does not determine thought (Sapir-Whorf hypothesis), but our thoughts are influenced by the filter effects of language.

The form taken by language is certainly affected by the limitations/abilities (see footnote 5) of human cognitive processing.

It is not difficult to assume that human cognition marks the structure of language. Examples to confirm this assumption (Larsen-Freeman & Cameron 2008: 93) include the fact that central syntactic additions are less frequent than initial or final ones; the suffixation of morphological affixes is much more common than adding prefixes or infixes, probably because the lexical support requires processing before the information derived from the attached affixes becomes usable. Similarly, expressions begin with a subject to provide a starting point for the message. We could also categorize other examples as cognitive phenomena: assigning certain causal constituents the status of old and new information, categorizing experience, developing prototypes, using conceptual schema, metaphors and analogies.

The linguists in the Five Graces group (Beckner et al. 2009: 5-9) view grammar as a network constructed of categorized instances of language use. Evidence from various sources shows that changes occur in response to use and that these changes contribute to the shape of grammar.

Three phenomena can be observed:

1. Speakers do not choose randomly between all the possible combinatorial possibilities when they produce sequences: there are conventional ways to express certain ideas. Communication involves a wide range of prefabricated sequences.

2. Articulatory models of speech indicate that when words co-occur in speech they are gradually perceived as chunks.

3. With respect to historical changes, the regularity of joint use is what determines joint use: "Items that are used together fuse together" (Bybee 2002).

This detailed knowledge of the interactions of grammar and lexis in use, which includes knowledge of which words commonly go together in which constructions, leads to a tightly interwoven conception of lexis and grammar (see subsection 3.1 of this chapter). The cognitive representations underlying language use are constructed through the categorization of expressions in examples and groups of examples based on their language form, their meanings and the context in which they have been experienced. (Notice the parallel between these cognitive representations taken into account in linguistics and the cognitive representations that must be taken into account in the psychological characterization of individuals and in learning processes.)

Corpus-based studies of synchrony or diachrony, experimental studies and modelling studies are found to produce valid data for our understanding of the cognitive representation of language.

Given that grammaticalization can be detected in all languages in all periods, we may go beyond language use and reasonably assume that the original source of grammar in human language lay precisely in this process: as soon as humans could collocate and produce two words together, the potential existed for the design of grammar, with no mechanisms needed beyond sequential processing, categorization, conventionalization and the production of inferences (Heine & Kuteva 2007).

8 Culture

Culture can be (at least partly) understood as a reflection of what human beings find interesting and important, while at the same time reflecting a complex interplay of biologically evolved tendencies. More specifically, language and culture are emergent phenomena of an increasingly complex social existence.

What we have in common as humans is a biological tradition that began with the origin of life and persists through the present day in the diverse histories of human beings. Maturana and Varela (1987: 206-210) note that our diverse linguistic heritage gives rise to all the differences in the cultural worlds in which we, as people, can live and that, within biological limits, these worlds can be as diverse as we want. All human knowledge belongs to one of these worlds and it is always experienced within a cultural tradition.

I am assisted in this reflection by the definition of culture offered by Sigmund Freud (1999). According to Freud, culture encompasses the set of productions and institutions that distance our life from the life of our animal ancestors. These productions serve two aims: 1) to protect humans against nature (forging survival tools) and 2) to regulate relations among humans. In short, culture also appears to have an adaptive function. We recall that the dynamic of adaptation (Morin 1983: 69) does not occur at the level of an individual or a species conceived in isolation within a rigid and unchanging environment. Rather, it occurs in a complex interplay of integration and self-organization within an eco-organization.

In the case of the first aim, we have already seen that human beings can be addressed as organisms without ceasing to consider each human being as an agent and without denying the essential creativity of social life. This creativity, amplified by the function of awareness, is no more than a specific aspect of the ability of organisms to take action to some extent as originators of their own development. However, men and women are organisms and organisms generally make themselves, creating a history of life (Goodwin 1998).

In this respect, if any organism is the product of the integration of life processes and historical processes, then the same thing also occurs to human beings and cultural processes. As for constructing a planetary culture, living together in a space – geographic, virtual or of any other kind – is not a question of crudely adding up the contributions of everyone. Nor is it a matter of each subgroup jealously guarding what is its own, a response that would involve ceasing to integrate what we have and the environment we live in. Such an attitude, which runs contrary to the attitude found in living organisms, would certainly be unfavourable to survival. What the construction of a planetary culture involves is

the elaboration, by means of communication, of an emergent new cultural complex. Integration is not dilution, but rather articulated incorporation.

In the case of the second aim, regulating the relations of human beings, these relations are clearly established through communication.

The human trait arising from self-awareness that most distinguishes us from the higher primates is our ability to approach and get to know other humans, to put ourselves in their shoes; in other words, a capacity for *empathy* and symbolic communication with other human beings (emotion and *language*), even with objects and other animals. Another human trait is the ability to analyze the world in motion, take part in it and transform it, and see ourselves as a part of that world (science and *culture*) (Mora 2001).

Communication between one individual and another is the foundation from which any cultural edifice rises. Human beings are the most cultural animals. Dominance is assured by our enormous development of language, which far surpasses the language of other animals and which enables us to achieve the best possible communication in the natural world to date.

It goes without saying that we could improve communication by better understanding the language and culture of people with whom we coexist (by adopting an empathetic attitude to these people).

As a result, when we speak of culture in a specific territory, we speak of culture in the language specific to that territory. All other co-existing cultures will take part in producing the emergent culture, but the language of the territory is the mode of expression that permits the ecological preservation of human diversity.

In my view, therefore, a *culture* goes on growing as a result of contact between human beings, who may be of different origins and who, in a given environment and as a consequence of coexistence, produce an emergent cognitive and social phenomenon with its own characteristics out of the harmonious confluence/cohesion of those realities in contact.

The nature of language comes out of its role in social interaction.

Joint actions depend on what may broadly be called shared cognition.

For shared cooperative activity, several mental attitudes are necessary, including a structure of subplans for joint action, a commitment to help others and a shared belief in everything that comes before.

Language operates on four levels:

1. Producing and listening to statements.
2. Formulating and identifying propositions.
3. Indicating and acknowledging communicative intent.
4. Proposing and taking joint action.

This complex model is fragile as anyone who has been misunderstood knows. The fundamental reason for this fragility is that we cannot read the minds of others.

Conventions are not hermetic. A speaker chooses words and constructions (language conventions) to communicate in a given situation, basing such choices on the previous use of these conventions in similar situations. The listener acts in the same way, but with a knowledge of prior uses of conventions that is not the same as the speaker's knowledge. For this reason, we can speak of the

indeterminacy of communication, which has as a product the presence everywhere of language change.

Such indeterminacy has positive and negative aspects. Among the positive aspects is the phenomenon of resonance that any language production produces in the receiver and that creates new concepts and new knowledge through its effects. Indeterminacy also encourages creativity.

As for the negative aspects, we are all aware of the difficulty of fluid communication, erroneous interpretations and misunderstandings, but also of the synergies that lead us to speak of the miracle of communication when they occur.

9 From Genes to Culture

The human species has succeeded in transmitting a comfortable world by virtue of our ability to extend what was previously only transmissible through genes by means, now, of our accumulated experience, i.e. through culture. The final ironic result of our extragenetic intelligence is precisely the subsequent conservation of our genes (Margulis & Sagan 1997: 263). Practically all human behaviour is transmitted through culture. At the same time, biology has an important effect on the origin of culture and its transmission (Margulis & Sagan 1997: 185).

From the various advantageous positions of biology, psychology and anthropology, a process has been conceived and named co-evolution between genes and culture. This hypothesis observes, on the one hand, that the human lineage has added the parallel route of cultural evolution to genetic evolution and, on the other hand, that the two forms of evolution are related (Wilson 1999: 187).

Genes prescribe epigenetic rules or norms (concerning the development of an organism under the joint influence of inheritance and the environment). These rules or norms are the neural pathways and regularities in cognitive development by which the individual mind takes shape. The mind grows throughout the entirety of life by absorbing those parts of the existing culture that are available to it, according to the guided selection of epigenetic rules inherited by the individual brain.

Epigenetic rules are innate operations of the sensory system and the brain. Moved by emotion, epigenetic rules direct the individual toward more rapid, more precise responses that are more likely to ensure survival and reproduction (Wilson 1999: 284). Accordingly, I think that we could speak of language and language behaviour as an epigenetic ability.

Culture is created by the common mind and each mind at the same time. It is a product of the genetically structured human brain. Genes and culture are bound together in a flexible union that follows complex paths. According to Wilson (1999: 320), co-evolution between genes and culture is the underlying process by which the brain evolves and the arts are created.

“The brain constantly searches for meaning, for connections between objects and qualities that cross-cut the senses and provide information on external existence. We penetrate that world through the constraining portals of the epigenetic rules. As shown in the elementary cases of paralanguage and colour vocabulary, culture has risen from the genes and forever bears their stamp.

With the invention of metaphor and new meaning, it has at the same time acquired a life of its own. In order to grasp the human condition, both the genes and culture must be understood, not separately in the traditional manner of science and the humanities, but together, in recognition of the realities of human evolution" (Wilson 1999: 241).

10 Brain and Culture

Human cognitive competences and activities need a cognitive apparatus, the brain, which is a biological, physical, chemical machine. The brain requires the biological existence of an individual. Human cognitive skills can only be developed within a culture that has produced, preserved and transmitted a language and – together with that language – a logic, knowledge and criteria of truth.

Knowledge has anthroponymic universals, produced because every member of the human species has a sensory apparatus, brain, system of representation, brain/spirit relationship, use of doubly articulated language, the ability to create a symbolic, mythological and magical knowledge – and awareness.

Bruner's thesis (1997) is that culture shapes the mind, it provides us with the toolkit by which we construct not only our worlds but our very conception of ourselves and our powers. Language appears to be a form of the human mind's cultural adaptation.

In addition to the collective dimension that is embodied in a society and culture shared with other people and that gains coherence through dialogue (enabling communication or at least a type of communication), human beings also move in a cosmic dimension. This cosmic dimension is the sphere in which humans are immersed in nature, the cosmology of science and religion. Since prehistory, humanity has always taken this dimension into account, experiencing the transcendence of nature beyond the individual and society. When animism flourished, people felt that everything was animated by a spirit in which everyone participated. As people moved away from nature (to farming communities and to cities), they began to feel the need of a cosmic dimension. Art had to fulfil the function of establishing some type of cosmic connection. Religion and philosophy did as well (Massip 2006: 22-23).

In modern society, science attempts to link us to the cosmos to some extent, but the attempt is limited. Many people do not have a sound understanding of science. We are in a process in which a great number of people wish to re-establish this dimension.

11 Theories and Time

11.1 Linguistic Theories and Complexity

The *integrational* linguistics of Harris views linguistic signs not as autonomous objects of any kind, either social or psychological, but rather as contextualized

products of the integration of the various activities of individuals in specific communication situations. In the same vein (Toolan 1996), integrationism declines to accept that text and context, language and world, are different and stable categories.

The *sociocultural* theory (Vigostky, commented by Lantolf 2006) shares with complexity the idea that learning and language can emerge from the interactions of individuals.

Depending on the object of study, we can also distinguish the diversity of theories among linguists: some aim to explain *I-Lang* or the internalized system of language – a component of the mind/brain – taken as the primary object of interest in studies of evolution and the function of the faculty of language. *Applied* linguistics, on the other hand, is concerned with what Chomsky calls *E-Lang*, externalized language or language behaviour contextualized and updated in the social process (Widdowson 2003), which must deal with culturally specific systems of communication and how they change (Larsen-Freeman & Cameron 2008: 18-19).

11.2 Reducing Complexity

Linguists have reduced complexity in three ways (Larsen-Freeman & Cameron 2008: 91):

1. Segregating the systematic part from the undisciplined part. Chomsky and Saussure concur that the object of research must be homogeneous.

2. In addition to removing language from the context of use, linguists have been selective in the data they have chosen. In pursuit of interests in *langue/competence*, their data have come from intuitions about grammaticality and from judgments regarding which created phrases are grammatical and which are not. By doing so, they have segregated the morphosyntactic or grammatical subsystem from the subsystems of phonology, semantics and pragmatics.

3. A third way to reduce complexity has been to leave out the dimension of *time*.

From this picture, we can see that three elements are needed for any linguistics that aspires to take complexity into account:

1. We cannot leave out the non-systematic part of language. For example, if a given hypothesis does not fit when it is applied to certain varieties or when we observe certain variants, the observed data must be taken into consideration and the hypothesis modified to the extent needed to account for the data.

2. Language must always be studied within the frame of its context of use because, as we saw in 2.4, the context is not separate from the system, but is a part of the system and of its complexity.

3. Time is always a concurrent dimension and must be taken into account when making interpretations.

From the perspective of complexity, models of language use are dynamic and their use is probabilistic. These models can be found at each level of language.

In order to conserve our cognitive sources, the most commonly used models become conventionalized (Hopper 1988). However, even these conventionalized models have the power to change, particularly when they show *variation*, the harbinger of a coming change (Larsen-Freeman & Cameron 2008: 79-80) (see subsection 5.2 of this chapter).

Dynamic models of language use enable us to capture the *stability* and *variability* of language. From the theoretical perspective of complexity, a language at any point in time is how it is because of the way in which it has been used. We could say that any use of language changes language in some way.

When a word is used to express meaning, it can take on new meanings inferred from the setting in which it has been used (Bybee 2006), including the meaning that others give to it.

Models in language are, therefore, epiphenomena of interaction: they are emergent stabilities (Hopper 1988). Regarded together, they comprise what we could call, in terms of complexity, "an attraction basin in a dynamic system".

As language models are capable of adaptations by members of the speech community, some become more privileged than others and they persist or at least change at a slower rate than the others.

Even though a language is open to all kinds of influences and it undergoes change, it maintains an identity, as do other autopoietic systems, such as the human body, in which cells are created and shed while the person, in his or her outward appearance, remains the same.

12 Epistemological Conclusions

12.1 Brain Activity and Epistemology

The brain generates activity, thought and language that reflect the properties of the complex adaptive system that is the brain itself. As a result, we believe it is logical to take account of brain function when positing our way of conducting science and proposing a dialogue between reflective knowledge (the philosophical dimension), empirical knowledge (the scientific dimension) and knowledge of the value of knowledge (the epistemological dimension) in order to build a continuous feedback loop drawing on knowledge and reflections, on knowledge of knowledge (Morin 1995: 219).

An epistemology (and I use the word here as an umbrella term for all three kinds of knowledge) that takes account of how we function mentally will enable us to devise more closely suitable approaches to our objects of study, because we can only get closer to them from our minds.

It is illustrative to recall the functions of the brain's hemispheres. Neuroscience has gradually defined and labelled the predominant functions of each hemisphere. Selecting a number of characteristics, for example, the *left* hemisphere is verbal, sequential, digital, analytic, deductive and objective, while the *right* hemisphere is non-verbal, simultaneous, analogic, synthetic, inductive and subjective. Dominance is simply the apparently active translation of one side, but the role that must be attributed to the opposite side is equally important. It is merely less

demonstrative; it operates in the shadow. Its engagement and mechanism depend on the analyses sparked by the information received by the dominant side. Its integral response gives rise to the organization of the practic execution that can seem, at times, to emerge solely out of the decisions taken by the dominant side. Tomatis proposes calling the dominant side *executive* and the other side *integrative*. (Conducting science also requires this dual approach.) If brain function serves as an epistemological metaphor or model, it is clear that linguistics does as well. In this way, we need to bear in mind that linguistics cannot be done well if there are only two approaches: analytic (more typical of the left brain) and integrative (the right conceives situations and strategies of thought in a total manner). Rather, linguistics needs to integrate various kinds of information (sound, image, smell, sensation) and transmit them as a whole.

Through interpretation of the dialogue that keeps the two hemispheres of our brains in perpetual relational arousal is, without doubt, how we will one day uncover the mechanisms of our transcendant human speciation (Tomatis 1969: 164-166).

The views of Edelman (2002: 250) come into play here as well. Even though the need to "naturalize" epistemology and root it in psychology has already been raised, we suggest that this is not sufficient. Being mindful of how information and awareness appear in nature, we need to go farther and argue that epistemology needs to be rooted in biology and particularly in the neurosciences.

12.2 Neuronal Connections

Another model of how complex adaptive systems work that may serve as a useful metaphor for epistemological reflections is the model of *neuronal connections*. Mora (2001:15) speaks of the neuronal triad: some neurons process environmental information, while others send orders to muscle cells; interneurons have the ability to integrate and process information and reflect on the most suitable response. As a result of applying these epistemological consequences to linguistics, I propose an integrative linguistics that would give equal priority to processes *and* events, to relations *and* entities, to developments *and* structures (Massip 2005).

The proposed linguistics would take account of the dimension of time as a vector inherent in language and indissolubly tied to description – a vector that is, after all, inevitable in dynamic systems. On the one hand, time is associated with complexity. On the other hand, irreversibility and evolution call for a comprehensive viewpoint. Any state results from an evolution oriented in time and its definition has to preserve this orientation (Prigogine & Stengers 1997: 24). Also, the proposed linguistics would put an emphasis on research, not only the study of the material figures of things, but also the study of their dynamics. It would bring together and integrate different theoretical models of the language system with models of social systems, where the reality of language is enacted.

At the outset, we saw that the sum of the partial studies of a complex, non-linear system could not account for the behaviour of the whole. That is valid, too, when we speak of science, when we do the work of synthesis. In my view, when we do the work of synthesis, an overall structure emerges and this structure, in

turn, has an impact on the analysis. We could call this outcome integration or a holistic vision. The emergent structure is new information, created out of the links, out of the relationships. The French sociologist and anthropologist Edgar Morin admonishes determinism for "hiding the risk, hiding what is new". Morin suggests that a dubious notion underlies the reduction of the knowledge of a whole to the knowledge of its parts: that somehow the organization of a whole does not produce any new quality in relation to the parts considered in isolation (Morin 1977:128,136). By contrast, Morin integrates "recapitulatory intuition" within the field of complexity. To knowledge that separates, he is convinced (Spire 2000: 91) that we urgently need to add knowledge that brings together (Morin 1996:10).

13 Conclusions

Cognition, awareness, experience, embodiment, the brain, the self, human interaction, society, culture and history are inextricably bound together with language in ways that are enriching, complex and dynamic. Language models are emergent. Synchronic models of language organization exist at several levels, from phonology, lexis, syntax and semantics to pragmatics, discourse and genre. And this is to say nothing of dynamic models of use and diachronic models of language change.

The theory of complexity gives us an approximation for understanding systems undergoing change. Putting time and change back into our systems, we can find new ways to understand the processes of using and learning language.

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5 An Experientially-Based Informationless Communication

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Abstract. In this chapter I present an outline of my approach to communication and information, which is based on a previous cognitive model (Vilarroya 2002). According to this approach, the cognitive system parses its experiences in units. Units of experience are spatio-temporal units with boundaries, normally integrated by coherent sequences of events spatially, causally or thematically related. In this framework, the meaning of a word corresponds to the network of units of experience in which the word is grounded. Accordingly, the reference of a word is an experience, and words should be understood as evocative, not symbolic. Hence, communication cannot be based on the transmission of a "thing", but on the completion of an "act": the evocation of the right network of experiences.

Preamble

I was in the orchestra pit of an empty theater. The musicians were wearing their everyday clothes, and the director seemed very upset: "No, no, and no. You don't see what it means, you don't get what this passage is all about! You have to approach it as if you had just found your first love, many years after having lost it. Your love is still intact, and you can see it in each other's eyes, in your expression, and you feel an explosion of jubilation in your stomachs. You are drunk with happiness, like a pirate before a treasure chest, like a child on Christmas morning. All that accumulated energy explodes like a volcano! But, and this is very important, you mustn't mistreat the treasure, because it is very fragile. It is like a kitten that is drowning in a river and is trying to climb onto a piece of driftwood. And you are the driftwood."

1 Introduction

I had never thought that communication could employ such tortuous ways as the scene in the Preamble depicts. Why could the director not be forthright and tell the musicians simply what to do? Why had he dressed his orders in so sophisticated

analogies? Are there no words in which to put the information he wanted to transmit? May be not.

Communication is understood to be the transfer of ideas, concepts, thoughts, by one individual to another through the use of substitutes for these ideas – words, gestures, etc. – that transport the meaning, or information. According to this general idea, communication is an activity that is established between an emitter – an agent that wants to transmit a message – and a recipient – the agent that receives it. This activity consists of the transmission of a message that is represented by a code, usually a type of language, like Morse Code, which is transmitted by way of a signal, the physical substrate in which the code is transmitted – like the electric impulses in telephone transmission by cable – through a channel, the system that transmits the signal. In short, the emitter transmits a message to the recipient if the emitter encodes the message, converts it into a signal, if the signal reaches the recipient, and if the recipient manages to decode the message. To use a very graphic image, verbal communication consists of something like wrapping up a certain thought *content* in words and sending it to the recipient, who has to unwrap the message.

But, what's that content, the "object" of communication, or what is to be transmitted, at all in an act of communication? The fact of the matter is that humans have been asking themselves for centuries what it is that they transmit in a communicative act. They have considered meanings, propositions, thoughts, ideas, beliefs, attitudes, emotions and many other things. Let us focus on the hypothesis that information is the "contents" of communication. But what's information? There is no agreed definition of information. In general, human approaches to the concept of information with a view to its possible definition tend to follow the path of describing it as "things" that are received by an individual and that have some kind of interest for the recipient. Etymologically the term information is a noun formed from the verb "to inform" that was borrowed from the Latin "informare." While the original Latin word means "to give shape, model," the word "to inform" has come to be used in a figurative sense, in the sense of "sending a message." However, the concept of information still has not been made explicit. There are authors who describe information as "news or facts about something," and some dictionaries describe it as "knowledge, communicated or received, that refers to a particular fact or specific circumstance." Others have come up with a more amusing definition, like "Information = knowledge - human body." In general, however, information is assimilated with the concept of meaning or sense, the concept of knowledge that is transmitted from one organism to another. That is, I do not know Chinese, so if a Chinese person says something to me in the street in Chinese, I most likely won't understand what is being said, and therefore we cannot say that an informative act has taken place. Only when we understand the message can we say that we have received information. Of course, there are others who say that is not necessary. One thing is information, which can be in any message, and another thing is its interpretation or revelation. Whether there is a paleontologist nearby or not, a dinosaur imprint contains information about the dinosaur that produced it. In any event, information is considered to be "something" that has causal power, that is true or false, that can be measured, that

consists of something about something, and can answer the following question: what is this message about? This excludes those messages that are chance events, like the fact that rain drops falling on a porch cannot be understood as a message in Morse code, although some falling rain drops can be interpreted as "It's raining." From here then it appears the vision of communication based on the property attributed to language, to words, of containing a piece of information: the meaning of a sign is the information that the sign represents.

However, the idea of wrapping up contents and transmissions can only be used as a metaphor. Messages are not passed along like giving money to a cashier. Messages, if they exist, remain in the brain of whoever emits them. The person sending the message does not load the message into a code, nor does the person receiving the signal unload the message from the signal. In this sense, some authors have abandoned the analogy of a message "containing" information. Sperber and Wilson's view of communication, for example, states that communication consists of managing to reach a "place," which generally is a thought, through a process of inferences and analysis of the words that have reached the recipient. More specifically, while the first perspective consists of the transport of ideas, in the second model communication is understood to be a process of analysis of signs. According to this approach, an individual modifies the physical surroundings of his or her interlocutor in such a way that the person can construct or infer the mental representation that the emitter wanted to transmit. Oral communication, for example, would be the modification by the speaker of the acoustic surroundings of the listener, and as a result the listener will have to analyze the signal so that, at best, thoughts similar to those of the speaker will be activated. Therefore, the idea is that an individual communicates in order to reach the objective of making the other person recognize something, instead of seeing communication as the transmission of a message from one individual to another. This means that what is relevant is the influence on others, getting them to understand, through signs, that which is being transmitted, with the hope that the influence will be enough to fulfill its purpose. Consequently, words are not containers of meanings used for the transport from one person to another, but are rather the medium used to make the interlocutor recognize what one wants to transmit, the keys with which the recipient will be able to reach the same place as the emitter. In fact, the function of the words in this model is to indicate, in a more or less distinctive way, the type of analysis that is required for the recipient to reach the desired thought. And the analysis by the recipient consists of using certain premises of reference to make a series of inferences based on the words uttered by the emitter, and then following the steps that logically extend from the premises.

However, my stance on communication does not fit this approach either. Understanding a message doesn't mean carrying out a process of inference based on symbols, using presuppositions about what the interlocutor knows or doesn't know. Although Sperber and Wilson's model is closer to my model, it doesn't fully comply with my view on human communication. Specifically, we cannot describe, in the context of an act of communication, the human recipient as performing analytical and inferential work on the words, since the action of the words is determined beforehand, and cannot be modified. When words reach the cognitive

system they spontaneously and unconsciously activate their meanings. Furthermore, human words do not carry with them the keys for such an analysis, nor does the interpretation of an human discourse start from a set of premises of reference, since humans don't have data in their heads. When a girl says to her brother "The best thing would be for Dad to stop working," the two of them are not using premises such as "Dad works too much" or "Dad is sick" or "It's not worth it for Dad to keep working" because their cognitive systems do not record these sentences as data.

2 An Experientially-Based Communication

My stance on communication is based on a cognitive model which was developed elsewhere (Vilarroya, O. *The Dissolution of Mind*. Rodopi 2002). I have not the space here to develop the theory. I would try nevertheless to present the basics in order to address my view of communication.

The cognitive architecture I defend is experientially-based. According to this approach, the cognitive system parses its experiences in units. Units of experiences are spatio-temporal units with boundaries, with beginnings and endings, even though what constitutes a boundary is not yet neurobiologically well established, but normally have to do with coherent sequences of events spatially, causally or thematically related, such as units of experiences related to activities, for example in children, of eating, playing, going to bed, going in a car, etc.

A unit of experience is *every* spatio-temporal unit which the cognitive system parses, and therefore I do not establish any pre-conceptual difference between types of experiences. In this sense, the cognitive system parses all of its experiences, and it does so to any sort situation in which the system is active, including all sort of perceptual, emotional, motivational or proprioceptive experiences. A unit of experience is thus an interconnected web of perceptual, emotional, cognitive activities placed in a spatio-temporal context. These activities are the product of innate capacities of the cognitive system plus the specific experiences of the individual. These innate capacities and experiences will allow, in due developmental time, that the child's cognitive system gives rise to the conceptual structure of adults.

This conceptual structure would consist of as the set of cognitive, emotional, motivational activities that complements what could be described as a sort of virtual world. The virtual world would be the world in which the individual could be said to be living, containing the elements, individuals, relations, etc. that would "comply" with his/her past experiences. Specifically, if we define:

> *Cognitive Homeostasis:* The state of equilibrium between a cognitive system and its environment.

We can derive the definition of virtual world:

> *Virtual World:* The world that maintains the homeostasis of the cognitive system.

In other words, the virtual world would be that world that maintains the stability of the cognitive traces, the world which would not surprise the individual, if that individual were to give it a thorough examination. Let us suppose that in an individual, Erik, his experiences had shaped the following:

> 'It only rains when there are clouds.'

The consequence of this is that in Erik's virtual world a kind of law exists that could be described as 'for it to rain there must be clouds.' This is a virtual law, in that Erik's cognitive system does not have it written down anywhere in his brain. It is as if this virtual world derived from Erik's experiences satisfied this law implicitly, like the real world satisfies it explicitly. In the same way, if in all of another subject, Katherine, experiences horses can't talk, nor do they have wings, we can say that in Katherine's virtual world 'horses can't talk.' It is not that she has a file in her head containing that information, it is that if Katherine comes across a horse that talks one day she will be surprised.

For each experience, nevertheless, a chunk of virtual world exists from which it is derived. This chunk of world can be defined as:

> *Virtual Perspective:* The part of the virtual world that maintains the homeostasis of a unit of experience.

When Katherine has an experience in which the contents consists of relating different past experiences under what human beings would describe as 'Katherine believes that unicorns live on the slopes of Montserrat,' a chunk of virtual world exists derived from this experience in which unicorns are living on the slopes of Montserrat. Therefore, to analyze this belief it is not necessary to derive all of Katherine's virtual world, just that part of it that maintains the homeostasis of that experience, or in other words, that part of the virtual world that is derived from that experience. In short, having an experience implies adopting a point of view in the virtual world, seeing this world in one way, noting aspects of all the experiential background.

If we apply this model to human language, then the idea of words having specific meanings which are transmitted in messages has to be forgotten, and we should substitute it with the model that words are not symbolic, but evocative. A word doesn't stand for an object, individual, property, or action, but functions as something that evokes a certain experience and the related perspective. As a result, the human language cannot be conceived as a code, in the sense that each word corresponds to a specific meaning that, through rules of combination, allows for the creation of sentences in which the parts are combined and give a new meaning. Moreover, human language doesn't correspond with a type of instrument through which, along with a logic apparatus, an individual can infer ideas, thoughts or more general conceptualizations. For this reason, human communication cannot be based on any of the models that have been developed so far.

In order to provide a hint of how an experientially-based communication model may look like, we can approach it with the basic structure of emitter, channel, and recipient. This basic structure is valid not only for face- to-face communication,

but also communication mediated by a technological artifact, communication deferred through a code, or when the communication is initiated without the intention of reaching a recipient. Now, based on this outline, an experientially-based communication has to be defined:

> *Communication:* The evocation in the recipient of an experience equivalent to that which the emitter wants to evoke.

In other words, genuine communication corresponds to the successful modification of another person's pool of experiences in such a way that an experience is evoked in the recipient that is equivalent to the emitter's. It's a communicative act if the two humans activate comparable experiences, and manage to evoke equivalent perspectives each in their own virtual world. If that is the case, the communication has been a success. In order to succeed in evoking a certain perspective, the emitter can use any type of mechanism that manages to alter the virtual world of the recipient.

What does the experiences being equivalent consist of? Two experiences are equivalent if the perspective derived from them is the same, if the virtual world that complements the experiences is the same. As we've said so far, humans live in what we've called a virtual world, the perspective being the part of the virtual world that maintains the homeostasis of a specific experience. Now, for two human individuals the process of communication consists of the manipulation of the virtual world of the recipient in such a way that the emitter evokes in the recipient a experience the homeostasis of which is maintained by the same virtual world, or to put it a better way, by the same set of possible virtual worlds.

Imagine that the virtual world was, for example, a nativity scene, with its little figurines, its baby Jesus, its Virgin Mary, its Joseph, its angels, shepherds, wise men, and the animals. Let's suppose that Katherine and Erik are looking at this nativity scene. Let's suppose that the two of them perceive the same contents. Suppose then that Katherine says to Erik "The angel told the shepherds about the birth of the baby Jesus." For this communicative act to be successful, Katherine will have had to manipulate the nativity scene that Erik is looking at in such a way that she gets Erik to see the angel talking to the shepherds, telling them something like "Christ is born." Taking this scenario to the extreme, we can see Katherine take hold of the angel and move it to where the shepherds are, and saying with the voice of the angel "Christ is born." There are many aspects of the perspective that don't have to be exactly the same in order to maintain the homeostasis. So, in this communicative act it is not crucial whether the angel said "Christ is born" or "Baby Jesus is born," or whether the angel looked 60 degrees to the right or 65 degrees, or if the angel flew at 10 miles an hour or 20. These details make up all of the possible worlds that maintain the homeostasis of that experience in each of the individuals.

What if the perspectives are not equivalent? Suppose that between Erik and Katherine there is a content of that nativity scene that they don't share; that is, the experience is not equivalent. Let's say that the nonequivalence is that to Katherine, the Virgin Mary is a virgin, but that to Erik, she is not. Say that Katherine tells Erik "She's called the Virgin Mary because she was a virgin; the baby Jesus

was conceived in an immaculate conception." Well, at that moment a discrepancy is produced, so the communication will not have been a success. However, the word "virginity" has activated a conceptual connection that existed in Erik' cognitive system, and that connection is transferred to the current experience, so that this content can be added, as if it were a coat of paint, to the Virgin Mary. Therefore, a manipulation of that experience has been objectified, the discrepancy disappears, and the perspectives that maintain the homeostasis of the experience are once again the same.

Should a successful communicative act imply exact past experiences or experience's contents? Let's look at a situation in which Katherine says to Erik "Cowards usually don't look people straight in the eyes." Here Katherine wants to evoke in Erik an experience in which we can see certain contents. For one thing we have "cowards." Imagine that the word "cowards" evokes in Erik a series of experiences gathered from situations in which, to simplify, the leader of the neighborhood gang called him or one of his friends a "coward." What happened in these experiences was that he or one of his friends refused to do certain thing that they had been dared to do: Erik was labeled a coward when he refused to confront the members of a rival gang, when he didn't jump off a ten–foot high fence, when he did not lie to his parents, etc. Well, these experiences that gave rise to a knowledge in which the set of memories of the attribution of "coward" connected by conceptual connections, make up what the word "cowards" evokes. Another thing is the expression "not to look people straight in the eyes" which provokes a peculiar situation in Erik. Simplifying, Erik recognizes the words but has never heard the complete construction. In this situation, what Erik's cognitive system does is to evoke a series of experiences based on the expression "look people straight in the eyes." This expression does not have a very intense conceptual connection; instead it evokes situations related to "looking" and "eyes," which correspond to the experiences in which Erik looked at the person who he was talking with. That is, it evokes experiences normally evoked by the expression "look at your interlocutor" for which he does have a conceptual connection. Finally, the particle "not" evokes the situation opposite to that of "look at your interlocutor." Consequently, the sentence "cowards don't look people straight in the eyes" evokes in Erik an experience in which the cognitive system tries to establish or reveal some connection between the "coward" experiences and those of "not looking at your interlocutor." But Erik has not detected the content "not looking at your interlocutor" in the "coward" experiences, so he cannot understand what Katherine is trying to say with that sentence, regardless of whether or not he accepts that such a perspective may exist. In a way, then, we could say that Erik can not understand Katherine because their virtual worlds are not equivalent. Suppose then that Katherine adds "Cowards don't look people straight in the eyes because that is where the strength of the individual resides." Once Erik has heard this, he has an experience in which the conceptual connections of "eyes" and "strength" are activated, the perspectives of which he does share with Katherine. In this new experience, Erik transfers the association between "strength" and "eyes" to the association between "look" and "cowardice," and he can finally understand what Katherine is saying.

Are there norms or conditions that constrain communications? Human communication is conditioned by the tacit agreements and the reference knowledge held in common by the two individuals involved in the communication. For example, it is assumed that the emitter will, unless there is evidence to the contrary, calculate the discourse according to several parameters: the person will tell the truth, evaluate the knowledge of his audience and adapt the discourse to it, etc. In general, these considerations are also valid in my model. Now, the difference is that in the case of my model, the conditioning factors are not data that must be kept in mind, and upon which the interlocutors agree, but rather that the two will place themselves in a similar experiential context; that is, in a context in which it is expected that people will tell the truth, or in a context that allows for irony, or a context of amusement, etc. The communicative act does not require the computation of data but rather the activation of the experiential context which is relevant to the communicative act. Of course, these contexts are activated thanks to certain experiences that anchor certain conventions of communication that condition the possible evocations. Among them, we can emphasize two conventions that are kept in mind in all communicative contexts and which allow us to clarify the presuppositions and implications that are kept in mind in a communicative act and what they correspond to:

> *Maxim of equivalence*: Communication takes place on the basis that the interlocutors can share the same perspective.

To communicate is to activate, to visit, the same virtual landscape as our interlocutor and see what the speaker wants us to see in that landscape. That is why any human who embarks on a communicative act has to assume that the success of the communication depends on the people looking at the same part of the virtual world. Therefore, this condition is concerned with what we could call commensurability of the virtual worlds, or the guarantee that the humans who are going to communicate have lived enough, or have had comparable enough experiences, so as to have available to them a compatible virtual world – the relevant one for the communicative act. This principle indicate a fundamental difference between my model and others. Individuals, once they have acquired linguistic competence, can understand any sentence containing words and combination rules with which they are familiar, but they need for one more condition to be fulfilled: the people involved must share an equivalent perspective. If they talk about soccer, about a certain team, then they have to have accumulated a set of experiences related to that particular sport, and about its place in the social fabric, the virtual worlds of which have the same contents. The more common the world that joins them, the easier it will be for two individuals to understand each other. This can occur, obviously, without necessarily having physical proximity. Two people who share an equivalent perspective can understand each other perfectly, despite their being a considerable distance apart. In consequence, when humans talk about something like the "concept of freedom," or even the "concept of society according to so and so," what is necessary is that they share equivalent perspectives. The second convention on which communication is based is the following:

> *Maxim of competence:* Communication takes place on the basis that the two interlocutors share the same communicative competence.

In other words, the interlocutors have to have learned to use the same tools in an effective and compatible way: language, body language, communicative conventions, etc. In short, the communicators assume from the outset that the virtual perspective can be the same, and that they know how to use communicative tools in the same way. This has the advantage of not requiring that complicated principles be put into effect, nor that costly assumptions be activated during the communication, nor laborious inferences be made and checked with the other person. In sum, the success of the communication depends on the ability of both people to use the tools, but above all to share the same experiential virtual world.

Can the communicative success be guaranteed? Communication is not an all or nothing affair, but rather a continuum that ranges from total incomprehension to an almost perfect sharing of the perspective. The degree of comprehension, or incomprehension depending on how you look at it, corresponds to the degree of differences between the virtual worlds of each individual, and of their ability to manipulate their pool of past experiences. In this sense, one can *never* have a complete guaranty that they understand each other. To communicate is to get the other person to have an experience similar to the one that he or she is having. Individuals would only be able to guarantee the success of the communication if they could enter the virtual world of the other person and see their perspective, but that's impossible. Therefore, we lack the guaranties that would allow us to assume that the other person is adopting an equivalent view of the virtual world. Now, as the second convention indicates, for communication to be successful, each human has to be competent in the use of communicative tools, including both linguistic and non-linguistic ones, and know their conventional uses. More specifically, we have, first of all, the language of that community, which is comprised of elements similar to human languages, like phonology, syntax, the lexicon, etc. These instruments are basic, but they are not the only ones. Their importance and centrality means that it has been forgotten that communication is packed with other strategies and tools. Any linguistic, paralinguistic, or non-linguistic tool can be used to make the other person evoke the desired experience. Humans approach any communicative act with a great interest in the communication being successful: they are communicative beings. So they will do anything to achieve the goal of making what they want to say understood. Any indication is valid to make progress towards comprehension. Thanks to this circumstance, two humans can find themselves for the first time in a strange situation and they can evoke the same experience very quickly. Thus, they can use other communicative tools like body language, including physical contact, eye contact, gestures with the head, body position, movement, responding to the other person's movements. There are also other tools of a more social type like fashion, clothes, commercial items, protocol, rituals, games, and so forth, that can also be used as tools.

3 Information in Experientially-Based Communication

What about "information", then, in an experientially-based model of communication? To communicate is to situate the recipient in the experience that the emitter is trying to stimulate. So, the object of the communication is not a "thing" but rather an "act." In fact, information can be understood in my model as coinciding with its etymology: information would have the original Latin meaning of "to shape" because it shapes the virtual world of the communicator. Its noun form should disappear since there is nothing that is transmitted.

A communicative act implies then no transmission, only interaction. And this interaction consists of the emitter of the message "shaping" the virtual world of the recipient. Clearly, this "shaping" is metaphorical, but I think it's the best way to understand what happens. Just like an individual can grab another person by the shoulders and make the person look at some part of the nearby landscape, an human can intervene in the cognitive system of the person listening and make him or her look in a certain direction. Through the use of tools, language, and other types of communicative codes, like prosody and gestures, the emitter "enters" the virtual world of the recipient and performs operations that, thanks to the conventionality of certain codes, and to the homogeneity of the experiential background of each human, and to the cognitive architecture, manage to active the relevant part of the virtual world in which the recipient lives. Therefore, we could say that in a communicative act, when the recipient has received a message, and has understood it, that person has not apprehended informative material, because there's no such thing. The material in that individual's cognitive system is the same, except that it's more or differently organized. Let me put an extreme case to make my point.

> "What time does the train leave" asked Katherine; "At ten after eight in the evening" replied the station master.

How can I defend that in this exchange there is no transmission of information? The recipient of the message seems to have received "informative data" that she did not have before, something that may change her behavior. In my model, though, what the station master tells Katherine works because it modifies Katherine's virtual world. Only when this modification is "viewed" by Katherine, she will be capable of interacting with the world in the direction that her interlocutor intended. And this change will consist of a train, in Katherine's virtual world, leaving the station at a particular point in her temporal context. And for this change to be effective, Katherine will have to have learned to evoke experiences according to the temporal axis used by the station master. More specifically, when Katherine receives the message about the time her train leaves, what happens is the following: the station master who has informed her enters Katherine's virtual world and modifies it, so that what evokes "the next train" is associated with an aspect of the temporal context that is correlated with the use of certain conventions regarding the use of certain objects, like clocks. If Katherine had not learned to use clocks in her community, then hearing "it leaves at ten after eight" would not be of any use to her. If the modification of the station master has to be appropriate it's because Katherine has learned the rules that allow her to deduce that

there is a certain position of the hands on a clock face, when the short hand points to the "8" and the long hand points to the "10," and that trains wait for that moment to leave. This would not be a piece of information. That is, the train leaving at ten after eight is not data, it's not something that exists in the world independently from the capacity of this data to transform the virtual world of the recipient in order to change the willingness of the recipient to do certain things and not others. For example, let's suppose that the station master says "Twenty hours and ten minutes" instead of "Ten after eight in the evening" and let's suppose that Katherine hasn't learned about the use of the 24 hour clock. Has information been transmitted? No, and not because she "doesn't understand what it means." If at that very moment someone explains to Katherine what the 24 hour clock is all about, then we could say that she has the necessary elements to understand what it's all about, but Katherine may still not understand the message because she hasn't been able to evoke the desired experience, that is, incorporating the temporal axis to the experience that she is having at that moment. For her to understand, he must have had experiences in which the 24 hour clock is superimposed on a regular clock, until the overlap is finally quite complete.

Let's explore some more informational possibilities. What time does the station master mean? The time according to that area's time zone? And what does that time mean? Isn't it somewhat different from Greenwich mean time? The time according to whose watch? The station master's or the engineer's? If the train usually leaves at ten after eight and thirty seconds, then the information is no longer information because it's not true. This detail may seem trivial, but it just may be that the time lag resulting from the train leaving an hour or a fraction of a second late is of great importance in determining, for example, the future of the universe. For that matter, what does it mean for a train "to leave"? That it starts moving, that it's moving too fast for a passenger to get on, or that it leaves the station...? Also, what does "the next train" mean? The next one as of the question being asked, when the question is over or during the conversation?

All of these considerations are an implicit part of the virtual world, and can therefore be easily modified. However, they are *not* implicit in the data-sentence, and to be considered information they would have to be. Consequently, to extract information from a sentence like "at ten after eight" it would be necessary to address everything we know about the humans, from the way their brains keep track of time to the railroad conventions, and including the use of technological instruments. It is thanks to the fact that the station master's sentences can be transformed into a modification of her virtual world, including her future virtual world, that Katherine can make use of them; if not, there is no real information. And all of this can be applied to any utterance made in a human language.

Then an important question is whether communication does serve to enrich the virtual world of the interlocutor or not. In my model, the base material, or what comprises the virtual world, and which has been constituted from experiences, cannot be increased or diminished through communication. In order for the contents to enter, the individual must have the experience for him or herself. It's as if we were to say "You feel an electric shock if you touch the two poles of a live wire." If Erik has never felt an electric shock, then the semantic associations of

the content will not be established until he does feel it. Even though the virtual world does not increase through communication, a communication can change the virtual world in such a way that it is enriched in its *organization* or *magnitude*. In a way we can say that after communication takes place there is no augment in "experiential material" but there is a change in the organization of the virtual world. In the case of the train, Katherine's virtual world has not been "enriched" with new contents, they have simply been organized in a different way. In a figurative sense, it's as if the station master entered Katherine's virtual world and set her clock at ten after eight in the evening.

Is there a way to measure or evaluate the information of a communicative act? If we understand that "to shape" is a way to reorganize, then there is a way to measure the informative capacity of an act of communication, what we could call the "informativity" of a specific communication. In this sense, the informativity of a communicative act would be the magnitude of manipulation, or organization, of the recipient's virtual world that the act is capable of bringing about. The informativity would be a property of the communicative act, and not of the codes, or the signals, that are used in it. From here we can derive the principle that the informativity is not a property independent from whoever is using it. In a string of signs, in an icon, in a dinosaur imprint, there isn't "something" independent from the cognitive apparatus of whoever is using it that is "information."

This doesn't mean that informativity is a subjective property, because potentially it is possible to make an analysis of the experiences, and it is potentially possible to measure – although now it's hard for us to imagine how – the changes that have been brought about by the signs or the manipulations of the emitter in the recipient. Among other things, this implies that the modification of virtual worlds that takes place in a communicative act can never be pre-established. The elements that condition how a certain sentence modifies the virtual world of the recipient are, no doubt, so complex that they cannot be calculated in advance. We must keep in mind the use of communicative tools in the exact context: what words, gestures, and other communicative tools are used and in what way. Also, we have to consider the experiential background of the recipient, that person's attention to the process, his or her motivation at the time of communication, and all the other conditions that can affect the communicative act.

I would finish by focusing on what "to comprehend" would correspond in my model. The aspect that characterizes my model, and distinguishes it from others, is that to comprehend a discourse, an utterance, a text, is not to understand its words, but to have an experience, adopt a view of the virtual world. It's not that the meanings hang from the words, or because the words are connected to a little box where the meaning is held, that explains why humans understand each other. They understand each other because when they say each word they dominate and penetrate all the experiences in which this word has been used, uttered, heard, etc. While they talk, the words take the humans to perspectives of their virtual world, moving from one to another, and from one time to another. Consequently, comprehension is not something that can be defined in relation to the transmission of something called information, but instead should be characterized specifically in relation to the modifications to which the recipient is subjected in the communicative

context. Erik can manipulate Katherine's virtual world through words because the words are anchored in contents of the cognitive system, and also thanks to her ability to evoke these contents. Never because the words mean something. And we can add that, in order to comprehend, humans have to be in the position to understand. A human cannot understand a message, an idea, the experiential characterization of which cannot be reached with the contents that are *already in the virtual world of that person*. If the virtual world of an individual doesn't contain the objects, properties, and associations that make up the perspective of a certain experience, then no matter how much is said or explained, that person will not be able to understand what the emitter wants to evoke with his or her sentences. In order for language to be successful, it has to work with the raw materials of experience, since experience is the material of which the knowledge of humans is made of.

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6 Conversation as Emergent Function

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Abstract. In this chapter we suggest that the clearest shortcoming in scientific work is the failure to take account of complexity and the emergent functions that derive from it. Specifically we will explain the notion of conversation as one of these functions generated from the interaction of many elements that, in turn, are functions of other emergent interactions. Breaking down the analysis of conversation into elements does not allow us to see how conversation has arisen from interactions with other functions, the environment, etc. For this reason, we have to expand our perspective in order to study it. Unknotting the tangle of underlying interactions is often impossible or at least extremely difficult. A multidisciplinary approach and the convergence of scientific viewpoints can offer avenues for us to develop conceptions more in line with the perspective of complexity.

1 Introduction

For the purposes of work and research, science has traditionally fragmented reality into parts small enough to be able to study them or, in other words, to conduct an analysis of reality. The basis for this approach has been the belief that once a scientific treatment was concluded, the sum of the parts into which reality had been divided would give us the entire interpretation. Most of the time, when we have checked whether a theory fit reality, we have found that reality failed to correspond with our predictions in many respects. In this paper we suggest that the clearest shortcoming in scientific work is the failure to take account of complexity and the emergent functions that derive from it. Specifically we will explain the notion of conversation as one of these functions generated from the interaction of many elements that, in turn, are functions of other emergent interactions. In the text below, we will use the word *analysis* in the sense of breaking down the reality under study in order to make it simpler and easier to treat scientifically and, therefore, easier to formulate hypotheses.

2 Properties of Emergent Functions

Emergent functions have a number of fundamental features. The list below sets out the features that are most relevant for this paper (Phelan, S. E. (2001), Standish, R. K. (2008), Heylighen, F. (1988, 1991)).

Proximity (physical). The two constituents of water, oxygen and hydrogen, cannot react (interact), for instance, unless we restrict their random motion through physical limitations. For two or more elements to interact and thereby change their own essence, they must be close and, in most cases, physically close. Otherwise, interaction does not occur and the appearance of emergent functions is not possible.

Interaction. As mentioned earlier, an interaction is a kind of relationship in which components change aspects of their essence and produce a new entity, e.g., water. The interaction between the two gaseous elements that constitute water result in a product that is entirely different from the individual elements. This feature of emergent functions may be the most important one, because it changes the conception of what a relation is. We might say that an interaction has different levels of quality and that only the simplest interaction is relation, which produces no appreciable changes in its elements.

Circularity. Typically, an interaction does not occur all at once. Several attempts are required for the changes to take place. When a reaction starts and stops before finishing and then starts again, this is called circularity. In the end, the results (or result) are the consequence of a series of reactions or interactions.

Resonance. Not all items present in a specific context may interact with each other. They must have some intrinsic characteristics that allow them to interact. In the case of water, the reactive capability of the two constituents makes the reaction possible. A third element, such as an inert gas, would not participate in the reaction. This reactivity, similarity or affinity between the elements is called resonance.

Self-management. The result of an interaction is other elements with properties that differ from the properties of the original elements. The ability of new elements to organize themselves into coherent forms and aspects based on similarities and new reactive capacities is called self-management. Sometimes the result may even be uniform and stable (Gershenson, C. 2007).

3 Conversation Analysis

An analysis of the constituent parts of human conversation produces a series of aspects that are commonly studied in a fragmented way. We could call these:

- *Verbal aspects*. These are the elements traditionally studied in conversation and they are called speech. They are often associated with the study of language and are produced by a person who is speaking.

- *Non-verbal aspects*. Speech is naturally associated with a number of productions related to silences, pauses, intonation, types of articulation and so on.

- *Cognitive aspects*. These aspects allow us to build a speech or set of content to be expressed. They include coherence, sequence, structure, timing, planning and so on.

- *Emotional aspects*. Related to speech are the emotions that a person feels while saying something. The same production when you are angry is not the same as when you are bored or happy. Therefore, there is an emotional component that unequivocally alters the information being conveyed and that, in transcribed form, we would not clearly understand. Some nonverbal aspects coincide with emotional ones. In linguistics, these would be contained in suprasegmental speech features.

- *Contextual aspects*. Our brain is incredibly good at capturing the surrounding context and incorporating it into speech. If a room is hot, to make this clear when talking with another person in the same room, we do not usually ask for clarification because the other person will also perceive that the room is hot. The speaker and the listener tacitly agree on the reality perceived by both of them, and no explanation is demanded. Phone conversations and written language provide examples where the context is difficult to grasp and almost impossible to convey unless a large amount of descriptive detail is provided.

- *Body aspects*. An individual's stance, distance, position in a group of speakers, facial expression (also considered as an emotional and non-verbal aspect), hand movements, etc., are aspects that give information of other realities not indicated by the strictly verbal.

It is commonly believed that 55% of speech is non-verbal, 38% suprasegmental and 7% verbal. This paper is not interested in the numbers or in debating the veracity of these claims. What they do suggest, however, is that verbatim transcripts cannot fully capture what a speaker has intended to say and that the real meaning of what has been said is often captured, for example, in non-verbal, emotional and physical information, as well as in the context involved.

Òscar Vilarroya (2002) refers to what cannot be explained by an analysis of a conversation. He starts from a naïve conception of language. His intention is to show aspects of speech that cannot be "fragmented" when breaking down a sentence, discourse, etc. in order to understand it. This is also the case when devising computer simulations to understand what language is (Steels 1996 2000). The aspects identified by Vilarroya are:

Polysemy. Using the same word in different situations to refer to different objects or properties in the environment. A naïve conception of language would consider that a word refers to a single object or situation. However, in natural language, this is not the case. A word can be used to refer to different things. Typical examples arise in the use of humour and the double or multiple intentionality of irony.

Synonymy. The use of different words with the same or very similar meanings. This case is the opposite of polysemy.

Multi-referentiality. The same word can be used to refer to different objects, situations or properties, although in similar contexts. A typical example would be to use the same word to indicate the different situations of objects in space, e.g., up, down, right and left, to indicate an object's position relative to the body of the speaker or listener.

Categorial indeterminacy. A particular reference in a particular context can be conceptualized in different ways. A specific category can be used in more than one way. Therefore neither its definition nor its application is rigid.

4 The Analytical Perspective

The analytical perspective refers to interpretation made before dividing up reality for study. The working hypotheses are established from portions or sub-divided parts treatable with the tools of research. The basic assumption is that the relevant parts can be studied and the sum or totality of the findings will explain the reality under study comprehensively. This approach has resulted in an inconsistent view of explanatory theories and a poor view of the phenomena studied. The main shortcoming of this approach has been not to consider the interaction between the variables involved and thus eliminate the great difficulty posed by including their interaction.

Another consideration is that the descriptions of phenomena under study have required this assumption of the divisibility of reality. This, in turn, has distorted how phenomena are perceived.

Traditionally, the factors or methods of interpreting reality for the purposes of study have been:

Reductionism or analysis. Sufficiently explained above.

Determinism. The hypotheses were intended to explain a fixed and indisputable reality. For many years, this has led to the phenomenon of reification, or the creation of reality in the name of science. From the beginning, every scientist or scientific theory must allow for the falsehood of any contribution. This has marked the history of scientific advancement.

Dualism. Tendency to believe that reality is divided into two opposite poles, disregarding that reality is normally spread over a continuum with infinite possibilities.

Rationality. The only way to treat and conceive reality, forgetting there are many other ways of thinking, formulating and interpreting reality.

5 The Complex Perspective

The characteristics of complexity explained above need to be applied in order to understand conversation as an emergent property of one or more complex systems that interact with one another. These subsystems are:

1. Mind reading
2. Social intelligence
3. Social and cultural context

5.1 Mind-Reading Modules

Mind reading is an ability that human beings typically attain when they develop the four elements or modules that constitute this ability in order to read the minds of fellow human beings. By "mind", we understand the brain function that enables us to know what others think (believe, feel, imagine, etc.), an activity that we do naturally and quite well. These four modules are described below as set out by Baron-Cohen, S. (1997):

ID: The Intentionality Detector. Motion stimuli are interpreted as mental states of goals and desires. These states are primitive and give meaning to the universal motion of all animals. The senses involved in the ID are mainly vision, hearing and touch.

EDD: The Eye-Direction Detector. This has three basic functions. The first detects the presence of eyes or eye-like stimuli. The second detects whether these eyes are directed towards one thing or towards another. And third, we infer that if the eyes of another organism see something else then this organism sees that thing as well. These three features are adaptive because the organism can know whether another organism sees it. Eye contact enables us to know that another person sees us and we see him. This is called dyadic representations. As we can deduce, the sense involved in this mechanism is sight.

SAM: The Shared-Attention Mechanism. This is responsible for creating triadic representations. These specify the relationship between oneself and another person and a third person or object. The mental function is constructed like this: I and another person are seeing the same thing (object or person). These representations are constructed using any perceptual information about the status of another person or animal. The sense most important in this mechanism is sight and it is difficult to imagine achieving the same result with the other senses.

ToMM: The Theory-of-Mind Mechanism. This mechanism allows us to infer all the mental states of others from their behaviour. These states are deceiving, thinking, knowing, imagining, dreaming, believing, cheating and guessing. ToMM has the function of representing this set of mental states and turning them into a useful theory (hence its name: to create a theory of the mental reality of the other).

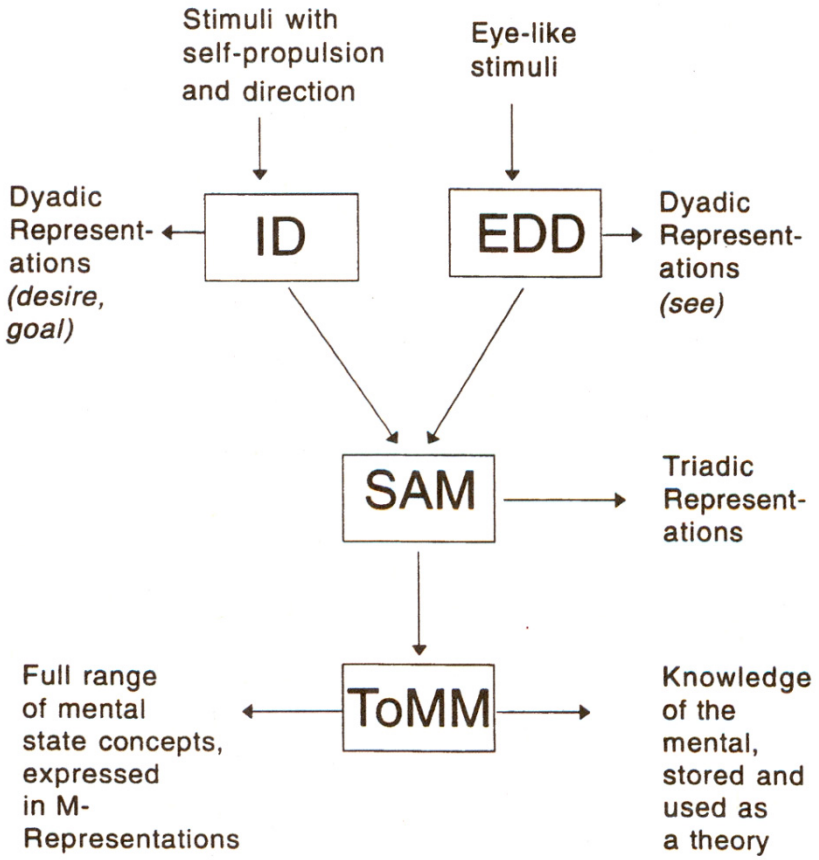

Fig. 6.1 The Mindreading System (Baron-Cohen 1997)

If we summarize what we have found so far, three mechanisms allow us to read behaviour in terms of mental epistemic states and read eye direction in terms of perceptual mental states. The fourth mechanism allows us to interpret and integrate all the mental states of people from their behaviour.

The system of mind reading matures when interacting with the social environment (family, school, friends, neighbourhood, etc.). With emotion, proprioception and so on, mind reading gives rise to social intelligence.

5.2 Social Intelligence

Social intelligence is an emergent function that comes out of the interaction of the above functions. It is a capacity that results from these functions and allows us to interact with other people. It is one of the multiple human intelligences and when

it is affected by different types of difficulties, it becomes a syndrome known as autism (which has different types and levels).

The emergent functions considered in isolation can interact with different physical and social elements, giving rise to other products and functions.

When social intelligence interacts with the environment, culture, other intelligences, etc., many emergent functions of different types are generated. One of these functions is conversation.

Viewed from the perspective of complexity, can conversation, as an emergent function generated out of multiple interactions, explain what the analytical perspective cannot explain? The answer is yes.

If most humans converse naturally and without intentional learning, we can conclude:

1) The conditions that allow us to interact cannot be learned, i.e., they are developed from a genetic endowment that is expressed through the action of the environment.

2) Interaction is the basis of the conversational world.

3) Conversation is not learned intentionally. It includes social and environmental aspects, but these aspects are not learned in order to make use of them in conversation.

6 Who Studies Complexity?

Schools of psychology, like Phenomenology and Gestalt, have studied phenomena such as cognition from a complex viewpoint. They have focused on concepts such as field, figure/background analysis and closure. They see that an interpretation of reality often depends on the specific environment involved and that, if this environment is ignored, we can miss the mark in our conceptualization of reality.

At present there are institutions like NECSI and the Santa Fe Institute that are already incorporating complexity into their studies and research in various disciplines such as economics, climate, psychology, etc. In fact, any area of knowledge can draw on this approach.

In psychology, one area that aims to address complexity is the Cognitive Sciences. The cognitive sciences involve six disciplines working together synergistically to study cognition. The figure below shows what these disciplines are and how they are related. The figure also shows a list of sub-disciplines created by their interaction. The cognitive sciences are multidisciplinary, but there is no concrete institutional level that includes all the areas that comprise it (Gardner, H. 1987; Clark, A. 1999).

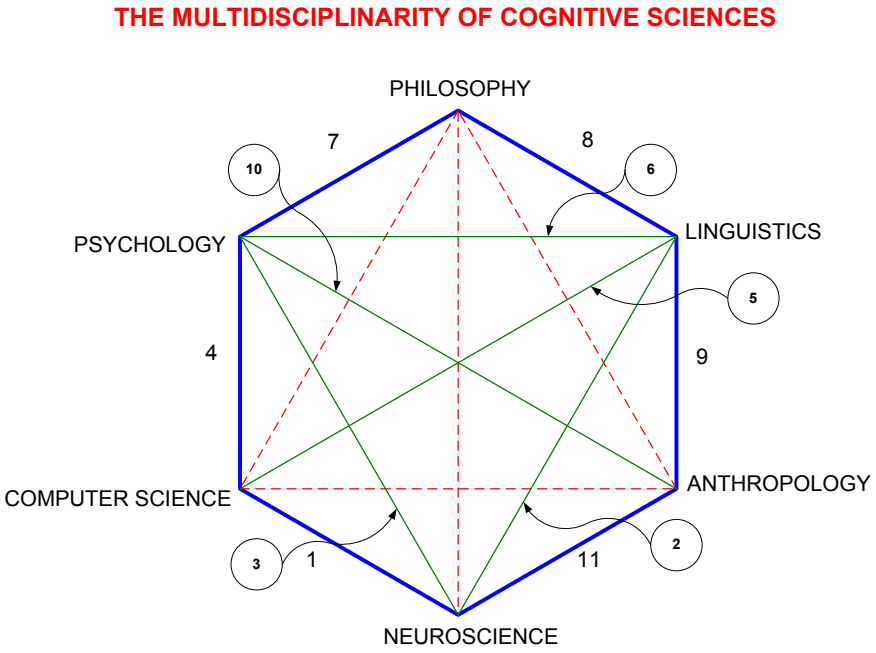

Fig. 6.2 Cognitive Sciences Multidisciplinarity

7 How Are Cognitive Functions Generated?

The modules and nuclei that specialize in the construction of certain functions by interacting with non-specialized nuclei and modules and interacting with given bands of reality are what give rise to cognitive function. From an evolutionary

standpoint, this does not happen all at once but gradually and may be viewed as complete at approximately 12 years of age.

Most cognitive functions can be considered emergent because their starting point is complex in the sense explained above. We can include all types of intelligence, memory, perception, etc.

Thus the conception of the mind is not just as brain function, because it also contains bodily processes, cognitive processes and functions, interactions with the environment, and more.

As a result, we can describe conversation as an emergent function because:

- Two or more minds (people) interact with each other.
- The minds of speakers automatically and instantaneously adjust to the productions of one another.
- There is no immediate transmission or understanding of information in the literal sense, but rather an evocation of past experiences and inferences. If not, the speaker would not be understood by the listener (Sperber, D. & Wilson, D. 1994).
- Most processes involved in conversation are unconscious, for example, the inclusion of the environment, body posture, facial expression, the interpretation of content, etc.

8 Conclusions

First, the study of what is complex requires a conceptual shift and a change of approach. The tools used for study and research should include complexity and engage with its principles. Many studied phenomena have complexity in their origins and development.

Our brain (cognitive system) captures complexity naturally because its function is designed by evolution to work on simultaneously.

To understand most genuine human phenomena, we must take into account that they are evolutionary (Bickerton, D.; Calvin, W. H. 2001).

Evolution, too, has generated most of its products in a complex manner.

Many of the approaches taken in the social sciences and humanities need evolutionary interpretation and complexity to attain an in-depth understanding of their objects of study.

Conversation is an emergent function that becomes available to individuals through the maturation of their brains (mind reading and social intelligence), their interaction with the physical and social environment, their assimilation of their own culture, and so on. As explained above, conversation is complex and its origin is difficult to study because the study of interaction is often undertaken from obsolete stances. This statement is also valid for the investigation of specific syndromes such as autism. Unknotting the tangle of underlying interactions is often impossible or at least extremely difficult. A multidisciplinary approach and the convergence of scientific viewpoints can offer avenues for us to develop conceptions more in line with the perspective of complexity.

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7 Communication Situations: A Dialogic Quiz?

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Abstract. Considering the new proposals of what we understand nowadays as "the knowledge society", the conventional concepts of taxonomy, non-flexible frames and closed systems of categorization applied to scientific proceedings, seems to be more a blocking artifices than useful operational tools. As a result of that, a crucial aspect to note is that one of the weaker points with regards to a cognitive issue is the lack of interaction of individuals with their own environment. From the structural analysis applied in different fields it can be observed that the asynchrony and some distortions between the data input mind processing and their interpretation are more due to communication competence and a definition of meaning, than to any technology involved. Thus, the concept of ecosystem, considering ourselves as a part of it, is just the starting point from the perspective of cognitive sciences. That means that the criteria of opposition as a categorial system, as well as the consideration of any static frame or model, are far to be a a suitable way for a complexity issue.

1 Introduction

In 2008, Elaine Sarkin Jaffe, a highly esteemed scholar, doctor of medicine and cancer researcher from Cornell University, was invited to give a lecture as part of an academic ceremony at the University of Barcelona. She talked about some specific and innovative aspects of research carried out in different US institutions. After speaking about oncology and focusing on lymphoma, sarcoma and cell activity, she made a sudden switch to analyze some communication problems related to lexicon and discourse patterns. It was surprising to realize that she was interested in how some concepts are misinterpreted among her colleagues, since a lack of clarity in the speech can be very harmful in the medical field. She explained that it is not always easy to share discourse arguments and provide information in suitable terms and expressions to describe the concepts that you want to transmit. In fact, the cognitive process from the individual to the collective to achieve consensus is a complex path that frequently appears to be blocked by some terms and coined expressions that have no clear correspondence with the abstract concepts. Such textual forms are not more than discourse frames constructed and presented as closed protocols. Thus, the blocking process leads to the question of whether it is really possible to understand unequivocally a message received from a speaker.

Such an objection seems to be rather atypical in a scientific field, in which the tendency is usually to establish the conceptual aspects that are related with a specific subject, in this case the highly technical specialization of oncology.

2 Complexity and Informal Speech

The question, however, is beyond the scientific domain. Questionning whether we are really able to assure with absolute certainty that we clearly understand what a speaker says or tries to say, leads us to consider the dynamic models of language that are connected to cognitive processes. In any case, the construction of closed protocols is likely to produce distortions, not only in relation to the lexical order, but also on a pragmatic level, as can be experienced in the everyday informal speech.

Obviously, all discourse patterns are organized by means of language, from novels to abstractions of any mathematic concepts or philosophic ideas. Over the centuries every field of knowledge has produced its own discourse, by creating protocols from specific concepts. However, no such discourse holds a close and exact correspondence with reality, not even with our immediate natural, physical or intellectual environment.

In speech we often use verb forms and coined expressions that have no clear correspondence with their literal meaning. However, as a result of consensus in the use of language, we understand perfectly the divergent and non-canonical sense according to the patterns of the specific language. This is the case, in Catalan, when people say “ara vinc" (I come), although the 'correct' grammatical form should be “ara estic venint” (I am coming), a present continuous frame that connotes a dynamic interpretation, rather than the static interpretation of the simple present. Some Latin-American speech varieties use the expression “vino esta mañana” (indefinite past, a Spanish verb form with no clear correspondence in English) instead of “ha venido esta mañana” (simple past), which is the formal expression in standard Spanish. Such breaking of grammatical patterns is a good example of the lack of synchrony that is a common practice between a written language and informal speech. This forces us to consider that there are many differences and alternative codes within the same specific language. The treatment of verb tenses, for instance, seems to escape from the experienced path of real time, and is closer to the notion of verb aspect. In any case, the calculation of time is complex enough for the accurate use of many metaphors to harmonize the real time, the verbal time and experienced (or psychological time), as Norbert Elias suggested in his discussion of the living (or existential) dimension, which is no more than the conscience of the individual in a specific position in space and time. In this case, the concept of time is another metaphor in itself. Thus, when we talk about the stages of present, past and future, we are indeed producing and applying a metaphor on another metaphorical frame, placed in different levels of meaning.

In spite of the divergence between literal meaning and the use of language, we have enough interpretative resources to communicate and to be clearly understood. This is why our tendency is to organize any kind of speech around conventions about a reality, in order to keep a close (or even exact, if possible)

correspondence with the physical world and with any notion of time, even as a simple approach to a specific time stage. In any case this is only a projection of our own interpretation of the environment. In contrast, when our aim is to reflect the reality of the physical world, the discourse must be constructed using metaphors that, as mentioned above, are no more than conventions built from other conventions.

Since such conventions involve consensus and agreement, expressions are usually produced as closed protocols in order to establish suitable correspondences and connections on specific cognitive aspects. This is achieved by considering two situations: the interaction between the physical world and our own environment from a deictic perspective, as Norbert Elias wrote, which is the basis of the ecosystemic approach, and its projection towards abstract concepts.

However, what we are discussing is not just a formal question. It also refers to content, since any language can act on two levels, with its own metaphoric set of projections. If we take this into consideration, it is obvious that in complex societies the use of new technologies tends to produce a loss of syntony with our environment, not only in matters that concern the physical world but also in reference to intellectual concepts, and sociocognitive phenomena related to language.

3 From the Historical Discourse to the Art of Advertising

Such a complex structure can be experienced in any field of knowledge. The fact is that we are situated in our own specific activities, in which we can check some possible distortions in the interpretation of concepts. Any discourse related to history is a clear example of this and is a complex area in which sequential situations occur at different levels, such as the simple interaction between diachronical and synchronical criteria, or cause and effect mechanisms with short-and long-term consequences, which are often unexpected as they are produced in indirect ways. Another issue related to history is the concept of historiography and intertextuality, since from the perspective of this pragmatic consideration, the notion of historicity is reduced to the discourse we receive. Therefore it seems rather obvious that if a specific event was not recorded in a documentary way, it is extremely hard for us to give credibility to its possible (in fact real) existence in the past. Consequently such an event cannot why be included in what we understand as historical record or “official” statement. However, we can consider an anthropological approach as an auxiliary matter, as a last resort for understanding some situations from an alternative point of view. Once again, we encounter an interpretative problem owing to the closed protocols, in which there is tension between canonicity and heterodoxy, without considering the question of the reliability of historical sources. There are many complex processes in history, such as the mechanisms of social transformation, the interaction between different individual psychological profiles in the collective, and many other situations produced by the abovementioned cause and effect action.These processes cannot always be explained satisfactorily in canonical ways.

This leads us to consider the need to redefine concepts, as man is an emotional being and not as rational as we insist on believing. History, therefore, is no more

than a process in which emotions are an essential constituent, in spite of any discourse justifications from rational arguments. Thus, we have reached the limit of deriving an absurd self-satisfaction from establishing and introducing any kind of enthelechy, even by coercitive means. Apart from intellectual and ideological content, it is quite clear that any historical event involves visceral aspects that are hard to quantify, and even to define, in relation to ethical and Cartesian parameters. Whenever we deal with the French Revolution, the Spanish Civil War, or any other traumatic event, due to its nature, we can categorically state that it involved people with complex psychological constituents. These people produced complex discourses in an ambiguous way, some aspects of which are subject to external factors that are absolutely relevant. In fact, even when we are not talking about anything more than the human factor, which depends on a wide range of variables, we keep searching for rational interpretations in an unequivocal sense. We are, therefore, placed in what we could define as "pragmatics of history".

However, it is essential to consider chronemic acceleration as another relevant factor in historical progression. To explain this concept we can imagine a kind of funnel shape or an inverted cone. This shape is like a spiral frame that tends to enlarge towards some fuzzy and inaccessible borders, which are also paradoxically foreseeable to some extend. Such a frame can frequently be found in nature, as Àngels Massip discussed, and analogies can be drawn in different levels, from the basic shape of galaxies to the outline of different communication situations. Human progress takes place by means of a great amount of stored information produced through complex communicative processes that tend to go back towards their own starting point, without generating any intersections in the spiral path. This frame is highly productive and can be adapted to a wide variety of language forms.

In the past, society tended to remain fixed on some specific agreed parameters. In this case, scholasticism projected a static and hierarchical model with immutable categories. Even though this model must be considered decidedly obsolete today, due to some of the obvious characteristics of human nature, a few residual aspects persist in some sectors of society. In contrast, in the paradigm that we live in, which is more post-Enlightment than post-modern, everybody has access to information. However, once again, there is a problem with the alternative of media communication built in closed and unconnected blocks.

Quite unconsciously, but with a great deal of self-satisfaction, we are still using some closed obsolete protocols, that were useful in the past, even when we are the object of daily media criticism. However, this situation is far from surprising, as the use of repetitive patterns remains a constant in the evolution of society. Whenever social conflict occurs through an imbalance between the ruling system and the real situation of society, a traumatic convulsion is produced. This inevitably leads to a reaction and a counter-reaction, so that, from the perspective of an ecosystem, we can assume that an environmental fracture is produced with the resulting break of communication. In a situation produced by an unbalanced system, the need to readjust the meaning towards some static models often arises, to restrain the process. Examples of this are some neo-scholastic proposals, as well as the adoption of drastic, dogmatic and paternalist ways. However, once again we

are confronted with a lack of interpretation of our own protocols, which also represents a blocking process in internal coherence. It is worth noting that most of the ruling political ideologies, and even most of the current political parties, have their origins in the nineteenth century and emerged from a Manichean split between right and left wing. Thus, some conceptual words such as "nationalism", "democracy" or "popular" become absolutely ambiguous, owing to the fact that they connote some arguments that do not always keep clearly correlate with reality. In spite of this we keep on using them as a marketing tool in political campaigns, without considering the real fact that any citizen, far from being closely affiliated with any "right" or "left" categories, is absolutely capable of simultaneously adopting a "right" and "left" wing behaviour, even with no need to be placed in a "centre" position at all.

This kind of ambiguity can be found everywhere. Any advertising discourse, for instance, clearly illustrates this argument. The interpretation of images, commercials, and even film syntax requires training, as occurred some centuries ago with theatrical performances. This is why rhetoric of the image is essential in media communication as a form of language; it is condensed, syncretic, but also ambiguous. Actually, any physical shape or production has its own discourse. The "smile" logo, or the *déjà vu* quiz proposed in a popular commercial featuring the so called "Martini Man" are good examples of the power of the image. I showed this commercial as part of a psychology course on advertising communication that I taught at the UAB (Barcelona). The students recalled the images as something fuzzy or maybe forgotten, even when the French actor Jean-Paul Belmondo was absolutely unknown to all of them, as was the film "A bout de souffle", and Jean-Luc Godard, of course. This is a very interesting instance that forces us to question the origin of the mechanisms of memory that make such unconnected images coherent, and to try to discover the sphere in which iconic references are processed. Indeed, images act as a very powerful discourse as they are closely related to emotions, even if they always need a referential element.

Throughout the twentieth century, mass communication developed exponentially, which led to the introduction of alternative interpretative patterns and some disfunction between thought, speech and action, that caused considerable distortions. On the subject of interpretation and the rupture of communication with unfortunate consequences, is worth reviewing the historical dynamics between 1914 and 1945, a struggle which still has consequences today. The turn-of-the-century technological and modernist discourse is directly proportional to the dynamics of the First World War (1914-1918). Certainly, the horror of the battle fronts involved a unexpected situation that was previously unimaginable, a struggle that led to the emergence of fascism, the crash of 1929 and the justification of surrealism as a new creative trend. Following this cause and effect chain, more traumatic consequences arose with the Spanish Civil War, the Second World War and the Holocaust, which was the highest peak of a long succession of horrific acts on a human level. Furthermore, the Cold War metaphorized such stress until present times.

All of this can be extrapolated to any field of knowledge, and forces us to question two essential aspects: the construction of an ergonomy of knowledge and the

adoption of the concept of ecosystem. However, this subject is not new. In the sixteenth century John Donne, one of the Jacobean metaphysical poets, wrote: "No man is an island, entire on itself. Each is a piece of the continent, a part of the main". It seems that there is no alternative other than redefining existence by introducing suitable new concepts and using new intellectual mechanisms. We need to deconstruct obsolete stereotypes to keep in syntony with the real world. We must deal with training and new skills. We also need to investigate emotions and try to break their dissociation with reason, as Alain Corbin suggests in his "history of the senses". Finally, we need to take intuition into consideraton, as a source of creativity related to the environment and to our own emotions, as Henri Bergson stated.

The frame of discourse in vernacular speech obviously supports my arguments. Proverbs, idiomatic expressions and popular sayings are a good example of this kind of interaction. Different languages may have specific common ways of expressing the same concept. However, the parallel constructions are far from the same. For example, in Spanish, people say "cerrado a cal y canto" (literally "closed with lime and brick", which means "to shut something firmly"), while the Catalan version is "tancat amb pany i forrellats" (that is "closed with a lock and iron bars"). Cases of clear inversion of concepts can also be found, as in the expression "es un hombre de pies a cabeza" (that is "he is a man from feet to head") and "és un home de cap a peus" ("he is a man from head to feet"). In addition, many idioms only exist in certain languages. It is worth noting that the treatment of information is different in each language, since it depends on the specific cultural tradition.

With regards to the problem of closed protocols, taxonomic order is one of the first snags we come across. In this case, we can find some conceptual oppositions, even when the categories are far from clearly opposed, such as the classic dichotomy between "litterature" or "sciences". The most suitable solution could be a mere categorization of pure and applied sciences. The use of closed categorical systems produces an avalanche of information, and is also a blocking process owing to the system of stiff unconnected compartments. Therefore an essential need is to adopt an ecological self-conscience rather than a methodology that tends to close in on itself. As Pierre Karli suggests, it is worth introducing a transdisciplinary education involving the removal of axiomatic prejudices, such as "science without conscience" or "pragmatism without belief". Basarab Nicolescu also talks about the trans-disciplinarity as a third way by which it could be possible to create harmony between thought and knowledge. Therefore, intellect and understanding are involved as categories that are opposed to specialization and any closed discipline.

The interaction between science and language is absolutely obvious and creates a need to adopt new methodological proposals from the implementation of nonlinear systems and concepts that can introduce an ergonomy of proceedings. Examples include systemic models, mechanisms for generating order or applying the uncertainty principle, as asserted by Heisenberg. To achieve this, we need to make an effort to adapt our mind to a multi-facetic reality, in which the whole is greater than the sum of the parts. The logics of the sensible world, as Piaget wrote,

depends on the sum of many variable factors, in which the notion of shade is paramount. Indeed, as an old adage asserts "if you are not part of the solution, you are part of the problem", or, in other words, there is no experience without considering the experimenter, as Heisenberg suggested.

4 A Whole Music Experience

In 1914, Henry E.Kriebel, an expert in musicology who focused on the Afro-American tradition, wondered how it was possible that “uncultured” people who had never developed any kind of fine arts and even less musical compositions, could project such refined aesthetic sensitivity, to the extent that they surpassed what “cultivated” Western societies had produced over centuries (*Afroamerican Folk Songs* 1914). Some years later, in 1922, Alejandro Guichot wrote something similar about flamenco, stating that one of its main characteristics was the projection of a “deep melancholy”. Guichot defined that musical genre as a “música doliente y extraña” (a mourning and strange music), with a structure of repeated periods, melodic shifts and strange inflections.

Aside from any aesthetic considerations, if music can be understood as a way of communication, a wide range of alternative forms should be closely analysed. We wonder how it is possible to know whether a specific rhythm is really tango or jazz music. From a psychological perspective, Oliver Sacks dealt with the interaction between music and the brain-mind duality to demonstrate the existence of a close relationship with emotions and the internal intuitive psychomotion system, in which a categorial gradation can be noted, from virtuosity to amusia and other brain disorders in the process and recognition of musical patterns.

It is obvious that music is closely related with emotions, what in the Afro-American musical tradition is called “feeling”, even when it should not be considered as an exclusive feature of that genre. The emotional aspect that is inherent in any musical expression has a very wide range of forms. However, it frequently appears to be stronger in popular varieties, owing to a closer thematic and structural proximity with the living imaginary of the audience. This is the main reason why we can consider music as a whole experience. The interaction between time and space through that musical experience takes place everywhere, and involves both, the performer and the audience, since it can generate any kind of dance as well as poems and myths.

In the case of blues and its derived or interconnected varieties, a field that I have been studying for many years (Puig-Giralt 2009), we can note some common features that are the basis of its complex structure:

Spontaneous production: Popular music is generated from the social imaginary of shared traditions. This conditional feature leads to the emergence of a media phenomenon and an activity that generates empathy.

Genuine character: Honesty and truth are high values in themselves, as well as a powerful means to broadcast daily situations that can generate feeling in a process of intersubjectivity.

Non-canonicity: Free expression involves a creative process by breaking established norms and patterns, a feature that connect aesthetics with communication.

Syncretic origin: Different forms of music bring new perspectives that flow into new concepts. The hybridization of European folk music in the United States together with the Afro-American musical trends produced a syncretic stream that was projected in the notion of blues. In a similar way, popular music has its origins in flamenco, the fado, the French chanson and a wide range of musical media genres.

Connections on different social levels: Music is a democratizing experience and process, as emotions and imaginaries are shared in different social levels.

Whole music experience: Any immersion in a specific piece of music involves a kind of catharsis, since it can be perceived and experienced in different ways. Music can be danced, played and sung, or simply enjoyed as a live or recorded performance. Some kinds of sounds can even alter the state of consciousness, as percussion does.

The call and response frame: Although not quite a generalized feature, in terms of communication, the minimalist call and response frame acts as a very powerful and productive resource, as well as an empathic element of connection, in which the organization of musical patterns is concerned, not only with aesthetics but also with communication.

Thus, pop-rock music can be presented as a powerful and media phenomenon, as well as a catalyst for communicative situations, since it invites us to participate and to enjoy ourselves by means of different activities that frequently overlap. It involves a wide range of living and creative experiences, from the musical rhythm and lyrics to fashions, together with the technological advances.

However, owing to the musical canonical patterns of the nineteenth century, and even those found up to the mid-twentieth century, the blues and other non-canonical genres were considered literally as a "musical aberration". Blues was considered to break the rules of canonical European musical theory. Nevertheless, it is worth noting that the blues also includes some features of European music, not only from popular folk origins, but also from "official" cultural sources. Technically, the blues scale used to present a tonal alteration in the third and seventh degree that flows into a nearly neutral tone, the "blue notes", a specific feature in which the feeling effect is produced. This effect is no more than the synthony of sound with the psychomechanism of emotions. Experience worldwide has proved that many kinds of musical styles, not just blues, present complex structures that can be understood in many specific ways, not only in terms of the subject of the musical composition, but also with respect to a pure aesthetic realization in a complex communication circuit. Another issue in this area is why the minor scales often have a greater effect on the emotions than the major ones. Is the reason biological or cultural? In terms of complexity of thought is likely to be both, and may be connected by means of a feedback system.

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8 Education, Emotion, Complexity

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Abstract. An interest in improving education, beginning from a strong questioning of what its object is and continuing with an exploration of the role of emotions throughout life, guides a reflection on the complexity of education. Emotions enable the evaluation of oneself, of others and of reality. As the foundations of our uniqueness, they drive us to action and regulate our adaptation to the environment and are therefore presented as an anthropological feature. Integrating emotions with thought and action guarantees the unity of the individual. Therefore, ignoring the education of emotions (emotional intelligence) tends to reduce the complexity of the subject, of the human collective and of education. Together, these factors have an influence on all dimensions of education, including integrated education, learning and knowledge, participation, and governance in education. The complexity of education requires a thorough and progressive training and the optimistic and affectionate collaboration of all involved parties.

1 Introduction

The title of this paper conveys a sense of personal passage through the world of research into the quality of education, moving through the discovery of the role of emotions in life to the incontrovertible complexity of education and complexity theory.

Two positions have no doubt influenced the direction of this pathway. Currently, educational change, rather than focusing on substituting certain views and strategies for others (the traditional schooling/active schooling divide of the last century), takes the form of an accumulation of elements that should be considered both separate and also related, given that they have an influence on the educational process of the subject.

It is worth highlighting that parallel to this undeniable fact, the rigorous questioning of what the object of the education system should be, from the perspective of the various authorities involved, results in an inability to address adequately the complexity by which it is increasingly characterized.

The contributions of complexity theory shed light on many of the issues that are the subject of ongoing debate and that give rise to the defence of simplistic, individual perspectives presented as mutually exclusive, thus preventing a profound re-examination of the issues.

Rather than reconciling complexities, this polarization accentuates divergences and encourages the search for those considered responsible for the difficulties encountered in trying to reach satisfactory solutions.

In order to explain the impact of the function of emotions and how they relate to complexity, we will refer briefly to the theory of complexity and then enter the debate around the change of focus regarding the recognition of emotions.

2 References to the Theory of Complexity

As Dr. Àngels Massip stablishes in her chapter, and according to the reflections of three main authors (Maturana, biologist 2003; Prigogine, Nobel Prize winner in Chemistry 1983; Morin, philosopher 2001):

1. Cognition has strong links to brain-body, since cognition emerges from perception, emotion and action. Hence the importance of metacognition (*to know* knowledge).
2. Life is a process of autopoiesis. Living beings and their brains construct themselves.
3. Dialogic, complex thought is required to advance our understanding of complexity, and to explain multidimensionality, interdependence and paradox.
4. The sum of the parts is not the whole. The connections that exist between various units build new dimensions.
5. Ecology acts as both a global framework and as a limiting factor, connecting subjects to the planet. Humans are systems organized into social systems.

3 The Emotions, Here and Now

The discovery of the Theory of Multiple Intelligences (Gardner, H. 1983, 1995, 2001) and discoveries made in the neurosciences (LeDoux 1999, Damasio A. 1996, 2005) document the change of focus with regard to emotions.

To raise awareness of their contributions, some of their noteworthy statements are presented below:

* The active and abiding presence of emotions in all human activities.
* Faced with the exclusive predominance of reason, the influence of emotions in the process of the life cycle is affirmed. From love, to learning and growth.
* The cerebral reason-emotion-action link.
* There is an ongoing relationship between reason, emotion and action, through neural connections. This is called brain plasticity, thus making sense of lifelong learning.
* There is also a strong link between emotions and the body. In fact, we do not have a body, but rather *are* a body. Hence the importance of biology in our lives. This ranges from the struggle for survival to the role of emotions in health.

* There is an ongoing exchange between the interior (the self) and the exterior (other people, the world, the universe). The notion of learning system is thus confirmed as the foundation of development and learning dynamics.
* From the previous statement emerges the interdependence between "self, the other, other people", as the condition for becoming human. Human contact places us in our condition. There are historical situations that provide evidence of this fact, ranging from survival and adaptation to inferior forms of life.

As a result of the previous contributions it is necessary to explore different aspects that affect the educative process, incorporate new dimensions and rethink other, more or less common ideas, which distract us from the desired objective.

Currently we can say that the unity of the person is a product of the integration of thought, emotion and action.

Dispensing with the emotions is a simplification that mutilates the complexity of reality.

In fact it distorts the subject and reality, given that emotions are presented as an anthropological feature that forms an aspect of humanity.

Dispensing with emotional education is a simplification that isolates us from the individual and social experiences and the life adventure of the subject. It tends to reduce the complexity of the subject—all subjects—of the human collective, and of education. It also reduces the notion of system.

It is essential to take emotions into account and train people in their use, as is the case with other intelligences. This is essential for personal and social development, ethics and solidarity, learning and knowledge.

4 The Characterization of Emotions

In order to emphasize the role of emotions and the need for training in their use, a profound exploration is needed of those dimensions contributed by the latest research.

Emotions encourage self-evaluation, the evaluation of others and of reality; they represent an initial position that influences subsequent reflection from the cognitive dimensions, with which they are integrated, mutually influencing each other. In this way it should be acknowledged that they constitute the basis of the unique nature of each one of us. Diversity, not always well understood in education, has its origins in the integration of the three elements that make up the unity of the person, and undergoes changes throughout life.

Depending on the relationship between acceptance and rejection that drives our emotional state, the emotions regulate adaptation to the environment and drive us to act from desire. It is this determination to be interested, to do, or to do without, that guides life activity.

Beyond primary emotional choices, which may be positive or negative, we are able to train our emotions in a way that permits us to direct our own lives and establish positive relationships with others and with reality. This is what is meant by Emotional Intelligence.

4.1 Emotional Education

Two types of abilities exist in the field of emotional intelligence. These are briefly outlined below.

Intrapersonal or self-referential. These are the abilities that, as previously stated, permit us to direct our own lives. They comprise experience, awareness, knowledge, management and regulation of emotions, and they are the basis of self-esteem (feelings of worth, feelings of capability) always in reference to the other.

Interpersonal skills are the abilities to relate to others. They permit us to build relationships with others, to live and work together. They centre on *empathy,* an awareness of others that brings us closer to the other in their condition of self as I am a self, as human and as dignified as me.

It is in these capabilities that one can distinguish those related to coexistence (e.g., listening, dialogue, openness, confidence, assertiveness) pointing directly to exchange, and those referring to collaboration and working together (e.g., activities and group direction, decision making, conflict resolution).

We emphasize that there is an interdependence between the self and the other (a human being of worth and dignity like me) and between self-esteem and empathy; consequently, both are involved in personal maturity. This brings efficiency and satisfaction, it is related to the need to love and be loved, as a basic human need and source of happiness.

4.2 School Education

In schools, education is organized institutionally in parallel with the acquisition of knowledge adding complexity to what has been outlined above. It occurs in a global context that ranges from the relationship with the student and the direction of the group, exchange with other professionals in the school, parents, community education and the region, through professional and administrative regulations, to the curriculum, the educational plan, teaching and teaching materials, assessments and so on.

In this matrix, the interchange with others, together with the realities that define the environment, plays a fundamental role in this structure, which as previously mentioned is complex and diverse. The communication established basically depends on the emotional training of interpersonal skills as much as of intrapersonal skills.

A broad view of this situation leads us to see education as a complex task. Complexity theory warns against simplification, as a systemic relationship exists between all of its elements, demanding the necessary integration of opposites (e.g., the teacher's authority and the student's freedom) through dialogic thinking and preferential attention to those subjects with a role to play in reconciling the structure.

Managing complexity demands that the teacher exercises emotional competence in carrying out their educational task, and especially that they involve the students in this effort. Dr. Estalella, director of the 'Institut-Escola' (a secondary

school in Barcelona) from 1932 to 1939), responded to the question about the success of education, saying that it lies in the enthusiasm of the teacher.

Emotional competence is also essential for effective teamwork. Fundamental to tackling complexity within the framework of the school is emotional maturity, emotional and behavioural self-control, the ability to recognize complexity, the parts and their sum, the notion of system, and an optimistic attitude to life.

4.3 The Emotional Competence of the Teacher

It should not be forgotten that emotional competence is a dynamic concept that is the product of how we tackle the situations and conflicts presented to us. This is what is meant by lifelong learning.

What follows is a list of dimensions that teachers need to address to be emotionally competent:

* To integrate thought, emotion, action in all the dimensions of their lives.
* To use emotions as a source of self-awareness and an impetus towards personal growth.
* To direct the emotions to have an impact on self-improvement, and that of others and the environment.
* To acquire new emotional habits. Un-train ourselves, review inherited emotions, awaken dormant or forgotten emotions.
* To adopt calm, presence, sensitivity, fairness, affection, as features of an emotional style that makes us unique.

5 Rethinking Education

The collection of facts and reflections on complexity theory and the role of the emotions drives us to un-train ourselves (Bach, E., Darder P. 2004) and to rethink education.

We must move beyond the accumulation of partial truths unconnected to life or to its subjects, to manage uncertainty and prompt in-depth development.

This affects all dimensions of education.

We turn to the dimensions of particular interest to me. They cover a variety of aspects (integrated education, learning and knowledge, participation and governance in education) that give rise to new courses of action.

5.1 Integrated Education

This is considered to be the fundamental goal of education.

It is realized in the development of all the aspects of the person: physical-bodily, intellectual, emotional, emotional-affective, ethical, social. Taking into account all that is said in this article, we might add aspects ranging from biology to ethics, and even from cell to cosmos. It is possible to say that this matter has become a legislative priority. Yet it is not sufficiently present in current legislation.

Historically, preschool was the place for emotions. Compulsory education represented the progressive acquisition of knowledge of the life sciences. The educated person is someone who knows many things. Similarly, proposals for integrated training have been channelled through cognitive routes, lacking an emotional dimension, treating it as knowledge and not experience.

We consider the impact of the inclusion of attitudes, values and standards in the curriculum. The presence of these behavioural elements was limited to intellectual knowledge and they were not integrated into students' personal development. This also occurs within the basic competencies (which require social responsibility and a personal bond towards the acquired competencies), at a time in which Pedagogy increasingly affirms that education has an emotional dimension and that an emotional connection between teacher and student is necessary (Hargreaves, A. 1998).

5.2 Learning and Knowledge

Learning should be conceived as the construction of knowledge in the meeting place between the uniqueness—of the individual and the group—and the contributions and questions of science, and not merely as the acquisition of accepted scientific knowledge. Life is a construction, but science is presented as universal knowledge, complete, absolute.

This relates to Paulo Freire's quote, "No one educates anyone. All of us learn from each other, mediated by the world we live in".

Science generalizes; it ignores aspects arising from the scientific field itself. Different scientific fields are compartmentalized, failing to show the relationships that exist between them, failing to bring us closer to the complexity of life and of the subject.

The structure of the curriculum oscillates between subjects and areas and separates or fails to build bridges between sciences and humanities.

The subject of the learning develops their own life process (reason, emotion, action) in interaction with the other and with reality. The domination of learning by one of its elements, in this case the rational, is a limitation that, apart from not meeting the needs of the subject, distorts reality and contributes to promoting disinterest (in this case, to study or not to study).

Experiences lead to knowledge, resulting in learning engraving itself on life itself, "made up of genes and culture." The emotional dimension is an essential part of experience.

This is what K. Egan (1997) highlights in demanding the introduction of narrative in education, "... [T]he narrative must return human emotions to the curriculum, as only they bring meaning and understanding".

5.3 Participation and Governance in Education

As education plays a great role in the future of societies, the idea of the complexity of education also advances due to the overlap and interdependence between the different agencies involved and influencing the process. This influence goes

beyond the strict confines of the educational community, extending to the various institutions and stakeholders.

We recall the recent manifesto of the ESADE Forum, an event held by ESADE, an internationally renowned business school in Barcelona, which called for the participation of social institutions in the governance of education. Participation is two-fold: improving the quality of education and encouraging the personal growth of participants. Participation means engaging with the group, achieving the maximum possible consensus among the "parts" so that "everyone wins."

If we refer to the region where it is carried out, participation leads us to management in the sense that it provides us with the concept of governance. It is management and local government based in the region, from a global educational plan that guarantees the basic elements and counts on the responsibility of the participants. A change of this magnitude accentuates complexity and uncertainty (Subirats, J. 2008).

6 A Brief Final Consideration

In short, we want to emphasize the need to exercise a strong influence on the initial and continuing training of teachers and also to promote cooperation within the education community in order to overcome the constant criticism and discontent among stakeholders that impedes the acceptance of a new approach in order to overcome new challenges.

The complexity of education requires thorough and progressive training and the optimistic, affectionate collaboration of everyone involved.

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9 Minds and Screens: Communication and Socialization from a Complexity Perspective

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Abstract. This chapter presents an example of the application of the complexity perspective to the study of social reality. In particular, it focuses on analyzing the relationship between young people, media and education in today's society. First it examines the types of assumptions that often guide research in this field and that have contributed to a rather simplistic approach being taken to the study of young people and the media. Then focuses on a theoretical perspective commonly adopted in the social sciences and how this perspective has contributed to the on-going application of a non-complex approach to the study of children, young people, media and education. I point in which ways non-complex analysis of reality can be misleading and I contrast it with the complexity point of view. Lastly, I comment on possible ways to apply a complexity perspective when working on media education in the schools and when developing educational media.

1 Assumptions about the Relationship between Media and Young People

Perhaps one of the most common accusations leveled at the media is that children take a passive role in front of the multiple images that they receive daily from the many screens available to them. Since the arrival of the television in our homes, this has been a constant complain. With the advent of the Internet a few decades later, however, some people began to feel that children were more active when they sit in front of a computer than in front of a television (Tapscott 1998). Nevertheless the general assumption that using media leads to taking a non-active role in processing the information received is still a dominant one both in the public opinion and in the academia. At this point, we cannot deny that children and young people receive an increasing amount of information through the media. We also know that children face inherent risks in the type of information to which they have access and in the information they give about themselves online. (Livingstone 2009). However, we know very little about how children interpret the information they receive. We also tend too often to pay little attention to trying to determine the social and cognitive abilities that children and young people develop while using different media.

To accuse media, especially television, of creating in children an inability to distinguish between reality and fiction has also been a common discussion ground in the public sphere and in the academia. The basis for this state of opinion is that children and adolescents live in an increasing media-saturated world, with messages that often portray negative social models. Nevertheless, a question remains to be asked: to what extent do media messages have the power to replace the models that children are exposed to in their daily life, where their parents, school and friends play an important role? Could children really grow insensitive to violence just because they have watched too many fights on television, played with too many violent computer games, or had accessed to violent material on the Internet? The results of the several studies made on media violence and children do not seem to prove a direct long-term effect of media content on people's behaviour, but they do open up the question more broadly to the role played by other social agents such as the family, school, and peer group.

Other assumptions are also commonly accepted when looking at media in the school context. Perhaps the most important of these is the view that media consumption is a waste of valuable time and the major cause of failure to complete formal education.

These assumptions have some characteristics in common that are probably related to the way in which we look at the issue of media and young people, or more specifically, at the elements of reality that are there but have been overlooked. Very often, studies on child and teen media consumption express concerns over the possible effects that these communication tools might have on children's development and teens' social behaviour. The underlying assumption in most of these studies seems to be that television and computers are considered perhaps the most powerful socialization tool for today's children. However, and accepting that it is true that all forms of media are attractive to young audiences, and that some media contents -violence, advertising, sex- could not be considered a positive influence on young minds, this does not necessarily mean that the continuous exposure to media content can erase the socialization work of other agents such as the family, school and peer group cultures. Neither can we assume that media content reaches all young audiences in the same way. Child and teen consumption of media should, therefore, be analyzed taking into account the complexity of the context in which this consumption takes place. The omnipresence of screens does not replace the influence of other socialization agents such as the family, school and peer group. Rather, media have increasingly become simply another of the elements present in children's and young people's daily lives. This means that it is perhaps no longer accurate to refer to media as something new, special, or more powerful, or different. The media are there and should not be ignored, but they cannot be singled out since the experience of media consumption is continually mixed with other social and communication experiences in daily life.

To think of media consumption as a part of the communication and social habits of children and young people is a necessary approach if we wish to understand how children learn to distinguish between reality and fiction. When taking this perspective it is not new to conclude that the continuous experience of children with media language creates in them a solid ground for interpretation. For

example, children quickly learn that real stories, those that appear in the news, for example, do not have music in the background, or that close up shots of characters are common images in fiction but not in reality. Soon enough, advertisements, television series, news, movies, sports became genres that children learn to distinguish through the experience of consuming them. Another way in which children learn to distinguish between reality and fiction is hearing comments in response to certain contents when they are watching television with their parents. For example, a murder in a film would probably not generate much comment from the adults that are watching it. However, the news that someone has been murdered will probably be the subject of some adult reaction. In this way, children unconsciously learn how to distinguish between reality and fiction. Only very young children watching television on their own would fail to benefit from this contextual element of having an adult commenting on what they are watching. However, it's very rare to find children who are always alone in front of the television screen. Solitary consumption of media nonetheless does posse a problem in the case of the Internet. The question then is this: how do children learn to distinguish whether the information to which they have access is true or not? But this question leads to another question as well: how do adults know what is true or not in the Internet? Perhaps the only way out of this predicament, both for children and for adults, is to learn not to trust the information that appears on the Internet. Children should be taught to be cautious about the information to which they have access, and always double-check it by consulting other sources.

The assumption that consuming violent contents on television or the Internet could turn children and young people into violent individuals needs to be reconsidered as well. First of all, we need to clarify the concept of violence and determine whether we are referring to physical, verbal or psychological violence, or a combination of all of these forms, because some of these types of violence will be easier for a child to interpret than others. For example, psychological violence, such as attempts to lower the self-esteem of an individual, will perhaps not be understood easily by a child who is watching scenes of this type in a television series. Hitting or killing someone will be more obvious types of violence and therefore the subject of a correct interpretation by children watching them. However we should not forget that violence in fiction is not the same as real violence. Therefore, the effect that fictional violence may have on one, whether a child or an adult, should not be considered the same as the effect of a real experience with violence. Children and young people react in different ways to fictional and real violence. Whereas the first type does not seem to affect them, the second type does so in very strong and indelible way. This has been reported both in children, and in teenagers, in two of my studies dealing with violence and the media. In the first study, (Albero Andrés 1996) it was observed that children aged 7-10 years old were happy watching violent cartoons or playing violent games in the school playground. However, all the children interviewed for the study said that they did not enjoy watching the news because everything that appeared there seemed to be bad, and they knew that it was reality, not fiction. In the second study (Albero Andrés 2011) teenagers aged 12-16 made fun of scenes in violent movies but were deeply affected by violent acts that they had experienced in the streets.

These young people gave examples of robbery, street fights, of parents' arguing, riots, and drivers shouting at each other, as situations that they had experienced directly and that had made them feel fear, concern and rejection.

The assumption that children and young people waste valuable learning time in front of screens, and that this situation could be the cause of school dropouts, also needs to be reviewed from a complexity approach. First of all, we need to consider what types of cognitive and communicative skills might potentially be developed when children use screens, to what degree, from which individuals, and in what contexts. Only if we have this information can we possible channel this type of learning and take it into account when planning what, and how to teach in the schools. Secondly, it is important to learn the social, cultural and individual causes that lie at the heart of the failure to complete compulsory education. These causes could stem from students' individual contexts, but also from the little interest and low applicability to real needs that often characterize school subjects required of children, especially older children and adolescents. We should not forget that the organization of school and school subjects still common in most of the so-called developed countries is basically the same as it was a century ago, and it was created according to the social needs of that time. Yet, these needs have changed. Now society demands different skills and abilities that are often not part of the school curricula because school systems have not taken into account the socio-affective and cultural contexts in which teaching and learning takes place in the twenty-first century.

2 Causes of the Use of the Non-complex Approach

The questions that I have tried to pose above are aimed at illustrating the failure of taking a non-complex approach in the study of social reality. I would now like to comment briefly on the three grounds on which this approach has been used when studying the relationship between children, youth and the media.

The first one of these grounds has been the application of so-called technological determinism to the study of reality. That is to say, to believe that technology is the main and only engine that drives society. When applied to the study of media and society, this approach has tended to give media an omnipotent and omnipresent role that perhaps does not correspond to reality. Thus, the arrival of each new communication technology has been singled out in order to study its effects on people, especially on young people. In doing so, other elements that are part of the use of media technology, such as reception contexts, family relations, and the values of culture and age group, have been somehow neglected.

Technological determinism has, no doubt, been strongly influenced by the prevalence of social theories such as behavioural theory, which explains group and individual behaviour only as the response to external stimuli and the imitation of social models. Therefore, media messages, which are persistent, and attractive to audiences because of the use of images, have too often been the focus of studies that try to apply the stimulus-response paradigm to the relationship between young people and the media. Thus, the younger the audiences, the greater the tendency to consider them as passive individuals, unable to protect themselves from media

messages, and ready to imitate behaviour models that could easily replace their previous ones. In the meantime, little or poor attention has been given to the mind and how it processes and stores information. The role played by strong affective relations -such as the ones that children have with their parents, or adolescents with their friends- has also been overlooked with respect to how young people interpret media messages. Nor have Individual experiences been taken into account to consider how they too could provide grounds for young audiences to interpret media messages.

The application of behavioural perspectives in the study of young people and the media has been a common approach perhaps due to the fact that this type of perspective is solidly grounded in the common argument that things can only be one way or the other. Dichotomy thinking -thinking in terms of good or bad, right or wrong, yes or not, white or black,- has often lead to the view that the stimuli of media messages could only result in a good or a bad model. Thus, depending on the message, consuming media would be a waste of time or a way to learn. This is, after all, the origin of educational media, which was envisioned as a way to counter the bad effects of commercial television and to help schools achieve their educational goals. Yet, children do learn from commercial media, and are often bored by educational media. The question is: Who learns what and how from commercial media, and why many children not find educational media interesting? Obviously, any response requires us to look not only at the media messages but also at the complex individual and social contexts of young audiences and the cognitive development and affective relations that play an important role in these contexts. It can be argued that individual characteristics and messages received from other socialization agents, such as family or school, mix with media content in order to create meaning for the individual consuming them. Understanding how this process works and differs according to circumstances and individual personalities can only be attempted by using the complexity approach.

3 How a Non-complex Approach Misleads Us

When looking at how people, and especially young people, consume media, there has been a strong tendency to give little or no importance to understanding the role of the individual's cognitive processes in understanding media messages, and therefore to understanding the potential effects of media on people consuming them regularly. From the complexity point of view, this type of approach has lead to three basic conceptual errors which I will briefly explore below.

The first conceptual error is basically to centre the analysis on media content, and to assume that the appeal of the narrative forms displayed in the messages is enough to make children and young people accept these messages unquestionably. As I mentioned before, it is assumed that the media content turns into a model to be imitated. This argument has often been used in relation to media content portraying sex and violence, and advertisements that create new needs for the consumption of goods. However, this type of analysis has consequently ignored other aspects of reality that play an important role in the way messages are perceived

and understood. As I mentioned above, long years of experience watching television, provide young audiences with the necessary clues to understand when a message refers to reality or to fiction. Other elements also shape the way in which audiences interpret media messages. One of these elements is **context**. In this case, we can argue that interpretation may differ according to situational variations such as, for example, watching television alone or in the company of parents, friends, siblings, or other relatives. Another element of the context is the degree of attention given by someone to what they are watching on television. Children and young people do not interpret television messages the same way if they are intentionally watching a program and doing nothing else, or if they are watching several television shows at the same time and zapping between different channels, or when they have friends over and have a television on only in the background, while the major focus of attention is the conversation going on among themselves. Therefore, the original efficiency of the media content to send a specific message may definitely be altered by the degree of attention the audience pays to it at any given moment.

The degree of attention that young audiences are willing to give to media content is shaped by the degree of **motivation** that they might have to consume specific content. This motivation could be both individual and collective. One of the sources of motivation is the relationship between media content and consumption habits. Young audience may find a specific aspect of reality with which they identify. This identification could be based not only on aspects of everyday life, but also on the need for fantasy, especially in children. Thus, a television series that portrays conflicts among teenagers, and movies or television series that portray adventures of individuals who can change their shape and live in an imaginary world, represent the type of content that is likely to motivate young audiences to watch. However, not all the messages that portray teen conflicts or fantasy worlds generate motivation. This depends on the degree to which audiences can identify with the message, and on the capacity of young audiences to understand the message that they are watching. Motivation to continue watching a program decreases when children fail to understand what is going on. This is something that can happen when children watch adult programs with their parents. A good example of this situation is portrayed in a study about children's television habits and everyday contexts that I conducted some years ago (Albero Andrés 1996). All the 7-10 year olds interviewed during the research agreed that they especially disliked watching the news, not only because they were real, as I noted earlier, but also because they often failed to understand what the news was about.

Motivation to consume certain media messages is often linked to functionality, that is to say, to the role that consuming specific content could play in their individual lives, and, more importantly, in their social lives. Therefore, children may watch television just because they have nothing better to do, but would choose to be with their friends if given the option (Albero Andrés 1996). Also, young people would want to watch a specific television show, or a Youtube video because their classmates often talk about it, or spend hours surfing the net in search of information about their favourite soccer team or television series, or spend long hours

talking with their friends through Facebook because this gives them the opportunity to be in contact with many people at the same time, and even to continue topics of conversation started at school. In all these examples, media consumption responds to the functions of keeping a communication flow between young people (Albero-Andrés 2004), giving them something to do in their free time, or opening up a way to pursue their interests in a specific topic by surfing the net. In any case, the functionality of media consumption is based on the young people's needs and social and individual experiences, which come to guide how they use media. Therefore, media consumption among young people is not necessarily shaped by the attractiveness of the messages, but by their own capacity to select which messages to consume, how and when, according to the needs they have as individuals in an age group that lives in a specific socio-cultural and historical context.

More often than not, the non-complex perspective tends to ignore all the aspects of importance to an audience's age group when trying to understand the effects that media messages could have on young people. Therefore, it is often pointed out that young people have very little chance of escaping from the all-powerful influence of the media's messages, because their minds are not yet completely formed and able to fight against media influences. In the same line of thought it is also accepted that media may instil values and attitudes in young people that could be harmful for the further development of their adult personalities. However, little is said about any possible differences in how children and adults interpret media messages. The tendency, thus, is to consider that a child and an adult understand messages similarly. But when we look at reality more closely, it is possible to see that, for example, if a television cartoon portrays two people fighting, an adult watching the cartoon tends to think that this violence is a bad example for children, whereas children watching it, probably focus on the way the story is being told, or on the combination of music, colours, adventure and suspense, or on the fantasy world in which the story takes place. (Hodge and Tripp 1986, Albero Andrés 1996). The assumption that media messages can only be interpreted in one way seems to ignore not only the semantic richness of the messages themselves, but also the way in which cognitive processes shape the mind, -and therefore, the interpretation tools- that the audiences use to give meaning to these messages.

Children and adults do not and cannot interpret media messages in the same way because their experiences are different, and so is their degree of cognitive development. However, it is also dangerous to think that media users have a way of interpreting media that is only related to their age. That is, it is unwise to assume, for example, that all children aged 8-10 will give the same meaning to a media message, or that 14-16 year old teenagers also have a specific way to interpret media messages. We ought to be careful with these statements because, deep down, what they mean is that we are considering childhood or teenagehood as a homogeneous category. This is another result of taking a non-complex approach to studying social reality. Rather, it can be argued that there is not merely one childhood experience with media or of anything else, but several different experiences that are closely related to the complex social and emotional reality in which each child or teenager is growing. Young people build their motivations and

expectations not only according to the economic status of their families, but also in close relation to their affective experiences, and the culture to which they belong. Children and adolescents are located in different social and emotional contexts, which are rich, different and complex in meanings and experiences. Therefore, we need to think of childhood not as a homogeneous category but as a heterogeneous one.

It is often argued that the use of media, and the reception of media messages that are common to different cultural contexts, could have a globalization effect on how children and young people interpret reality. However, this is perhaps another result of looking at reality through non-complex eyes. What does cultural globalization mean? Is this a set of cultural forms that are alien to our own cultural values? Using the complexity approach, we could argue that the elements that come from outside our own cultural frame do not necessarily replace it, or remain separated from our own cultural forms. What is probably taking place is a process of continuous adaptation in which alien cultural elements mix with our own, creating a cultural setting that is both similar and different to other cultural settings that share with us the same media content and media consumption habits. Thus, it is a fact that children in the Western world spend a great deal of their free time connected to social networks, or watching the same television series, but this does not necessarily mean that young people will abandon other cultural forms that are common in their countries. For example, social networks will not stop Canadian children from joining ice hockey teams, or Spanish children from playing soccer together, or young people of different cultures from eating their national foods, even though they all eat pizza and hamburgers, too. Global and local cultural references tend to mix and create a complex reality that plays an important role in giving a different and specific background for the interpretation of media messages. Nevertheless, the non complex way of looking at cultures tends to separate what is local from what is global and treats them according to a dichotomy of local or global, while media dominated cultures are both local and global, or as Robertson (1995) and Bastardas-Boada (2007) suggest, "glocal".

4 Applying a Complexity Perspective to the Use of Media Products and Media Education in Schools

The relationship between media and schools can be used to illustrate the application of the perspectives of a non-complex approach versus a complexity approach. I will do so by briefly pointing out the way in which each perspective introduces media products in schools, and creates media education programs.

Since the advent of television schools have tried to incorporate all new media inventions into the classroom structure and school curricula. Thus, school systems around the world have generated needs to produce educational media. However, the media created for educational purposes have often played a role very similar to the role played by textbooks. It can be argued that, in general, television content, computer games, and the Internet have entered classrooms already converted into

educational material or educational tools that have had the general purpose of giving children and young people access only to information that has been previously selected, processed and structured according to the aims of the school subject and the school curricula in which they were intended to be used. Consequently, the information received in this way has frequently ended up being no different than the one given in a textbook. The information introduced via educational media has been intended specifically to give content to be learned and evaluated through the usual school tools, such as exams. In all these cases, the interest and motivation in the information presented through media in the classroom has been assumed to exist, simply because the support used to transmit the information – television and computers- was an attractive one. However, the degree of success achieved by introducing media in this way has been very moderate overall. Children have shown no special interest in school educational media, and school results have not generally improved with the use of television or computers in the classrooms. What went wrong? Perhaps we could argue that this lack of success stems from the use of a non-complex approach in thinking about media and school. In the decisions taken to use media in schools, it is rare not to find dichotomy thinking about entertainment media, versus educational media. But, might not all media messages be educational in some sense, and might not educational messages entertain as well?

The separation between entertainment media and educational media is an example of the tendency to think in terms of one thing or the other, common of a non-complex approach. However, if we try to think in the complexity terms proposed by Morin (1992), we should not think of educational and entertainment messages as opposites of one another. That is to say, we cannot create educational media by concentrating only on what we are saying or, assume that the results will be good because the message has been created for educational purposes. This is, apart from excellent exceptions, what has generally been the case with educational media. Thus, it can be argued that educational media have shown a tendency to overlook the importance of media language. Whereas rhythm, music, and camera movements are very carefully crafted in entertainment media, educational media have too often given more importance to the content of what is portrayed than to the way it is portrayed. This focus on content has resulted in messages in which there is too much being said or showed and too little time for the audiences to absorb and make sense of all the information provided. Thus, following the content of these materials soon stops to be a pleasurable experience for their intended school-age audiences and becomes something that must be done, no different from other school lessons. This, in turn, results in lower motivation and therefore in less interest and educational benefit on the part of young audiences.

The complexity approach could offer a way to improve this situation, because it takes into account the two important elements that lead to media consumption. The first of these elements is the good use of audiovisual language, i.e., the ability to create messages made up of more than simply nice or illustrative images. These messages should have a strong combination of images to create and maintain interest, generate expectation, and give information in a comprehensive way that can easily be understood by their target audience. The second element involves thinking about the context and the reasons why children and young people consume

media. It is important to bear in mind that media consumption takes place on a daily basis and is an activity linked to leisure time. Children and teenagers visit social networks to communicate among themselves, and use both new and traditional media to watch fiction. In these fiction messages, they want to find humour, fantasy, adventure, and the portrayal of situations and characters that can identify with their own lives and conflicts. Children and young adults can learn from media messages if what they are shown awakens and maintains their interest. In this way, learning does take place when young people consume entertainment media. This means that schools could probably use the media experiences of children and young people to develop educational content for the classroom context, which could end up being more effective than to produce a "one size fits all" type of educational media messages.

Recognizing that young people's media experiences are part of their educational processes is a way to incorporate in our research efforts the important role played by emotional factors in the interpretation of media messages. Violent scenes in movies, for example, could be a good way to start a class in which a teacher plans to introduce themes such as war and racism. These could, in turn, be part of a world history lesson in any school curriculum. A television series that portrays the situation of a family in which both parents have lost their jobs, could be a starting point for a discussion about economics and the financial crisis. A film that portrays a teen pregnancy could be used in a sex education class, but also in a biology class. In all these examples, entertainment media, and young people's experiences of them could become a strong foundation on which to build an educational message.

Using children's and young people's interpretation of media content could lead us to discover the cultural foundations shared by a group of children or teenagers of a specific age, living in a specific cultural context. For example, the way in which young people use social networks, or watch movies and television programs on-line, could give us important information on their needs, desires, expectations, motivations and problems. All these elements are reflected in the way children and young people choose and interpret media messages, and even create them. All of this should be taken into account when using media in the school context. Unfortunately, an age group's own perspective of its motivations and needs is something that has frequently been overlooked with the non-complex approach, which has typically favoured the needs of the school curriculum for a given age group when developing educational media. However, when applying a complexity approach, it becomes evident that a message and its interpretation cannot be studied separately. In order to understand the way that messages are interpreted, we need to look at the complex individual and group reality in which this interpretation will take place. This will give us the tools to create adequate educational media for the target audiences.

The strong use of audiovisual language, as well as the importance of emotions and of individual and age group cultural contexts in the interpretation of media messages, could form the basis of media education programs that adopt a complexity approach. However, very often media education programs have been built on the principle that teachers need to protect their students from the harmful

effects of media messages and media use. As a result, the main focus of media education in many school systems has been on limiting how and when to use the Internet in classrooms and on analyzing media messages from the teacher's point of view. This way of understanding media education, based on a non-complex approach, tends to perpetuate the principle that children and young people are passive individuals who respond to media messages and demands unconsciously and uncritically. As a result, it has generally been believed that a critical awareness could only be provided by the adults in charge of formal education. Nevertheless, the media education programs that have come out of this way of thinking have proved disconnected from media realities and young people and, therefore, quite ineffective. The main problem with these efforts is that they have not taken into account children's and young people's media experiences, as a starting point for media education.

I would like to conclude this chapter by examining the basis of a media education program proposed by David Buckingham (2005). This program tries to develop a critical view of media use, but always using young people's media experiences as a starting point. It might provide a good example of how to start working on media education from a complexity approach. The program revolves around four basic points: media language, media audiences, media products, and media representations. However, instead of having teachers lecturing on these subjects, as other media education programs tend to do, this program tries to give teachers the necessary guidance to be able to encourage young people to find out for themselves how images, sound and text work together to create meaning. Then, by talking about their media experiences, students learn how producers define their audiences, and how audiences interpret media messages and why. By letting the students talk about their media experiences in the classroom teachers can help students to learn about who produces, controls, and distributes media texts, and whose interest they serve. And, finally, students can also become aware of the way media represent reality. That is to say, what ideas, messages, values, people, groups, conflicts, are emphasized in media messages and why. The program is an effort to present the traditional focus of media education (language, audiences, producers, and products), but through the process of creating awareness through the students' experiences. This awareness is channelled through two types of activities. One of these activities is, as I mentioned above, to encourage class discussions on individual media experiences. The second is to provide an opportunity for students to create their own media, and then talk about it with the rest of the class group. In this way, students can understand their own choice of language, the audience they will address, the interests they serve with their media text and the ideas and values that they have included in, or left out, of their messages.

The study of the relationship between children and media and the decisions that derive from it, such as media education programs, could certainly benefit from a complexity approach. It is only a question of applying the principles that sociologists such as Edgar Morin (1973, 1992) developed some years ago and that have proved useful in helping us to understand that reality is a subjective interpretation of our socio-affective cultural minds. We have also learned, with Norbert Elias (1982), that social reality should be understood and studied as a process, which

means that we are studying something that is constantly changing. And, consequently, that social reality is more than the sums of its parts because all of these parts interact among themselves in different ways. Therefore, we can no longer think in terms of one thing **or** the other, but only of one thing **and** the other. This leads us to accept contradiction as a part of social reality. In the case of the study of media and young people, taking a complexity approach has helped us to realize that it is not enough to isolate elements of social reality in order to understand it. Understanding media consumption should not be merely a question of media accessibility, because it cannot be isolated from questions such who, when, how, why, and under what circumstances this media consumption takes place. Thinking about social reality in a holistic way gives us the opportunity to discover the extraordinary complexity of the socio-affective and cultural contexts of media reception and interpretation among young audiences. It is from this knowledge that we need to plan any institutional decision, such as the role that media should play in the educational system.

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10 Self-organization in Communicating Groups: The Emergence of Coordination, Shared References and Collective Intelligence

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Abstract. Complex adaptive systems consist of a large number of interacting agents. Agents are goal-directed, cognitive individuals capable of perception, information processing and action. However, agents are intrinsically "bounded" in their rational understanding of the system they belong to, and its global organization tends to emerge from local interactions, resulting in a coordination of the agents and their actions. This coordination minimizes conflict or friction, while facilitating cooperation or synergy. The basic mechanism is the reinforcement of synergetic interactions and the suppression of conflictual ones. As a result, the system as a whole starts to behave like an integrated cognitive "superagent". The author presents several examples of this process of spontaneous coordination that leads to distributed cognition, including the emergence of a shared vocabulary, the development of standard referential expressions, the evolution of transmitted ideas (memes) towards more stereotypical forms, and the aggregation of diverse experiences into collective decisions, in which the system as a whole is more intelligent than its individual components. These phenomena have been investigated by means of multi-agent computer simulations and social psychological experiments.

1 Introduction

In the last few decades a new scientific paradigm has been slowly emerging: *complexity* (Waldrop 1992; Heylighen 2008; Heylighen, Cilliers & Gershenson 2007). This paradigm departs from the reductionism, determinism and materialism of classical, Newtonian science by focusing on the non-linear interactions between the components of a complex system. Out of these interactions new properties or forms of organization emerge, a phenomenon termed *self-organization*. The present paper will sketch the basic ideas of the complexity paradigm, and then apply them to social systems, and in particular to groups of communicating individuals who together need to agree about how to tackle some problem or how to coordinate their actions.

This is a very common situation in any kind of social interaction: individuals typically come to the table with different backgrounds, habits, ideas, cultures, perspectives and even languages. To be able to communicate at all, they should first

agree about a common set of terms and what those terms mean. This is the emergence of linguistic conventions. Then they should agree about basic assumptions, such as what the situation is, what can be done about it, and what should be done about it. Finally, they will need to agree about who will do what when. If successful, this sequence of agreements will lead to a coordinated form of action, where the different members of the group contribute in an efficient way to a collective solution of whatever their problem was. This phenomenon, where a group of initially independent agents develop a collective approach to the tackling of some shared problem that is more powerful than the approach any of them might have developed individually, may be called *collective intelligence* (Heylighen 1999; Lévy 1997).

The emergence of collective intelligence is intrinsically a process of self-organization. If the process were directed by a single individual (say, the group leader), who imposes a consensus view on the others, then that perspective would not be more powerful than the perspective of the leading individual. In other words, the collective would not be in any way more intelligent than its leader. Self-organization happens in a distributed or decentralized manner: the different members of the group all contribute to the emerging organization, and no one is in control. This makes the process complex and intrinsically unpredictable, as tiny differences in the initial state (such as who speaks first, or which word is initially used to designate a particular item) may lead to very different outcomes. That is why such a process of group discussion and emergent interaction patterns needs to be understood with the conceptual tools of complexity science.

The paper will start with a short review of these concepts, contrasting them with the older, Newtonian paradigm. I will then elaborate these concepts to provide an integrated foundation for a theory of self-organization, to be understood as a non-linear process of spontaneous coordination between actions. Such coordination will be shown to consist of the following components: alignment, division of labor, workflow and aggregation. I will then review some paradigmatic simulations and experiments that illustrate the alignment of references and communicative conventions between communicating agents. Finally, the paper will summarize the preliminary results of a series of experiments that I devised in order to observe the emergence of collective intelligence within a communicating group, and interpret these observations in terms of alignment, division of labor and workflow.

2 Complex Systems

Classical science, as exemplified by Newtonian mechanics, is essentially reductionist: it reduces all complex phenomena to their simplest components, and then tries to describe these components in a complete, objective and deterministic manner (Prigogine & Stengers 1984; Gershenson & Heylighen 2005; Heylighen, Cilliers & Gershenson 2007). The philosophy of complexity is that this is in general impossible: complex systems, such as organisms, societies, languages, or the Internet, have properties—emergent properties—that cannot be reduced to the mere properties of their parts. Moreover, the behavior of these systems has aspects that are intrinsically unpredictable and uncontrollable, and that cannot be described in any complete manner. Finally, Newtonian mechanics assumes that all

changes are reversible, and therefore that there is no fundamental difference between the past and the future. Complex systems, on the other hand, are characterized by an irreversible evolution, by an "arrow of time" that points unambiguously from the past to the future, and that allows no turning back (Prigogine & Stengers 1984).

While these observations are mostly negative, emphasizing the traditional qualities that complex systems lack, complex systems also have a number of surprisingly positive features, such as adaptivity, autonomy and robustness, that traditional mechanistic systems lack. These qualities can all be seen as aspects of the process of self-organization that typifies complex systems: these systems spontaneously organize themselves so as to better cope with various internal and external problems and perturbations. This allows them to evolve and adapt to a constantly changing environment. Thus, the arrow of time tends to point towards an improved, better organized or more adapted version of the evolving system (Stewart 2000). This adaptive organization produced by self-organizing evolution can be seen as a form of knowledge or intelligence: the system has become better at solving the problems that confront it; it now "knows" what to do when confronted with a perturbation (Heylighen 2007b).

More fundamentally, the complex systems approach has done away with the old philosophy of dualism, which sees the world as made out of two distinct substances: *matter*, as described by the natural sciences, and *mind*, as described by the social sciences and humanities. In the systems approach, matter and mind are merely two different aspects of the same basic phenomenon of *organization*, with matter representing the simple, static, passive, causally determined aspects, and mind the more complex, dynamic, active, goal-directed aspects. As systems evolve, starting from elementary particles via atoms, molecules and organisms to brains, societies, languages and cultures, they become more complex and adaptive, and therefore more "mind-like" and less "matter-like". However, that does not mean that mind should be understood merely as a complex arrangement of pieces of matter: the material components themselves can already be conceptualized as having rudimentary "mind-like" qualities, such as sensitivity, intention, and action (Heylighen 2011). For example, a molecule may sense the presence of another molecule and act upon that molecule via electromagnetic interaction between the charged atoms in the molecule. Its implicit "goal" or "intention" in that interaction is to find a configuration that minimizes its potential energy.

The components of a complex system are commonly called *agents*. These are individual systems that act upon their environment in response to the events they sense or experience. Typical examples of agents used in complex system models are people, firms, animals, cells, computer programs and molecules. Usually, agents are assumed to be goal-directed: their actions aim to maximize their individual "fitness", "utility" or "preference". In that sense, their actions can be seen as *intentional* (Heylighen 2011): they are performed so as to achieve a particular purpose or objective. When no explicit goal can be distinguished, their activity still follows a simple cause-and-effect or condition-action logic: an agent will react to a specific condition perceived in the environment (cause) by producing an appropriate action (effect). However, this causal perspective is

essentially equivalent to the intentional perspective (which Dennett (1989) calls the *intentional stance*), because irreversible actions eventually lead to a so-called "attractor" of the agent's dynamics, and an attractor behaves indistinguishably from a goal or intention. This is the most fundamental sense in which the complex systems approach transcends the mind-matter duality: causal (material) and intentional (mental) models are essentially equivalent—even though the one may be more easily applicable in a certain context than the other.

The environmental conditions to which an agent reacts are normally affected by other agents' activities. Therefore, an action by one agent will in general trigger further actions by one or more other agents, possibly setting in motion an extended chain of activity that propagates from agent to agent across the system. Such interactions are initially local: they start out affecting only the agents in the immediate neighborhood of the initial actor. However, their consequences are often global, affecting the system of agents as a whole, like a ripple produced by a pebble that locally disturbs the surface of the water, but then widens to encompass the whole pond.

The spreading of a wave is not a complex phenomenon, though, because its propagation is perfectly regular and predictable, and its intensity diminishes as its reach widens. Processes in complex systems, on the other hand, are usually *non-linear*: their effects are not proportional to their causes. When the effects are larger than the causes, we may say that there is an amplification or positive feedback: initially small perturbations reinforce themselves so as to become ever more intense. An example is the spread of a disease, where a single infection may eventually turn into a global pandemic. Another example is the chain reaction that leads to a nuclear explosion. When the effects are smaller than the causes, there is a dampening or negative feedback: perturbations are gradually reduced, until the system returns to its equilibrium state.

Interactions with positive feedback are very *sensitive to their initial conditions*: a change in that condition may be so small that it is intrinsically undetectable, yet results in a drastically altered outcome. This is called the *butterfly effect* after the observation that, because of the non-linearity of the system of equations governing the weather, the flapping of the wings of a butterfly in Tokyo may cause a hurricane in New York. The non-observability of the initial perturbations means that the outcome is in principle unpredictable, even if the dynamics of the system were perfectly deterministic: no weather monitoring system can be so accurate that it senses all the movements of butterfly wings… This explains why weather forecasts cannot be fully reliable, especially for the longer term. Positive feedback will amplify small, random fluctuations into wild, unpredictable swings, making the overall behavior of the system *chaotic.* An illustration can be found in the erratic up-and-down movements of quotations on the stock exchange.

3 Self-organization

The concept of self-organization is becoming increasingly popular in various branches of science and technology. Although there is no generally accepted definition (Gershenson & Heylighen 2003), a self-organizing system may be

characterized by global, coordinated activity arising spontaneously from local interactions between the system's components or "agents". This activity is distributed over all components, without a central controller supervising or directing the behavior. For example, in a school of fish each individual fish bases its behavior on its perception of the position and speed of its immediate neighbors, rather than on the behavior of a "central fish" or that of the whole school. Self-organization establishes a relation between the behavior of the individual components and the structure and functionality of the system as a whole: simple interactions at the local level give rise to complex patterns at the global level. This phenomenon is called *emergence*.

The term "self-organization" was first proposed by the cybernetician Ashby (Ashby 1947). He noted that a dynamic system left on its own will spontaneously evolve towards what we now call an "attractor": a stable regime of activity towards which the system will tend to return even if disturbed. He further noted that in this regime the different components of the system are in a sense mutually adapted, so that they function in a coordinated, "organized" manner. In 1960, the first conference on self-organizing systems was organized (Yovitts & Cameron 1960). One of the contributors, Von Foerster (1960), formulated another fundamental mechanism: the "order from noise" principle, which notes that the more random variation (noise) the system is subjected to, the faster it will self-organize (create order).

A similar principle, "order through fluctuations", was formulated a couple of years later by the Nobel-prize winning chemist Prigogine (Nicolis & Prigogine 1977), who applied self-organization to explain the "dissipative structures" that appear in thermodynamic systems far from equilibrium. In the same period, the physicist Haken (1977) founded the domain of synergetics, a mathematical approach towards understanding the spontaneous cooperation that emerges in systems with many components, as exemplified by lasers and phase transitions. Another early application of self-organizing mechanisms were neural networks: computer simulations of how the neurons in the brain perform complex tasks (such as learning, classification, and pattern recognition) in a very robust manner without centralized control.

In the 1980s and 90s, the study of self-organization was deepened by the mathematical models from non-linear dynamics and chaos theory (Strogatz 2000), and by multi-agent computer simulations, which allowed the investigation of systems too complex to be modeled analytically. This led to the emergence of the field of complex (adaptive) systems (see, e.g., (Holland 1992, 1996)), which studies systems consisting of many interacting components, such as societies, markets, ecosystems, and the Internet. Most recently, the notion of self-organization has become popular in computer science and engineering, as a means to design robust systems that can function without centralized control (see e.g. Elmenreich et al. 2009).

At present, the concept of self-organization has diffused into virtually all scientific disciplines, as an explanation for previously mysterious phenomena in which

complex structures arise from the interactions between simpler components. For example, it has been used in cosmology to explain the emergence of order in the universe (Jantsch 1980); in ecology to understand the evolution of complex ecosystems (Odum 1989); in biology to study the coordination between bacteria, cells or individuals in animal collectives, such as ant hills, schools of fish or swarms of birds (Camazine et al., 2003); in medicine, to explain complex disorders such as epilepsy, heart disease and cancer (Coffey 1998); in linguistics, to model the origins of lexicons, grammars and phonetic systems (Steels 2005; de Boer 2000a,b); in psychology to explain the emergence of higher level cognitive structures (Stadler & Kruse 1990; Thelen 1989); in sociology and management to compare controlled, top-down organizations with spontaneous, bottom-up communities (Coleman 1999); in economics to better understand the "invisible hand" that governs the market (Witt 2006); in geography, to study cities and regions as self-organizing systems (Allen 1997); in robotics as a strategy to get simple agents to tackle complex tasks collaboratively (Holland & Melhuish 1999); in philosophy as a foundation for a new evolutionary worldview spanning all levels from matter via life to mind and society (Jantsch 1980; Prigogine & Stengers 1984; Heylighen, Cilliers & Gershenson 2007).

It seems almost as if the concept of self-organization offers a key to unlock a treasure chest of new theories and applications throughout science, doing away with all the rigidities and limitations of the traditional "top-down", mechanistic approach. In spite of these promises, however, the science of self-organization (Heylighen 2002) is still in its infancy. Researchers in different disciplines have studied a variety of examples of self-organization, but they typically take different perspectives and analyze different aspects. This makes self-organization a dynamic, but heterogeneous and rather confusing field.

In the following, I will therefore try to formulate a general conceptual foundation for the study of self-organization, and apply this to the emergence of collective intelligence in groups. This is an extension and clarification of my earlier work on the theory of self-organization (Heylighen 2002, 2009; Gershenson & Heylighen 2003). It will require first of all an analysis of the concept of organization.

4 Self-organization as a Problem of Coordination

Organization can be defined as *structure with function*: the components (agents) of the system are arranged in an orderly way (structure) so as to achieve a certain goal (function). This is the meaning used in sociology and management: a typical organization, such as a company or government institute, consists of individuals who are arranged according to specified lines of communication and control. This structure is intended to facilitate the work of the organization towards its goals, such as providing a product or service. When we reflect a little more deeply, though, the notion of structure tell us very little about how this arrangement is supposed to contribute to the achievement of a function. Why cannot the same goal be reached by an anarchic group of autonomous individuals each contributing his or her best effort?

The relation between structure and function becomes clearer when we introduce the notion of *coordination* (Crowston et al. 2006): what counts is not so much how individual agents are arranged (e.g. in some kind of hierarchy or network), but how their actions work together in a harmonic way towards their collective goals. At the very least, these actions should not hinder, obstruct, or oppose each other. This is what I have called the avoidance of *friction* (Heylighen 2007b, 2008, 2011). At best, they will smoothly complement each other, the one continuing the task where the other one stopped, or the one adding the necessary ingredient that the other one lacked. As such they can solve problems together that they cannot solve individually. This bonus added by collaboration may be called *synergy* (Corning 1998; Heylighen 2007, 2008). *Coordination* can then be defined as: *the structuring of actions in time and (social) space so as to minimize friction and maximize synergy between these actions*.

Coordination can be subdivided in four elementary processes or mechanisms: *alignment*, *division of labor, workflow*, and *aggregation*, which I will now discuss in turn.

4.1 Self-organization of Alignment

Alignment is the simplest form of coordination. It means that the different actions (and therefore also their agents) "point in the same direction", or, more precisely, *aim at the same target*. Every (intended) action has an implicit goal or target, which is the situation that would be reached if the action would be performed without any perturbation or obstruction throwing it off-course (Heylighen 2011). Imagine two individuals simultaneously pushing against a heavy object to get it out of the way. If the one pushes to the left (direction or target of the push), and the other to the right, their actions will oppose and thus obstruct each other. Assuming that the forces with which they push are equal, the result is that the object will not move at all, even though both agents may spend all of their energy pushing it. This is an extreme example of friction caused by a complete lack of alignment. Friction does not in general imply *conflict* between the agents, though. Perhaps the two individuals really want to reach the same overall goal, such as getting the obstacle off the road. However, because their actions are not coordinated, they effectively oppose each other. To minimize friction, they should somehow come to push in the same direction, i.e. *align* their actions.

Alignment is in general easy to achieve by self-organization. Assume that the two agents cannot see each other, so that they have no idea a priori of what the other is doing. Still, when pushing in opposite directions they will feel that their movement is blocked. Therefore, their natural reaction will be to try and push in a different direction. If the new push is not opposed by the other's push, the obstacle will move, and the agents will continue to push in that direction. With a little bit of trial-and-error they may further discover that by pushing in one precise direction, their push is not only not hindered, but actually fully reinforced by the other one who is pushing in the same direction. Once they discover this shared direction, their actions are fully aligned, and their effort is maximally productive. Therefore, each of them will continue to push in that direction, even without knowing that the other one is doing the same.

This example illustrates the mechanism of self-organization at the most elementary level. An action that is not succesful will normally be varied (*variation*). On the other hand, an action that is successful will be maintained or reinforced (*selective retention or multiplication*). Successful actions are characterized by minimal friction and maximal synergy. Therefore, the evolutionary mechanism of the blind-variation-and-natural-selection of actions will sooner or latter produce an interaction that is more synergetic and less frictional. This mechanism does not require any planning, knowledge, or intelligence on the part of the agents. The only assumption is that the agents obey a logic of trial-and-error or variation-and-selection, producing a variety of actions until they find one that is maximally productive and stick to that one, irrespective of what causes that increase in productivity. Therefore, self-organization is a process that occurs at all levels, from atoms to societies.

Note that this mechanism synthesizes the principles of self-organization originally formulated by the founding fathers of the domain. Ashby (1947, 1962) conceived self-organization as the automatic "selection" of stable states (attractors) by a dynamic system. Von Foerster (1960) and Prigogine (Nicolis & Prigogine 1977; Prigogine & Stengers 1984) added that such attractors will be reached more quickly by injecting "random" or blind variation into the system, a principle they called "order from noise", "order through fluctuations", or "order out of chaos".

We next need to explain how alignment can extend from a pair of agents to a group. Suppose three individuals are pushing against the object. If two by chance align, the object will tend to start moving in the direction of their alignment. The third agent will now quickly discover that the best way for it to move the object is to push in the same direction. The same logic applies to a fourth, fifth, etc. agent. The more are already aligned, the larger the force in the direction of their alignment, the more difficult it will be for others to oppose that movement, but the easier it will be for them to join in with that movement. Therefore, trial-and-error on the part of those others will settle more quickly on the direction of the initial alignment. This is a process of *positive feedback*: the more alignment there already is, the faster others will join it. As a result, all agents will quickly align, making the collective homogeneous in its direction of action (see Fig. 10.1)

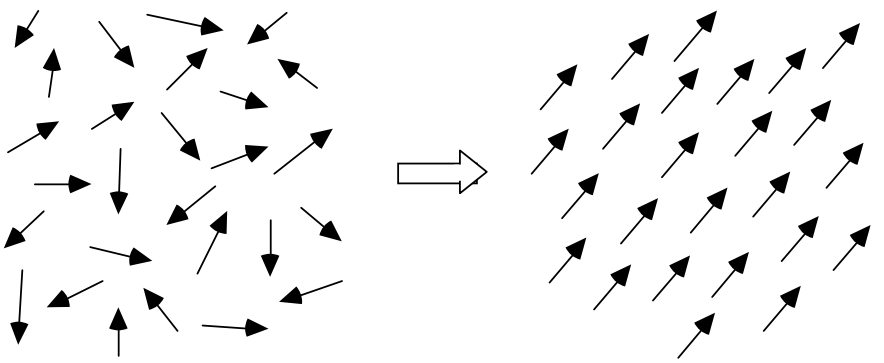

Fig. 10.1 Global alignment of directions of action, from random (left) to homogeneous (right).

If the agents are spread across an extended region of space, it may take a while for the alignment to propagate across that space, as more remote agents will initially not sense that in another region an alignment has started to form. Instead, the agents in one region may start to align on one direction, while those in another region align on a different direction. In this case, the space may subdivide into differently aligned regions (Fig. 10.2). This creates local homogeneity, but global heterogeneity. The borders between the regions will tend to be in the spaces where the initial interaction between agents are weakest, because agents are most likely to align with the neighbors they have the strongest interactions with. Along these borders, there is no alignment, and therefore there is still friction.

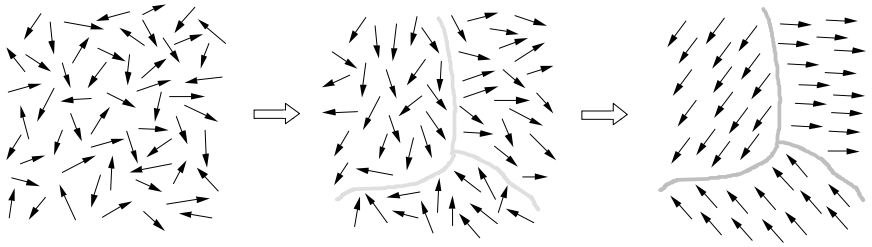

Fig. 10.2 Local alignment of directions of action, from random (left) to locally homogeneous, but globally heterogeneous (right).

This local or global homogeneization is a very common process in a variety of domains. Figures 10.1 and 10.2 were originally drawn to depict a process of self-organized magnetization (Heylighen 2006), in which a number of magnetized molecules, each with a magnetic field that initially pointed in a random direction, eventually become aligned—globally or regionally. The "goal" of these molecules is to minimize potential energy. This is achieved when their fields point in the same direction, because the North pole (arrow end) of a magnet is attracted by the South pole (non-arrow end) of a neighboring magnet, while two North poles or two South poles repel each other. Therefore, arrows pointing in opposite directions repel each other (friction), and thus will induce a change in direction, while aligned arrows will attract and therefore stabilize each other's direction.

Another classic example of such local alignment is cultural homogeneization, where people in a frequently interacting group will tend to converge in their dialectsbeliefs, attitudes and habits, while diverging from neighboring groups with which there is less interaction (Axelrod 1997; Van Overwalle & Heylighen 2006). This is the origin of relatively homogeneous cultural groups such as languages, religions, and ethnicities. As noted, the boundary between such culturally homogeneous groups is the place where most friction remains. (Lim et al., 2007) made a computer simulation of social self-organization that illustrates how locally homogeneous regions can emerge from an initially heterogeneous population. By focusing on the boundaries between these emerging regions, the simulation managed to successfully predict the spots where conflict would erupt in ethnically heterogeneous countries such as former Yugoslavia and India. We will examine such communicative convergence in more detail later.

4.2 Division of Labor

Alignment of agents and their actions is a first requirement for them to work in a coordinated, organized manner. However, if all agents merely act in the same way, their combined action will be at most quantitatively more powerful than their individual action. For example, ten agents can push a weight that is ten times as heavy than the weight pushed by a single agent. But you cannot build a house using only agents that lay bricks; you will also need the expertise to dig foundations, do carpentry, lay electricity, install plumbing, paint, etc. To reap the full benefits of cooperation, different actions need to complement each other. Only then can the activity as a whole achieve more than the sum of its parts.

This assumes that different agents perform different tasks, each specializing in what it does best. Since each agent is limited in its abilities, the one may compensate for what the other one lacks so that together they can solve a problem that requires a diverse array of skills. But the problem then becomes one of the *division of labor*: who does what? Assuming that there is a variety of different tasks to be done, and a variety of skills distributed among the different agents, so that each agent is skilled at different tasks to different degrees, the coordination problem becomes one of optimally matching each individual with each task. At first sight, this requires a supervisor having an extensive knowledge both of the necessary tasks and of the individuals' degree of skills, and the intelligence necessary to conceive of all the different possible permutations of agent-task assignments and to select the best one.

Yet, the problem allows for a simple, self-organizing solution. Assume that agents prefer to do the tasks they are most skilled at, because those are the ones that will cost them least effort. In that case, it suffices for the different tasks to be laid out in such a way that all available agents can examine them. As soon as an agent recognizes a task that it is particularly skilled at, it will pick up that task, leaving less fitting tasks for the others. Thus, the number of remaining tasks will gradually diminish. There is of course the risk that the remaining tasks fit none of the remaining agents, but we can make the assumption that all agents are flexible to some degree and can if necessary do a task they are not particularly skilled at, albeit less efficiently. In this way, the different tasks will get performed in an overall rather efficient way, although the arrangement may not be optimal. (Such less-than-optimal, but more-than-acceptable performance is what we normally find in the real world, as opposed to the idealized world of mathematical models, where things tend to work either perfectly, or not at all…).

One example of such self-organizing division of labor is Wikipedia, the Internet encyclopedia that is being written collaboratively by millions of people worldwide. No "editor-in-chief" has divided the labor among the contributors, by specifying which expert should write a page on which subject, as is done in traditional encyclopedias. Instead, the "experts" have self-selected by starting to write, adding to, or correcting any page for which they felt they had sufficient competence to make a contribution. Thus, a football supporter may add something about the scoring percentages of his favorite team, while a butterfly collector may contribute something about the color patterns of her favorite species.

Another example of such self-selected specialization is an ecosystem in which different species specialize in exploiting different niches. Individuals of each

species will explore many different habitats and ways of life withing their complex environment. If they find one that suits them, they will stay and thrive. If the present one does not suit them, they will move on until they find a better one (or be eliminated from the scene). Thus, different species and individuals specialize in exploiting the different niches that are available.

With some minor variations, the same process happens in a market economy: different businesses spread out and specialize so as to maximally fill each of the available niches, i.e. delivering the specific products and services for which there is sufficient demand, and for which their competence in delivering it is at least as good as the one of their competitors. This form of self-organizing allocation of agents (firms) to tasks (supplying goods and services) is sometimes referred to as the "invisible hand" of the market (Witt 2006). While in practice the solution will never be optimal, it has proven to be far superior to the alternative of a centralized economic planning, as practiced e.g. in the Soviet Union. The reason is that the "calculation problem" of establishing exactly how many goods of which type need to be delivered by whom is much too complex to be solved by any planner. Only self-organization can produce robust solutions to problems of such complexity and variability.

4.3 Workflow

Division of labor coordinates activities that happen simultaneously—in parallel. *Workflow* (van der Aalst & van Hee 2004) is its complement: it coordinates activities that take place the one after the other—sequentially. The name derives from the image of an unfinished piece of work "flowing" from one worker to the next, as if carrried by a conveyor belt in a factory assembly line. In general, a complex activity, such as building a house, happens in subsequent stages, and the later stages (such as painting the walls) cannot be performed before the earlier ones (such as building a roof and plastering the walls) have been finished. Planning and scheduling such a branching sequence of mutually dependent activities may seem to require an intelligent and knowledgeable supervisor, supported perhaps by specialized management tools, such as Gantt charts or PERT networks. Again, self-organizing solutions to the problem exist that function quite effectively.

The mechanism is similar to the one underlying the division of labor. An agent that has finished the task it initially selected will normally look around for other tasks that might fit its profile. If one of those tasks becomes available, e.g. because another agent just finished executing that part of an activity it felt competent at, but stopped when it no longer felt able to continue, the first agent will pick up the work where the other one left off. For example, a brick layer may leave a wall as soon as all the bricks are in place, and thus make room for a plasterer to cover and smoothen the rough brick surface. When the plaster covering has dried, a painter may then finish the work by coating the wall with paint.

While this type of spontaneous follow-up is rare in modern, centrally managed organizations, it is the rule in animal collaboration. For example, an antelope being chased by, but escaping from, one lion, may run straight into the path of another lion who is waiting in the bushes, ready to jump when the antelope comes near. In this way, the lions (or other cooperating predators) can coordinate their actions without need for central planning. Social insects, such as ants and termites,

similarly perform complex activities both sequentially and in parallel, the one taking over from the other whenever the occasion presents itself to carry on with a task that is unfinished. The same type of spontaneous follow-up happens in conversations or group discussions where one person proposes an idea which then inspires another one to add a further refinement, which then may elicit a correction from a third person, etc.

As long as a large enough number of agents with sufficiently diverse or broad skills is available, such a self-organizing solution to the problem of workflow can be quite efficient. There is no need to plan when a particular agent should execute a particular task, as long as enough agents are available so that a sufficiently skilled one is ready to take over soon after the previous task is finished.

4.4 Aggregation

To fully reap the benefits of synergetic action, we need a final mechanism of coordination: *aggregation*. Different agents contributing different actions at different times to a joint activity will be most effective when the fruits of their activity are assembled into a final product. This process of collecting all the contributions and synthesizing them into a coherent outcome may be called "aggregation" (Surowiecky 2005). Like division of labor, aggregation is a parallel process: different streams of activity come together simultaneously. However, while division of labor is a branching process, where an activity is split up into smaller, independently executed tasks, aggregation goes the other way, letting the branches converge again into a single result. Division of labor, workflow and aggregation can be seen as the three fundamental aspects or dimensions of a complex, branching network of mutually dependent processes—as depicted in Fig. 10.3.

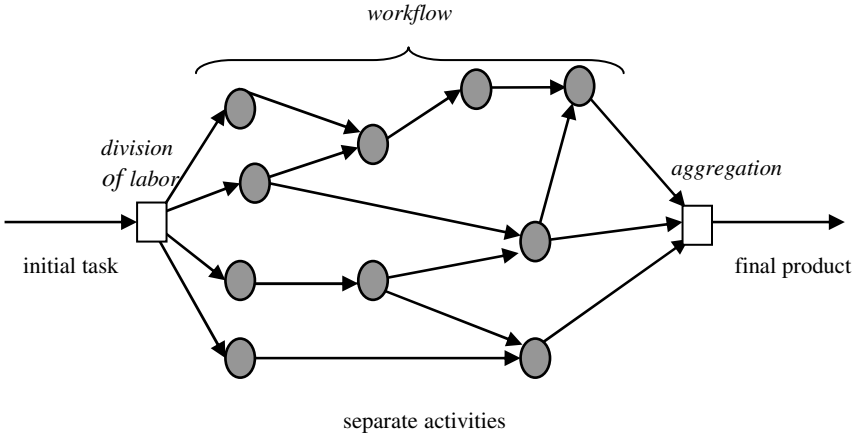

Fig. 10.3 Coordination in which an initial task is split up in separate activities performed by different agents (division of labor), which are followed by other activities (workflow), and whose results are assembled into a final product (aggregation). Grey circles represent individual agents performing activities. Arrows represent the "flow" of work from one agent to the next.

Aggregation too allows for self-organizing approaches. The simplest one is when the different actions superimpose their results on a shared substrate or medium. For example, the work done by the different builders and technicians on a house accumulates in the physical building itself. There is no need to assemble the plumbing with the electrical circuitry as both have been installed on the same walls. But aggregation via a shared medium can also apply to more abstract, informational activities. Again, Wikipedia provides an excellent example: the different contributions to this encyclopedia of global knowledge are aggregated automatically because they are added to the same website (Heylighen 2007a). Without this shared electronic medium, assembling the millions of contributions into a coherent whole would have been a task of gigantic proportions.

A similar example can be found in the organization of ant societies. Ants that have found food leave a trace of pheromones on their way back to the nest. In that way, they gradually develop an extensive network of pheromone trails connecting their nest directly to all the surrounding food sources. Discoveries of new sources or shorter routes are automatically aggregated into this collective "external memory", as the different pheromone trails are simply superimposed on the shared physical environment. Paths that are shorter or that lead to richer sources will collect more pheromone relative to less productive paths, so that the network continuously "learns" from the aggregate contributions of the individual ants, becoming ever better (Heylighen 1999).

A different form of self-organizing aggregation occurs when the products of the different activities can interact and develop links or "bonds", where the one fits in with the other (Heylighen 2006, 2011). The examples we discussed before of the spontaneous division of labor in ecosystems or market economies are also examples of spontaneous integration. Businesses or species not only differentiate from other businesses or species in order to better occupy as yet unclaimed niches, they also connect themselves to other businesses or species as providers of resources or services that they need for their own functioning. Thus, a typical business will be a tightly linked hub in a network of suppliers, clients, employees, regulators, and other stakeholders that all depend on each other. Together, they form an integrated socio-economic system that performs a coherent set of functions for society. The mechanism behind this is again variation and selection: agents interact with many other agents. If the interaction is succesful, they will tend to maintain it (selective retention), thus creating a stable bond of mutual dependency. Otherwise, the interaction will be stopped (elimination) and replaced by another one.

5 Collective Intelligence

5.1 Requirements for Collective Intelligence

The examples of self-organizing coordination we discussed up to now were mostly based on physical interactions. I now want to focus on purely informational interactions, where the problem to be solved as well as its eventual solution is formulated abstractly, in the form of questions and answers. Solving abstract

problems requires intelligence. When this intelligence is localized in a single agent, it may be called individual intelligence. When it is distributed over a group of agents, it may be called *collective intelligence*: it is only the group as a whole that is capable of solving certain problems (Heylighen 1999). Collective intelligence assumes that different agents have different forms of expertise (knowledge, information, skills). Otherwise, they would not be able to do more together than individually. Achieving collective intelligence therefore is a problem of cognitive coordination between the different agents. This can again be split up into the four basic mechanisms of alignment, division of labor, workflow and aggregation.

Alignment means that the agents should point at the same targets, so that they do not work at cross-purposes. This implies that agents should agree at least about what the problem is that is to be solved, and about what the different tools or methods are they may need to tackle it collaboratively. However, alignment here does *not* mean that the agents should perform the same actions, because in that case there is no collective intelligence. Adding identical efforts together, like when a number of agents push a heavy weight in the same direction, only makes sense when performing physical tasks, not when processing information. Indeed, when you add a piece of information (e.g. X=3) to the same piece of information (X=3), you still only have a single piece of information. Therefore, a division of labor, in the sense of different agents contributing different information, is essential. Depending on the complexity of the problem, workflow may or may not be needed. Some problems can be solved in a single step, all agents simultaneously contributing their expertise. Others need several iterations, the one building further on the previous one. But the final step of aggregating all the contributions remains essential in order to come to a coherent answer.

Note that this analysis can be seen as a deepening of the analysis of collective intelligence proposed by Surowiecki (2005). After discussing many examples of successful and less successful cognitive coordination, Surowiecki proposes the following list of requirements that a group must fulfil to exhibit collective intelligence (or *wisdom of crowds*, as he calls it):

- *Diversity*: the more diverse the knowledge and experience possessed by the different members of the group, the more the group as whole knows and the less its members are likely to overlook certain aspects, or to fall prey to the same bias.
- *Independence*: individuals should express their contribution as much as possible independently from other members of the group; otherwise, when the opinion of the one is influenced by the opinion of the other, there is a risk of *premature alignment*, i.e. between the contributions themselves rather than between the targets of the contributions.
- *Decentralization*: this Surowiecky's term for what we have called "division of labor": people should as much as possible be able to gather and process their information in parallel, so that they can together cover an as wide range of aspects as possible.

- *Aggregation*: collective intelligence requires an effective mechanism, such as voting, averaging or discussion, for synthesizing a diversity of individual opinions into a single, collective answer.

5.2 Groupthink and Polarization

The most important issue in such collective processes is to avoid what Janis has called "groupthink" (Janis 1972; for a review, see: Esser 1998). This is the phenomenon where people in a group all start to think the same, because a slight initial preference for one approach rather than another becomes amplified via positive feedback. The underlying dynamic is that if someone hears an opinion expressed by someone else, s/he will be more inclined to express a similar opinion. This happens partly because hearing a certain approach will "prime" the mind to consider things from the same perspective, partly because people tend to be conformist, and do not like to contradict or appear to be in conflict with others. The more often similar opinions have been expressed, the less likely group members are to express dissimilar opinions—partly out of conformism, partly because the more they hear a particular position defended, the more they will get convinced that this is the right one, and the less they will be inclined to think of alternatives. In that way, they may all quickly converge to the same opinion, without giving potentially better alternatives the chance to be duly considered.

A more extreme version of this process leads to the phenomenon of *group polarization* (also known as "risky shift"). This refers to the common observation that groups tend to be more extreme in their judgments after a discussion than the members were individually before the discussion (Isenberg 1986; Sunstein 2002). "More extreme" here means deviating more from the middle ground. For example, if jury members are individually inclined to judge a crime relatively harshly (e.g. proposing a 15-year prison sentence on average), after the debates they will tend to judge it even more harshly (e.g. deciding on a 25-year prison term). If a different group is asked to judge the same crime, but the members are individually inclined to be more lenient (e.g. proposing a 10-year sentence on average), as a group they are likely to come to an even more lenient judgment (e.g. a 5-year sentence). Polarization can be explained by the positive feedback underlying alignment, which amplifies deviations: the more people hear arguments for a "risky" position, the more they will think themselves of additional arguments for that position, and the more confident they will become in moving further away from the "safe" middle ground (Isenberg 1986).

Groupthink is an example of self-organization gone wrong, where non-linear interaction has led to premature alignment on a suboptimal solution, and where the positive contributions of diversity and division of labor have been neglected. Janis (1972) has documented several cases in which meetings of otherwise very knowledgeable individuals succumbed to such groupthink, resulting in catastrophically poor collective decisions (such as the failed "Bay of Pigs" invasion of Cuba by US-supported troops).

5.3 Avoiding Groupthink

The simplest way to avoid groupthink is to disallow direct communication between the group members, so that the one cannot influence the other one until everyone has been able make a full contribution. However, a collective solution still requires an aggregation mechanism that integrates these different contributions.

This is perhaps easiest to achieve when the looked for solution can be expressed as a number. In that case, everyone can independently make an estimate of the correct number, e.g. by writing it onto a piece of paper. The pieces are then collected, and the final solution is aggregated by calculating the average of the numbers. In many cases, this produces remarkably good results. For example, when at a fair people are asked to estimate the number of beans in a jar, or the weight of a bull, the average of their guesses is typically much more accurate than even the best of the individual guesses (Surowiecki 2006; Heylighen 1999). The reason is that each individual guess is biased by the limited experience of that individual, making the estimate either too low or too high. However, when many independent estimates are aggregated, these "errors" or deviations from the optimal solution tend to be "averaged out", because of the law of large numbers. This phenomenon can be demonstrated through agent simulations even for more complex problem solutions (Johnson 1998), as long as the solution can be expressed as a sequence of numbers that need to be averaged, and as long as the individual agents vary randomly in the errors they make.

However, when different individuals tend to have the same bias (e.g. all overestimating the weight of the bull), their aggregate solution will exhibit that bias too, and the best individual estimate will be more accurate than the average for the group.

The averaging method only works for quantitative decisions. Some of the most common methods, such as discussion in committee meetings, do not obey the criteria of independence and decentralization, and therefore may lead to poor results. The result can be improved if the different members express their opinions independently and anonymously (e.g. on a computer-supported discussion system) before they start responding to the opinions of others, and if the discussion is guided by a neutral moderator, who ensures that everybody duly answers all the important questions, and responds to criticisms of their previous answers. The anonymity makes sure that everybody's ideas are given equal attention (instead of the discussion being dominated by the more authoritative people). This is the basis of the so-called Delphi method (Linstone & Turoff 1975) that aggregates the ideas of a panel of experts, via several rounds of anonymous, mediated discussion.

6 The Self-organization of Shared References

In the examples of collective intelligence up to now, we assumed that the participating individuals either are able to communicate their positions to each other, or that there is a mechanism in place that aggregates their contributions. However, group self-organization is also fundamental to the emergence of communication itself.

6.1 The Origin of Language

The evolutionary origin of language is shrouded in mystery, since speech does not leave any traces in the fossil record. The only evidence available about how, when, or why human language emerged is extremely indirect (Christansen & Kirby 2003). This includes the use of primitive signaling cries in monkeys (Donaldson et al. 2007), the appearance of symbolism in paleolithic painting and sculpture, and the changes in the anatomical structure of the head and neck that may indicate the evolution of better vocal cords or specialized language centers in the brain. While it may be impossible to pinpoint exactly how primitive humans developed something that resembled modern language, we can get an understanding of the general process via which languages emerge.

Probably the most famous illustration can be found in the work of Steels and his co-workers (Steels 1998; 2005; Steels & Voght 1997; Steels & Belpaeme 2005), who made a series of simulations of the self-organization of the fundamental components of language. The simulations start with a group of software agents or robots (hardware agents) that have to learn to communicate without any a priori shared language. I will here only discuss the simplest simulations, which are focused on the emergence of shared references ("names") for observable phenomena.

An essential requirement for linguistic communication is that the participants should use words or symbols ("signifiers") that refer to the same entities ("signifieds"). A word stands for, represents, or denotes some concept or object that is different from itself. That external phenomenon corresponds to the "meaning" or "signification" of the word. This property of referring or "pointing" to something else is called *intentionality* in philosophy, where it is considered to be an essential characteristic of mind or intelligence (Pierre 2010). The concept of intentionality is to be understood so broadly that it applies not only to linguistic, symbolic or cognitive reference, but also to the goal-directedness that is inherent in intentional action. Having an intention means that your (future) action is directed towards a particular target, i.e. towards a particular situation that you desire to achieve or towards a potential means to achieve it. This is not just a philosophical point: such broad interpretation of referentiality/intentionality is necessary to understand the emergence of language in groups of animals, who do not clearly distinguish between symbolic reference (this signal refers to a predator bird that has been spotted), and goal-directed signalling (this signal means that you need to run for cover). (Donaldson et al. 2007) illustrate in a computer simulation how such "functional reference" systems can self-organize in animals under the influence of natural selection, starting from purely goal-directed ones while gradually becoming more like symbolic ones.

To shift from individual intelligence to collective intelligence, we need to make intentionality collective as well (Heylighen, Heath & Van Overwalle 2004). Words and other symbols can only be used for effective communication if the conversation partners understand them in the same way, that is if they agree about wat the word refers to. Developing such shared references is a problem of what we have called *alignment*. We have defined alignment as the unification or merging of the targets of different actions or agents. As long as there is no "director" agent

to impose a target on the others, this problem can only be solved through self-organization, that is, spontaneous, reciprocal adaptation of the agents' targets.

The artificial intelligence researcher Luc Steels (1998, 2005) has shown via computer simulations how a group of agents can come to "agree" about the meanings of the symbols they use, i.e. learn to use the same symbols or "names" for the same concepts, via a process of self-organization. The simulation starts with a group of agents, a collection of objects (potential referents) to which the agents can point, and a preliminary lexicon of words or potential names for the objects. Initially, the associations between a name and an object are randomly distributed across the agents, meaning that two agents will in general use different names for the same objects. To achieve alignment, the agents start interacting in pairs of randomly chosen individuals, so that they can learn to mutually adjust their associations.

The basic interaction is called a "naming game": agent X points to an object (e.g. a square), and agent Y formulates a name for this phenomenon (e.g. "bli"), i.e. the symbol that Y would use to represent this phenomenon. X then indicates agreement (if X would use the same name), or disagreement. If there is agreement, the association that exists in both agents' mind between the symbol ("bli") and the referent (square) is strengthened. If there is disagreement, the association is weakened in Y (for whom it was strong), but strengthened in X (for whom it was weak). In that way, after each encounter, the associations for the two agents become a little bit more similar: they have partially "aligned" their relations of reference or intentionality. This game is repeated a large number of times, with different pairs of randomly chosen agents who point to different randomly chosen objects and try to name them.

The general dynamics can be understood in the following way. Each time agent X encounters another agent that uses the name "bli" for the object "cube", X's association between that name and the referent becomes a little stronger, until it is stronger than any other association X has between that name and a different referent. At that moment, X too will start to use the name "bli" for the phenomenon "cube", and thus start reinforcing that association in other agents. Thus, names that happen to appear a little bit more frequently in the initial interactions will rapidly become more "popular", until all agents "agree" on using them. The simulation shows that as the game is repeated, the associations between the various symbols and concepts become more similar for the agents, until they are fully aligned. The result of this self-organizing process is the emergence of a shared vocabulary. This is the foundation for a language that the agents can use to communicate symbolically.

I will not here go into the further simulation research of Steels and his colleagues which illustrates how also other aspects of language, such as semantic categories (Steels & Belpaeme 2005), phonetics (de Boer 2000ab) and grammar (Steels 2005), can self-organize out of random interactions. Although the rules that govern the individual interactions may be more complicated for these cases, the fundamental mechanism of mutual alignment that is amplified and propagated via positive feedback remains the same. Instead, I want to briefly review research into the phenomenon of communicative alignment that focuses on real people rather than on computational agents.

6.2 Conversational Alignment

One disadvantage of working with human beings is that you cannot afford to have hundreds of individuals each interacting thousands of times, as software simulations typically do. Therefore, it is difficult to observe the emergence of a true language within a realistic community. Yet, we can easily study the phenomenon of communicative alignment within a conversation, i.e. a sequence of one-to-one interactions that is limited in time.

Such alignment tends to take place at many different levels (Garrod & Pickering 2007; Krauss et al 1995): intonation, rhythm, lexicon, reference to context (Heylighen & Dewaele 2002), grammatical structure, etc. The dynamics is always the same: when an individual hears the other partner use a certain pronunciation, expression, reference, or grammatical construction, this will "prime" (i.e. weakly activate or prepare) the cognitive structure that the hearer uses to understand and produce that form of communication (Bock & Griffin 2000). Therefore, when the hearer becomes a speaker, (s)he will be slightly more inclined to use the same (or a similar) communicative form. This in turn will make it more likely that the other individual will again use a similar form. Thus, subsequent uses of the form will reinforce each other until the conversation partners converge on always using the same form.

This is the same mechanism of alignment that underlies all self-organization: by reducing the friction that is otherwise caused by the need to recognize and interpret a novel form and because of the high probability of confusion that arises if the conversation partners use different forms, alignment on the same forms makes communication more efficient. As shown by many experiments and observations, one-to-one alignment is a very quick and automatic process that makes conversation much easier than it would be if the partners would have to explicitly agree about how they refer to the different items in their shared context (Garrod & Pickering 2004).

Conversational alignment will not only produce shared references; it will moreover tend to make those references simpler and more efficient. This has been established in a number of experimental studies of referencing, which examine the process by which people establish a shared perspective during a conversation (Schober & Clark 1989; Wilkes-Gibbs & Clark 1992). In a typical experiment, one person is designated as the "director" and is given the task to describe a number of pictures to a "matcher" who cannot see what the director sees but has to identify the pictures. In order to solve the problem, both participants have to coordinate how they will refer to the pictures. On their first reference to one of the pictures, most directors use a long description, listing detailed pictorial features, in order to make sure that the hearer understands what they are talking about. Then, matchers typically ask questions if the description is not fully clear to them, or confirm that they understood the directions (e.g., Schober & Clark 1989, p. 216). Over the course of successive references, as the perspectives of director and hearer become aligned, the description is typically shortened to one or two words, functioning as the shared symbol for the referent. For example, in one of the

experiments of (Kraus & Fussell 1996), the successive descriptions of an abstract shape were: "Looks like a Martini glass with legs on each side", "Martini glass with the legs", "Martini glass shaped thing", "Martini glass", and finally "Martini".

My colleague Frank Van Overwalle and I (Van Overwalle & Heylighen 2006) managed to reproduce this observation using a simulation based on communication between software agents using a connectionist architecture. After repeated exchanges, the number of features of the situation that were expressed were gradually reduced, until one dominant one was left. This can be understood as another case of friction reduction: as alignment increases, the probability of misunderstanding decreases, and therefore the effort necessary to communicate can be reduced by focusing on the most distinguishing word or expression.

6.3 Group Alignment

But what about groups consisting of several conversing pairs of people? Will they too converge to one shared reference, like in Steels' "naming game" simulations? According to the experiments of (Garrod 1998; Garrod & Doherty 1994), they do. In this type of experiments, two people who cannot see each other have to solve a maze problem together. To achieve that, they must be able to communicate about the different positions in the maze they both see on their computer screens, and the actions that are needed. This assumes that they agree about a particular scheme for naming the elements of the problem (e.g. "go to the third corridor on the right, up from the bottom left corner"). After some back-and-forth describing, questioning, and confirming, like in the Martini-glass experiment, they normally agree about a standard scheme for referencing the different components of the maze.

However, different pairs of people typically settle on different naming schemes. For example, some might start counting positions from the bottom-right, others from the top-left; some might use numbers, others prefer letters or words. In a second stage, each individual is paired with another individual from the same group. Since the two members of the new pair typically have learned different naming schemes in the first stage, they again need to align their references, and agree about a common scheme. When this switching of pairs was repeated several times, Garrod (1998) observed that eventually the whole group settled on a single scheme. This is normally the scheme that happened to be most frequently used in the first stage.

The dynamics here appears to be the same as in the "naming game" simulations of Steels (1998; Steels & Vogt 1997) and in the general case of self-organizing alignment: small initial advantages for one direction of alignment over the other ones are amplified by positive feedback until that alignment dominates all interactions, thus establishing a shared reference. In the connectionist simulation to which I contributed (Van Overwalle & Heylighen 2006), the naming game experiment was repeated with somewhat different assumptions about the agents'

learning mechanism and mode of communication than the original experiment, but with essentially the same results. This illustrates once again how strong the power of self-organizing alignment is for communicating groups.

7 An Experiment in Collective Intelligence

Establishing a shared system of reference (alignment) is only the first step in collaboratively solving a problem. Moreover, alignment can go too far, in the sense that unusual, but valuable, approaches are suppressed because of the tendency of the largest subgroup to impose its "targets" on the rest of the group. When alignment merely concerns the establishment of lexical conventions or agreed-upon labels, then in essence any label is as good as any other, and alignment is a priori positive. However, when the "targets" of thought and action are fundamentally different, excluding some targets because they represent minority positions will a priori reduce the potential for collective intelligence. Typical experiments in collective problem-solving either artificially impose maximal independence on the individuals (e.g. requiring them to write down their opinion anonymously) until the moment when their contributions are aggregated (e.g. by counting votes or averaging guesses), or allow free-ranging discussion with the intent to come to a consensual decision, thus running the risk of groupthink and a loss of collective intelligence.

Together with my students and colleagues, I have been reflecting about experiments that could provide a more precise but still realistic observation of the emergence of collective intelligence or distributed cognition (Heylighen, Heath & Van Overwalle 2004).

7.1 Setting Up an Experiment

The first issue was to establish accurate measures for the outcomes of the experiment, and in particular: (1) to what degree was there alignment between the members of the group?; (2) to what degree was the collective solution better (i.e. more intelligent) than their individual proposals? To establish a quantitative measure, I decided to ask questions where the members of the group could express their position on a seven-point scale, going from 1 (completely disagree) via 2, 3, 4 (agree somewhat), 5 and 6 to 7 (completely agree). To get sufficiently detailed, multidimensional data, I decided to ask at least 20 such questions. This would give me 20 numbers between 1 and 7 for each participant, plus the average for the group. The position of each individual on each of the questions could then be expressed as a list of numbers, e.g. (3, 2, 7, 1, …, 4, 6). In addition to averages, such lists allow us to calculate traditional statistical measures, such as standard deviations and correlation coefficients, that can be used to establish convergence or divergence between opinions.

A more tricky problem is how to quantify collective intelligence: in how far is the group solution "better" than the individual ones? An obvious approach would be to formulate the problem in such a way that it only has a single, unambiguous, quantitative, but not generally known solution, e.g. what is the precise number of inhabitants of Barcelona? The differences between each of the individual or group estimates and the actual number could then be used as a measure of accuracy and thus of intelligence. However, to reach such a quantitative solution, there is not much that individuals can do except offer each their own best estimate. This does not allow much room for the complex processes of self-organizing coordination that this paper has been discussing.

Originally, my intention was to observe and measure the process of achieving a shared conceptualization, where the members of the group would try to align their interpretations of a common, but ambiguous term, such as "fruit", "vegetable" or "sport". Some people may consider chess to be a sport, while others would restrict the term to physical activities such as cycling or swimming. Yet others may use the term only for competitive games, such as football or badminton, while excluding individual activities, such as jogging. To determine people's individual interpretation of the term, I had prepared a list with 20 activities, including the examples above, that may be considered as "sport" to different degrees. For example, all participants agreed that "tennis" is a sport, while no one thought that "solving cross-word puzzles" is a sport. But in between there were a variety of ambiguous cases, such as walking, horse riding, or parachute diving, about which different people had different opinions.

My student, the psychologist Geert Biebaut, converted the list of 20 such activities into a survey, and asked a group of volunteers (students in physical education) to indicate for each of them on a 7-point scale in how far they considered that this activity is a "sport". Initially, each volunteer filled in the survey individually, without contact with the others. In the second stage, they were asked to discuss the question "What is sport?" in group. To keep track of all the arguments put forward, this debate was performed on-line, using an Internet discussion forum. It resulted in an interesting discussion that reviewed various characteristics of sports, such as competition, effort and physicality. After each participant had made at least two contributions, e.g. proposing a better definition, or questioning the contribution of another participant, we let them take the survey again. However, the results were rather disappointing: while some individuals had changed their attitudes in some way, there was no obvious convergence between their opinions, and no clear direction in the shift of opinions. To make sure that this lack of results was not accidental, we repeated the experiment with another group, but the outcome was essentially similar.

The only significant result came from a principal components factor analysis of the different opinion vectors: the most important dimension of variation between the participants before the discussion also appeared to be the main focus of their

debate: in how far is competition necessary for an activity to be called "sport"? In other words, from the start there was a clear split in opinion, which fueled the debate, but which did not get resolved. In hindsight, this is not so surprising since the volunteers were students in physical education with a vested interest and long-term experience with the notion of sport, who were unlikely to significantly change their opinion after a single debate. This taught us that a next experiment should focus on an issue where the participants were less likely to have strong preconceived notions. Still, to achieve collective intelligence, they should ideally have a variety of personal experiences to build on, and preferably there should be a criterion to measure in how far the solution they develop is accurate.

As a member of the editorial board of the Journal of Happiness Studies, I had a ready-made subject: what are the conditions for a happy life? There has been a lot of empirical research on this question, performed by psychologists, sociologists and economists (e.g. Veenhoven 1998; Diener & Biswas-Diener 2008), that provides us with a basis for a more or less objective judgment. On the other hand, the problem is complex enough that there are different ways to interpret the data, and the research is as yet not very well-known outside a few specialized circles. Yet, happiness is something every individual should have some personal experience with, albeit limited and subjective. My hope was that if a variety of individuals could somehow manage to aggregate these experiences, their collective judgment would be much less limited and subjective. But to measure that, I needed a benchmark that could be considered as an approximately accurate judgment. For this, I could rely on a number of experts in happiness, who were mostly (ex)-colleagues of mine in the editorial board of the Journal of Happiness Studies.

From the literature on happiness, I distilled 20 factors whose correlation with happiness has been researched in some detail. These include obvious conditions such as health or wealth, and less obvious ones, such as IQ, life philosophy, or the degree of trust in other people (see Table 1). These conditions were then turned into survey questions, where the subjects had to indicate on a 7-point scale in how far they considered each condition to be important for achieving happiness. This survey was filled in independently by four experts and by the participants in the experiment, once before and once after their discussion of the subject. To make sure that the results would not be an artefact of a particular method of communication, the experiment was held with three groups discussing in three different ways:

1) in a live meeting that was recorded on video for later analysis;
2) in a "carousel" set-up, in which participants conversed one-to-one for a few minutes, and then switched conversation partners (similar to the Garrod and Steels experiments);
3) via an internet forum.

Correlation of Factors with Happiness

Table 10.1 Results of our survey as to which life conditions contribute to happiness, scored on a 7-point scale, from 1 (irrelevant for happiness) to 7 (crucial for happiness). The first colum of numbers lists the average score for one of the experimental groups before they had discussed the issue with each other. The second column lists their average after a live discussion and the third the average for the experts in happiness research. Note that the "after" score is generally closer to the expert score than the "before" score, even though the participants never received any information about the expert opinion. This seems to indicate the emergence of collective intelligence during the discussion.

Conditions of happiness	Avg. before discussion	Avg. after discussion	Average experts
Youth: being young	5.2	3.3	2.5
Status: at least as high as peers	4.6	3.9	4.3
Wealth: being wealthy	5.6	5.3	4.3
Friendship: having good friends	6.7	6.9	5.3
Chance: having good luck rather than bad luck	4.2	4.3	3.5
Peace: absence of military threat	5.3	5.4	5.3
Freedom: living in a free, democratic country	5.8	5.8	5.8
Equality: not being discriminated	5.6	6.0	5.5
Sunny nature: having an optimistic character	6.3	6.0	6.0
Autonomy: having your life in your own hands	6.2	6.7	6.5
Family: having children	4.9	5.3	2.5
Emotional stability: not being anxious or stressed	6.2	5.8	6.8
Intelligence: having a high IQ	4.0	3.2	1.5
Health: not being ill	6.2	7.0	5.3
Education: having a high level of education	5.0	3.7	3.0
Social participation: (sports) clubs, unions, ...	5.0	4.9	4.5
World-view: having a clear philosophy or religion	3.8	4.7	4.5
Relationship: having a stable partner	5.4	5.2	6.0
Safety: low risk of accidents, crime ...	4.7	6.0	6.0
Trust: being able to trust others	5.8	6.6	5.8

7.2 Results of the Experiment

While the data have not been fully processed yet, this time the results appear statistically and theoretically significant, and surprisingly similar for all three experiments. First, apart from three or four outliers in the scores, the experts appear to agree with each other quite well, and more so than the "naïve" participants. This confirms my assumption that the research on happiness is sufficiently advanced that some degree of "objective" accuracy is possible as to the importance of the different conditions. The average of the expert opinions can therefore be safely used as a benchmark for accuracy.

Second, there is a clear trend towards convergence or alignment: the individual opinions after the discussion are significantly more similar than before the discussion. This was established using three independent measures: (1) standard deviation and (2) entropy of the distribution, which both significantly decreased, and (3) internal consistency ("Cronbach's alpha"), which increased. About the same degree of convergence was observed in all three experimental conditions, albeit a little less clearly in the "carousel" group.

On the other hand, there did not seem to be any polarization, in the sense of opinions becoming more extreme after the discussion. In the present set-up, it seems logical to define the middle ground as the midpoint of the evaluation scale, i.e. the score 4. Polarization then would mean that if the participants scored a particular condition on average as lower than 4 (e.g. 3), then after discussion they would score it even lower (e.g. 2). If they gave it a higher score initially (e.g. 5), they would give it an even higher score (e.g. 6) after the discussion. It is easy to determine whether such polarization took place, by calculating the average difference in deviation from the middle ground between the situations before and after the discussion. It turns out that this difference is about zero (+0.29 in one experiment, i.e. a minimal increase; –0.14 in another, i.e. a minimal decrease).

Finally, and most surprisingly, the average or "collective" opinion after the discussions is significantly closer to the benchmark than the average before the discussions. This was measured using the correlation coefficient between the averages for expert and naïve opinions, which increased from about 0.65 to about 0.76 depending on the experimental condition, with the strongest increase for the live meeting.

This is a clear indication of the emergence of collective intelligence during the discussion: somehow the participants have developed a more accurate understanding of the conditions of happiness not only individually but collectively, and this while avoiding the pitfalls of groupthink and polarization. If this was merely a case of the static aggregation of individual experiences, like in the classic situation where people's estimates of the weight of a bull are averaged (Surowiecki 2005), then the average opinion before the discussion should have been equally accurate since the discussion did not add any facts that the group as a whole did not know. If their collective judgment has shifted significantly towards the benchmark, this must be because they systematically increased the importance of certain conditions for happiness, and decreased the importance of others. Such a process demands an explanation. Let me propose some initial hypotheses based on the general dynamics of self-organizing coordination that we discussed before.

7.3 Interpretation of the Results

The simplest explanation for this "shift towards more intelligence" is a process of alignment that would strengthen the initially most common opinions but weaken the others, thus modifying the average position in a non-linear way. This seems unlikely to have happened, because if the majority positions were sufficiently strong and removed from the middle ground, such a type of convergence should normally also have produced polarization. Moreover, according to the notion of groupthink (Janis 1972), this is unlikely to produce collective intelligence as it would suppress potentially valuable minority experiences. Collective intelligence might still result if the minority opinions were systematically less valuable than the majority opinions: perhaps the minority opinions were those of people who simply lacked experience with a particular condition. For example, someone who has never had problems with his health, may initially consider that condition to be rather unimportant to happiness. Once that person hears that most others have had experience with bad health seriously depressing their happiness, she may shift her opinion so as to increase the importance of health as a factor.

It seems unlikely, though, that majority opinions would tend to be systematically more accurate than minority positions. After all, for several of the conditions, such as youth, living in peace, freedom, or having children, few or none of the participants were likely to have much personal experience about the relative importance of these conditions, as the subjects were mostly young students who did not have children yet, and were living in a peaceful and free country. Therefore, their opinions about these topics appear more likely to reflect common prejudices (e.g. that young people have more fun than old people) than the statistically established facts (e.g. that there is hardly any correlation between age and happiness).

A more likely mechanism here is a spontaneous division of labor and workflow. In a discussion about a variety of conditions, the person most likely to speak out about a particular condition is one who has a lot of experience with that condition. Because of that experience, this individual will be able to argue with a lot of details, conviction, and self-confidence. Therefore, that opinion is likely to have a much bigger impact on the group than the opinion of someone who does not really know much about the specific issue, and who is likely to let others do the talking when that issue is discussed. In that sense, the participants in the discussion are likely each to take on one or more specific roles as the resident expert, say, on "having children" or on "having a life philosophy". For example, assume that one of the participants is a 60-year old mature student, who notes that he is much happier now than when he was young. Such a personal testimony may be enough to shift the others away from the common, but not very strongly held, prejudice that "you must be young to enjoy life".

But, of course, such self-proclaimed authorities can still disagree. That is where self-organizing workflow mechanisms may come in: as long as nobody has clear objections against the ideas that are being proposed, the discussion will proceed smoothly until that issue has been covered, and move on to the next issue. However, if one of the self-appointed "experts" feels that the last speaker has

overlooked an important aspect, she is likely to say so, and to add her own experience as evidence for the need to look at the issue differently. For example, she may note that her grandfather always insisted that he was most happy in his youth. This may trigger others to remember what their grandparents used to say about the issue, thus bringing in additional evidence. Self-organizing workflow is precisely this process of one contribution eliciting a subsequent one, which elaborates, complements, or concludes the previous contribution. At the end, the gathered evidence should be more complete and balanced, thus providing a better ground for an accurate judgment. In this example, the conclusion may be that different people experience ageing differently, and that there is not such a clear influence of youth on happiness as the participants initially asssumed. Such a conclusion would bring the discussion participants more in line with the experts, who know from statistical evidence that there indeed is no such clear relationship (see first row of Table 1).

As a last step in our attempt to interpret these results, it may be worth examining why there did not seem to be any groupthink, i.e. the common phenomenon of premature convergence in opinion that reduces collective intelligence. Typical conditions that have been proposed for the emergence of groupthink are direction by an authoritative leader, conformity pressure, and the need to come to a clear-cut consensus (Janis 1972). All were absent in the experimental set-up. Since the issue they discussed had 20 different components, it was difficult to come to a clear conclusion. Perhaps most importantly, the participants filled in the survey individually after the discussion. Therefore, there was no pressure, neither explicitly nor implicitly, to "conform" to the opinions of the others, since no one knew exactly what those others had entered in their survey forms. Still, there was some convergence between opinions, but this seems to have been of the "healthy" kind, where participants learned things from each other that were missing from their own limited perspective.

A final note on the mechanism of aggregation in this set-up: this happened partly in each individual's memory, which would accumulate the most salient observations made by others, partly through our procedure of statistical averaging of the collected opinions. The individual aggregation would normally have been more selective and subjective, but because of that perhaps more "intelligent" in singling out the most important contributions. The statistical aggregation, on the other hand, may have to some degree counterbalanced the tendency towards subjectivity by averaging a variety of subjective remembrances. A further analysis of the data may tell us in how far the individual opinions (not just the collective opinion) became more accurate…

In conclusion, the preliminary results of these experiments appear very inspiring for the further study of the self-organization of collective intelligence. The interpretations I have proposed in particular provide concrete illustrations of the dynamics of alignment, division of labor, and workflow. However, to make sure these interpretations are correct, we will need to analyse the results in more depth, in particular by studying the videos and texts of the actual discussions. Moreover, we will need to replicate these results with different experimental set-ups,

covering other problem domains than happiness, but where it still possible for the experiences of the participants to converge towards an objectively established "benchmark" solution.

8 Conclusion

This paper has reviewed the mechanism of self-organization, conceived as the spontaneous coordination of actions performed by different agents. Such coordination helps to make the actions more synergetic, while reducing the friction between them. The result is that coordinated actions achieve their intended goals more easily and more effectively. In particular, coordination may result in an apparently unreachable goal or unsolvable problem getting within reach, as sources of obstruction vanish and missing elements are fitted in.

The underlying dynamic of self-organization is local trial-and-error or variation-and-selection, in which two interacting agents try to mutually adapt their actions, until they hit on a "coordinated" pattern that is acceptable to both, and thus is selectively retained. This local pattern is then typically propagated step-by-step to the neighboring agents and the neighbors' neighbors. The spreading "wave" of coordination is thus amplified until it encompasses the global system, via a process of positive feedback.

Coordination can be decomposed into four relatively independent mechanisms: alignment, division of labor, workflow and aggregation. Alignment is the simplest, as it merely requires the agents to "point in the same direction", i.e. direct their actions at the same targets. This is necessary to avoid the friction that is otherwise caused by opposing actions. Alignment creates convergence or homogeneity between interacting agents. When the agents are distributed across space, the resulting homogeneity may be limited to a certain region, with boundaries between differently aligned regions emerging after self-organization. This can explain the appearance of separate cultures or languages, and the points of friction between them.

Even when such remaining friction is avoided, alignment is not yet sufficient to reap the full benefits of synergy, in which the whole of the actions produces more than the sum of the effects produced by each action separately. Synergy requires complementarity, in which one action makes up for what the other one lacks, so that together they can achieve goals that they cannot achieve alone. Synergy is promoted by the other three coordination mechanism. Division of labor means that different agents perform different actions at the same time, so that each can contribute its unique expertise to that part of the problem it is most skilled at. Workflow means that an action is followed by a subsequent action that fills in the gaps left by the previous one. Aggregation, finally, ensures that all these different contributions are assembled into a coherent outcome.

These mechanism have been defined at the most general, abstract level, so that they can in principle be applied to any complex system. Indeed, all systems and their components can be conceptualized as agents, i.e. entities that act in response to sensed conditions, and this with apparent "intentionality"—meaning that these actions are directed at a particular target or goal. However, the present paper has

focused on applications in social systems, where groups of human individuals communicate with each other.

The first issue here is the emergence of *collective intentionality*: how do groups align the targets of their communications and actions? In the domain of language, this problem has been investigated by means of a variety of software simulations and experiments with groups or pairs of conversing individuals. The basic mechanism is that each time an agent targets a particular referent or communicative structure in its interaction with another agent, this primes (weakly prepares) the second agent to target a similar referent, making a shift towards a common referent slightly easier. Many such small, individual shifts eventually snowball into the emergence of a reference shared by the whole group. This research confirms and illustrates the general mechanism of self-organizing alignment, while clarifying the origin of linguistic conventions.

A second issue is the emergence of *collective intelligence*: in how far do people manage to solve problems better as a group than individually? Most research in this domain has focused on the problems of *groupthink* and *polarization*, a form of premature alignment in which valuable contributions are suppressed because of a tendency of groups to conform to and reinforce any emerging consensus. This results in phenomena of "collective stupidity" or "madness of crowds", rather than "collective intelligence" or "wisdom of crowds". The general recommendation (Surowiecky 2005) therefore has been to minimize the (non-linear) interactions between individuals that promote alignment, and to use some neutral mechanism such as averaging to directly aggregate the individual contributions. While this strategy is undoubtedly useful in a number of cases, it risks to throw the baby out with the bathwater, as it makes self-organizing division of labor and especially workflow more difficult.

To investigate these issues, I have designed a number of psychological experiments in which a group of people discusses a complex question. In the second group of experiments the question ("what are the conditions for happiness?") was chosen in such a way that each participant had some limited, subjective experience with it, but a group of experts was available to provide a more balanced, objective estimate. The average judgment of the experts was used as a benchmark to measure the quality or accuracy of the different outcomes. The experiment was performed with three groups, each using a different form of communication. After each discussion the opinions of the participants had become more aligned, but not polarized, while moving significantly closer to the benchmark. A plausible interpretation is that spontaneous division of labor and workflow elicited synergy, and therefore collective intelligence, while the absence of any pressure to conform prevented groupthink. These are as yet still preliminary results, but they seem sufficiently solid to warrant further experiments in the same vein.

In conclusion, self-organization in communicating groups is a fascinating topic that can throw a new light on a variety of fundamental problems, including the origin of language and communication, how best to achieve coordination between agents and their actions, and how to maximize the intelligence of collectives. Both the conceptual framework and the methods for experimentation and simulation appear sufficiently developed to enable quick further progress. I hope this paper will encourage other researchers to further investigate these issues.

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11 General Linguistics and Communication Sciences: *Socio*complexity as an Integrative Perspective*

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Abstract. The paradigmatic revolutions in 20th-century demand that we reflect on our own paradigms in the light of the great changes in the other disciplines. The elements must not be represented as being outside those of the others, separate and independent, since the interdependencies and integrations are the foundation of reality. We need a dynamic 'ecologization' and 'complexification' of thinking, in order to consider the contexts of phenomena in an integrated manner with the phenomena themselves. We are unlikely to be able to understand human behaviour if we do not bring the mind-brain into the foreground of our analyses, as it is where reality is perceived, processed cognitively and emotively, and where – consciously or otherwise – the courses of action that an individual takes are decided. A science that sees language not as an 'object' but from a (socio)complexity perspective has a much greater chance of succeeding in the task of making linguistic and communicative phenomena intelligible.

1 Introduction: The Need for a Perspective of Complexity

Language exists like a great tree whose roots are in the subsoil of the life of society and the lives of the brain, and whose leaves blossom in the noosphere.

Edgar Morin[1]

Understanding all the phenomena dealt with by linguistics and communication sciences is not solely a formidable task because of their originality and heterogeneity and because of the interdependencies that they maintain, but also because of the absence of any appropriate general paradigms of thought for handling this level of non-simple phenomena. Based on fairly readily observable material facts that are external to the mind, traditional forms of scientific thinking have crystallized in certain modes and principles of understanding the world that might not be

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[1] 1991.

the most appropriate for understanding what are more specifically human acts, such as mental and socio-cultural phenomena.

While it is true that linguistics – together with psychology and sociology – has tried to follow the traditional scientific procedures of the natural and material sciences, we cannot fail to note the increasingly severe symptoms of crisis that manifest themselves if this approach is adhered to blindly and unthinkingly, treating the phenomena of psycho- and socio-linguistics as being more or less identical to those that the traditional sciences have sought to shed light on. Moreover, the very evolution undergone by the theoretical paradigms of those disciplines constitutes in itself a very important change in classical theoretical assumptions, making innovations that are highly attractive for the linguistic and psycho-socio-cultural sciences. We find ourselves, therefore, facing the need to revise our traditional principles and formulations so that we might be led to questions and theorizations that are perhaps more pertinent and suited to the phenomena that we seek to understand (Serrano 1983).

A rapid look at these other scientific disciplines – more closely concerned with the material facts of reality and, traditionally, leaders in the renewal of the paradigms with which we examine the objects and phenomena of the world – makes us realize just how beneficial it might be for the sciences of language and communication (and all socio-cultural disciplines, for that matter) to observe and study the evolutions that they have gone through over the last century. Following Chomsky's earlier attempts, examining afresh the theoretical and conceptual innovations of other disciplines, such as theoretical physics and biology, could prove to be enormously motivating for the renewal of the paradigms of linguistics and the fields it includes. Physics scholars such as Ilya Prigogine (1992 and 1996), David Bohm (1987) and Fritjof Capra (1985 and 1997), who can be read without possessing a great technical understanding, can, I believe, shed light on questions and ideas for the renewal of the conceptual images of the socio-cultural disciplines.

One of the most interesting frameworks – given its thought-provoking and integrative nature – to have been developed in recent years for a field such as linguistics is that of the so-called 'perspective of complexity'. Although based on contributions from various authors and fields, the formulation of 'complexity' that best fits our needs is, as we shall see, the one constructed by the French anthropologist and thinker Edgar Morin: "There is complexity when the different components that constitute a whole (the economic, the political, the sociological, the psychological, the affective, the mythological) are inseparable and when there is an interdependent, interactive and inter-retroactive weaving between the parts and the whole, between the whole and the parts" (1999:14). Based principally on the ideas contained in his works that I have found to be best suited to our lines of research, together with other ideas from the evolutions undergone by theoretical physics, biological ecology, and other fields, I seek to explore, provisionally and tentatively, in these pages some ideas that might be useful for the integral development of the various themes that make up a comprehensive and open linguistics.

2 Towards a Paradigm of Complexity

2.1 Constructing a World. The Representation of Reality, and Scientific Activity

Perhaps, in the spirit of Magritte, every theory of the universe should have in it the fundamental statement "This is not a universe".

David Peat[2]

What we first need to establish is our point of departure in tackling scientific knowledge. I consider it fundamental to establish that scientific activity does not escape the basic constrictions of human cognitive activity, but rather it is merely a more conscious and more carefully contrasted product of it. As this cognitive product depends on our models of reality and on the conceptual architecture that sustain our understanding of the world (Varela, Thompson & Rosch 1992), under no circumstances should we believe that this constitutes the sole and definitive 'truth'. Today, the great scientific theories, although they have been regularly tested against reality, no longer enjoy the status of permanent, definitively established knowledge but rather of provisional, substitutable knowledge that can be improved on by other paradigms and conceptual models yet to be created. We, therefore, give birth to – or rather we construct perceptively – a world represented by our limited senses and faculties.

Based on this awareness of the provisional nature of our scientific constructions we become conscious of the centrality of our *models* of the world, of our mental configurations of reality. We need not only to pay attention to the data but also to the representations which we (pre)sustain or which we create based on our observation of reality. Although absolutely indispensable to the scientific task, since Einstein we have known of the limitations of data: more and more observations on their own would never have led to the theory of relativity. What was required was a daring, creative 'theoretical leap' to a new paradigm, a new representation of a fundamental part of physical reality (Holton 1985). As Einstein himself pointed out, "concepts can never be regarded as logical derivatives of sense impressions" (1986). The earlier Newtonian representation, exhaustively "tested" empirically, was no longer the only possible model. It was now linked to an alternative vision, one that was more potent and comprehensive (and one subjected equally to empirical tests), which made us aware of the centrality of our representations, of our cognitive architecture, of reality. Science would now never again be about 'reality' but rather about *our* understanding of reality.

In the framework of the socio-cultural and communication sciences a paradox arises. The desire to act in accordance with the dictates of the 'scientific method' (given the extraordinary advances in the material sciences) led to the unthinking acceptance of the theoretical and methodological assumptions of 19th-century physics in many of the paradigms that prevailed throughout the 20th century. The adoption of this mistaken hyper-empiricism, for example, led many of its schools

[2] Bohm & Peat 1989:9.

to reject mental phenomena – ideas, emotions, meanings, etc. – as part of the reality that they should take into consideration in their research. This led to patently absurd situations: not just sociology without the mind, but even psychology without the mind. The only thing that existed from this scientific perspective was what was 'externally' observable, without realizing that there can be no 'external' observation without the mind of some observer who perceives and represents it. The analytical and reductionist procedures and the frequently separate, static and unidimensional images of reality derived from this early physics were still blindly followed even when the new physics began to distance itself from them. Thus, the English physicist David Bohm was able to write that we have reached "the very odd result that in the study of life and mind, which are just the fields in which formative cause acting in undivided and unbroken flowing is most evident to experience and observation, there is now the strongest belief in the fragmentary atomistic approach to reality" (1987:37).

Linguistics, as is only natural, also failed to escape unscathed from these tendencies, which only came to be questioned – and then only partially – late in the second half of the 20th century. Its objects are still frequently described and conceived internally, at levels of analysis that are barely integrated and which overlook their dynamic reality, as closed systems. Thus, linguistic 'signs' appear to exist without signifiers, as if they were independent containers that might transport their meaning materially, and verbal structures are studied analytically, breaking them down into smaller parts, isolated from their socio-cognitive context, and tending to ignore any changes and evolutions. While this has certainly led to substantial advances in the structural description of language communication systems, we now need to adopt a complementary perspective that incorporates, as I shall point out, the contexts of existence of linguistic forms and conventions as open systems.

2.2 (Re)thinking Reality

> *Chaos theory brought chance and uncertainty not only into our everyday life, but even to planets, stars and galaxies. (...) It allows nature (including man) to engage in her creative games with abandon, to produce novelty that was not implicitly included in her previous states. Her destiny is open, her future being no longer determined by the present or the past. No longer is the melody composed once and for all. Rather, it develops as it goes along.*
>
> Trinh Xuan Thuan, *Le chaos et l'harmonie*[3]

During the second half of the last century, we grew increasingly aware – and not just from within the sciences – of the different possibilities of representing reality and of the potential diversity of cultural models and cognitive landscapes that humanity can sustain. From the perspective of the scientific task as well as from that of everyday human activity, it is worth recalling the words that Carlos Castaneda puts into the mouth of his character Don Juan: "The world doesn't yield to us

[3] Cited by Spire 1999:64-65.

directly; the description of the world stands in between"[4]. Our maps of reality become, as a result, as important as the world that we seek to understand. Our paradigmatic lenses determine to a large extent the conceptual constructions that we believe we see.

Thus, an essential question for characterizing any educational project would run as follows: from which paradigm or paradigms do we look at the world? With which perspectives and visions of reality can we approach an understanding of socio-communicative phenomena? I believe that I have been lucky in my years in academia in that I have come into contact with ideas and authors who have enabled me to learn of the existence and development of new paradigms that I consider highly appropriate for obtaining a richer understanding of socio-cultural and, particularly, of linguistic-communicative phenomena. Although originating from different fields and distinct lines of research, these authors are constructing a perspective that has come to be known as the 'theory of complexity' (Morin 1980, 1991, 1992, 1999, 2001, 2004; Wagensberg 1985; Waldrop 1992; Gell-Mann 1996; Holland 1995, 1998; Eve 1997; Jörg 2011), perhaps the most appropriate name from those currently available, which include among others 'ecology' (Margalef 1991), 'chaosology' (Flos 1995; Bernárdez 1995), or 'systemic' (Von Bertalanffy 1981; Lugan 1993). I should say that what attracts me to these contributions is the possibility they afford of seeing the world via new concepts and from new angles, which are much more comprehensive and cross-disciplinary than those employed in classical scientific traditions. Primarily, what I see in them are the possible foundations for a 'third culture', that is the possibility of studying scientifically and with greater rigor human events, in an integrated and 'consilient' way with all other disciplines – as Edward Wilson called for (1999) – so as to realize the colossal complexity that human beings, their existence and productions represent.

The new paradigms that are emerging, albeit incipiently, question many of the assumptions that we have maintained in our attempt at making socio-cultural phenomena, considered from a general perspective, intelligible. "Neither the presentation in mathematical formulae nor classical physics can retain the rôle of dominant models that they possessed in the philosophy of August Comte", as Arnaud Spire points out (1999:58). The paradigmatic revolutions in 20th-century physics, the contributions made by biology to our understanding of living beings, the conceptual constructions built around the theories of systems, self-organization, chaos and complexity implore that we reflect on our own paradigms in the light of the great changes in the other disciplines.

An important task awaits linguistics today – and, obviously, all the other sciences of communication, society and culture. In first place, we need to ask ourselves which changes inspired by those in contemporary physics should be incorporated within our own theoretical representations; at the same time we need to study which contributions from biology (as a discipline that confronts the complexity of living beings) might also help us understand our phenomena; and, in turn, how we should create our new paradigms and concepts that, by drawing on

[4] Castaneda, Carlos. *Tales of Power*. New York: Simon & Schuster, 1974. Quote taken from Talbot (1986).

the creativity of these other disciplines, and on other equally innovative theorizations, can lead us to a better understanding of the phenomena with which we should be concerned. A contemporary scientific perspective "which highlights the random, the plurality of possibilities and irreversibility, breaking down the traditional symmetry between the past and the future" (Spire 1999:89), must perforce be enlightening and motivating for the linguist and for the advanced conceptualization of the discipline.

2.3 Wholes and Parts

The hologrammatic principle shows that in all complex phenomena, the whole is as much in the part as the part is in the whole.

Edgar Morin[5]

An excessively mechanistic image of the world has virtually led us to see analysis, the breaking down of phenomena into their constituent parts, as the scientific procedure *par excellence.* As with a machine, if we are able to see the elements of the whole unit and its 'internal' assembly, we are better able to explain the object and understand how it works. While this 'reductionism' of wholes to their constituent parts might have led to an enormous increase in our knowledge of the workings and organization of reality (especially of our physical-chemical world), it also presents limitations and shortcomings when we confront the more dynamic and complex dimensions of life and the psycho-socio-cultural world. An excessive reliance on this scientific procedure and the neglect of its complementary line of research – synthesis – can be negative for the advancement of knowledge as it ignores or discards altogether such important aspects as the context – the environment – in which the phenomenon or the 'emergent' (i.e., that which occurs not only because of an ordered juxtaposition of the parts but because of a non-simple interaction between them or between them and other fundamental elements in the environment) are produced.

In fact, throughout most of the 20th century, analytical procedure has probably been predominant in both biology and in linguistics. In the reduction to the basic elemental units, we believed we would find the fundamental answers for understanding phenomena. And certainly the amount of knowledge generated has been impressive. But more recently we have also seen its limitations. Discovering the sound formants of human languages, for example, allows us to know vital aspects of the 'material' plane of verbal codes, but it tells us little about their socio-significant function. I firmly believe, therefore, that alongside a linguistics that looks 'inward' there should also be a linguistics that looks 'outward', or one even that is constructed 'from the outside', a linguistics that I refer to elsewhere as 'holistic' (Bastardas 1995 and 1995b), but which could just as well be referred to by a different name. My current vision, therefore, is based on the idea of promoting simultaneously the perspective that goes from the part to the whole as well as that which goes from the whole to the part – i.e. top down and bottom up. Climb up to

[5] 1999b.

study the mind – as Chomsky has beseeched us – but continuing further, to find human *beings* in their socio-cultural (inter)relations, or alternatively beginning from this plane – from that of the whole – to come into contact with the knowledge obtained by those who take the route that leads upward.

This is how we should understand the term 'holistic', not just simply eliminating the parts of our theorization to design a simple, amorphous whole but rather, as Morin suggests, interrelating the whole with its parts and its parts with the whole – a holistic perspective that has an awareness of its parts. Morin, in adopting his eco-socio-cognitive complexity, succeeds in a fully integrative formulation: the part is in the whole which is in the part. Part and whole as inclusive, mutually defining, elements: "Complex thinking is a thinking that joins together opposites (...). Joining together opposites and going beyond them by the principle of the self-generating recursive loop (...). This principle of the recursive loop helps to understand things that we tend to separate and isolate –such as the individual and the species or the individual and the society" (1999b).

This approach enables us to overcome the long-standing antinomies that impede our understanding of reality and which distract us with sterile debate. What is real, therefore, is co-existent and co-dependent: the individual is in the society which is in the individual; the mind is in the culture which is in the mind; the language is in the society which is in the language. What we intuit as occurring is thus 'sayable' or formulable: the interdependencies, the imbrications, the reality of the elements that evolve mutually influencing and determining each other. Likewise for the physicist David Bohm the metaphor of the hologram – in which each of its parts contains information about the whole object[6] – is illustrative of this way of seeing the world more fruitfully, as I already said in my precedent chapter. Bohm (1987) distinguishes between seeking to understand reality via an 'explicate' or 'implicate' order. Seen from the first perspective things are *unfolded* and are only found in their own particular regions of space and time, and outside, therefore, of the regions to which other things belong. The elements are represented as being outside those of the others, separate and independent. By contrast, in the 'implicate' order, as in the hologram, "everything is *enfolded* into everything", the interdependencies and integrations are the foundation of reality, and the universe is seen as an "undivided whole in flowing movement".

Thus, linking up with quantum physics and related to the problem of wave-particle duality, Bohm & Peat reached the conclusion of the preeminence of 'field' over the particles that it might contain: "Instead of taking a particle as the fundamental reality, start with the field", or what amounts to the same thing, "the particle is no longer used as a basic concept, even though the field manifest itself in discrete units, as if it were composed of particles" (1989:182).

The possibility that an approach to general linguistics based on the 'field', that is, on the whole rather than on its individual constituent elements, might lead us to necessary and important contributions for a better understanding of socio-communicative phenomena seems not only clear but indispensable to me.

[6] In the hologram, unlike a normal photograph, each section contains information of the whole of the object, so that if we were only to light up one part we would still obtain an image of the whole (see Bohm & Peat 1989, p. 175.)

Conceiving of linguistic phenomena starting from a wholeness constituted by human beings-in-society-within-a-world and from there to *unfold* the different interconnected dimensions and elements that form this whole appears, therefore, a truly thrilling task. Bringing together the different planes developed to date by linguists into one common, integrative orchestral or polyphonic score, in an awareness of the distinct *emergent* phenomena[7] with new properties and functions that appear in their harmonic combinations, should be one of the fundamental tasks for linguistics in the 21st century.

Clearly, here, the application of metaphors or theoretical images of complexity will be of great use. By visualizing the different levels of linguistic structure not as separate entities but rather as united and integrated within the same theoretical frame, by seeing their functional interdependencies, by situating them in a greater multidimensionality that includes what for a long time was considered 'external' – the individual and his mind-brain, the socio-cultural system, the physical world, etc. – and expanding in this way our normal score, we should be able to make important, if not essential, theoretical and practical advances. Norbert Elias, working in the social sciences, was a precursor of this idea: "I tried to show that a society is indeed composed by individuals, but that the social level possesses rules that are unique to it and which one cannot explain only on the basis of individuals" (1991:83).

Certainly this expansion of the dimensions included in our scope leads us to the theory of systems and complexity, by means of which we can integrate both wholes and their parts, including the subsystems and supra-systems of our level of analysis, and seeing at the same time the 'internal' and 'external' inter-influences of our focus of attention, distinguishing but not separating, as Edgar Morin requires of us. This perspective allows us to consider the possibility of incorporating within linguistics the conceptualization based on the systemic and developed in understanding biological wholes. Indeed, this is Morin's proposal when he completes with the 'eco' prefix the concept of 'self-organization', the latter having been created to provide an awareness of the development of human beings and to transcend the theory of organization implicitly present in early cybernetics and information theory. If the idea of 'self-organization' emphasizes the individuality and autonomy of living systems, we discover in turn its weakness as it separates the self-organizing system from its environment. While more autonomous, living systems are at the same time more dependent on their environment. As Schrödinger points out, they need food, matter/energy, but also information, order. The environment is in their interior. It cannot be a 'closed' system but rather an 'open' one since "it can only be totally logical by introducing into itself the foreign environment. It cannot close itself off, it cannot be self-sufficient" (Morin 1992:46).

[7] "A property of an entity or complex system is said to be emergent if it cannot be defined or explained in terms of the properties of its parts, or if it is not reducible to these properties and their relations". In quantum physics the concept is transcendental and has important theoretical implications given that the material world can be seen from a completely new perspective. I believe that in linguistics the idea is also important. In fact, "nothing can ever be *wholly* reduced to the sum of its constituent parts. There is a surprising, creative edge to all existence" (Marshall & Zohar 1998:137-39).

Allow me to say that here I find a fundamental analogy with linguistics. Although linguistic systems are certainly not biological systems, "the environment is in their interior" and they cannot be understood unless we include within them their environment of human beings organized socio-culturally. There is no meaning without a signifier, and without a world to which we can refer, there are no languages without speakers-thinkers. Thus, the language is in the society-of-humans which is in the language - mutually interconnected, one within the other and the other within the one, fertilizing each other so that they can continue existing. We should, therefore, 'ecologize' linguistic thinking, stop taking linguistic systems as being 'closed' and open them up to their intimate connections with human beings, who after all are being constituted socio-cognitively by them. In fact, this 'ecologization' of thinking, this consideration of the contexts of phenomena in an integrated manner with the phenomena themselves, is not only a challenge for the sciences of language and communication but for all the human sciences (see the Commission Gulbenkian 1996). Sociologies – and even psychologies – without the mind, psychologies without society/culture, economies without human beings and the environment, medicines without emotions or feelings, etc. have dominated most of the paradigms of the 20th century. We should quickly abandon the conception of *homo clausus* in favor of *homo non clausus*, substituting it, as Norbert Elias says, for that of an "individual fundamentally in relation with a world, with that which is not him or herself, with other objects and in particular with other people...." (1991:111).

2.4 Time

The classical paradigm is that of certainty. It interpreted economics rather as one did in Newtonian mechanics, like a machine that always moves towards equilibrium (towards economic equilibrium). I think the opposite, that we should take account of randomness ... and with randomness the idea of risk, the idea of choice. This randomness is an integral part of the very structure of the universe. This is the message of the second principle of thermodynamics:
We must give a positive sense to what we attributed to ignorance.

Ilya Prigogine[8]

Another of the great paradigmatic changes that has emerged most clearly since the end of the 20th century is that of the assertion of the dynamic and historical dimension of reality. Prigogine, for example, reminds us, should we have forgotten, of the inevitability of time and the fragile nature of the balances that lend phenomena their appearance of stability. From here arises the need to incorporate fully within our theorization this dynamic and procedural vision, as Norbert Elias from within sociology has similarly urged. Thus, like contemporary physics, we know today that the world we study is not "an eternal truth but rather a simple moment in the evolution of the cosmos" (Prigogine & Stengers 1996:9). Prigogine speaks also of the processes of spontaneous organization, given that we find ourselves in

[8]Cited by Spire 1999.

an "irreducibly random world" (1996:40), in which "irreversibility is the source of order, the creator of organization" (1996:45). The new science is, like physics, a science of non-equilibrium, of the passage from determinism towards probabilities, which leads us to think of reality as a "world in constant change, a world in which the 'emergence of the new' takes on irreducible meaning" (Prigogine & Stengers 1992:11). These changes in the vision of reality lead as a result to a change in the very conception of science and the 'laws of nature'. These, henceforth, become "the laws of an open universe (...) that can affect the probabilities of evolution, within a future that they do not determine" (Prigogine & Stengers 1992:iv).

It is my assertion that linguistics should also adopt this perspective, following a 20th century that focused more on a static image, giving little consideration to the facts related to existential temporality. Linguistic phenomena should be seen as dynamic structures in evolution whose processes of maintenance should be explained as well as their processes of change, and thus overcome the criticism made by Henri Bergson in *L'Évolution creatrice*, as summed up by Prigogine: "Science (...) has been productive whenever it has managed to deny time, to provide itself the objects that allow the affirmation of a repetitive time, the reduction of the future to the production of the same by the same. But when it removes its favourite objects, when it undertakes to take up the same type of intelligibility which, in nature, translates the inventive power of time, it is merely a caricature of itself" (1992:19).

(Socio)linguistic structures and situations, therefore, should be seen as potentially changing and subject to constant reorganization, so that 'languages' themselves, as organizations of human communicative activity, become unstable dynamic systems in a kind of changing equilibrium. Thus, from the linguistic tradition, 'synchrony' and 'diachrony' – or 'static' and 'dynamic' in sociology – should not be seen as opposite, completely dichotomous conceptualizations, but rather as, mutually inclusive, integrated points of view. Research in the evolutionary dynamics of linguistics should be strengthened so that we might understand the processes that maintain and/or modify their structures, their fundamental factors and their interrelations with the rest of the elements of reality. Yet, languages do not change nor maintain themselves on their own, but rather they are in complete interrelation with the human beings on whom they depend and whom they serve. Together with Elias, we should reflect on "the organization of succession", on "the specific organization inside which a subsequent phenomenon flows from a previous specific succession" so that we might understand, for example, "how a form of economics, a form of thought and, more generally, a form of life in society can be born from a previous form" (1991:126).

Taking a similar perspective, David Bohm, basing himself on the ideas of Einstein, suggests that we ought to renounce, therefore, the vision in which the world is constituted by basic building blocks, and that, "rather one has to view the world in terms of universal flux of events and processes" (1987:31). Bohm goes on to say, "relativity and quantum theory agree, in that they both imply the need to look on the world as an *undivided whole*, in which all parts of the universe, including the observer and his instruments, merge and unite in one totality" (1987:32). Seen

in this light, "each relatively autonomous and stable structure (e.g. an atomic particle) is to be understood not as something independently and permanently existent, but rather as a product that has been formed in the whole flowing movement and that will ultimately dissolve back into this movement. How it forms and maintains itself, then, depends on its place and function within the whole" (1987:36).

I consider the ideas of Bohm to be of great interest for linguistics. His metaphor for seeing reality as "a flowing stream, whose substance is never the same" is perfectly suited to a dynamic conceptualization of linguistics and communicative codes in general. Organizations of systems of meaning used between humans, which, although subject to constant intergenerational replacements, maintain (or not) the former in operation and modify them in accordance with their global socio-communicative needs. Linguistic structures live, therefore, in this incessant flow, just as the socio-meanings that are adhered to them, changing and innovating in accordance with the vicissitudes of the general socio-cultural current of the peoples. Our challenge, therefore, is to go beyond prevailing perspectives that are more static than dynamic, and to incorporate all the contributions and to imagine a new conceptualization that takes into account the flowing dynamicity of all phenomena.

Contrary to what occurs today, socio-historic research into the linguistic evolution of humanity needs to bring together the various lines of investigation and make a qualitative theoretical leap. The most pressing need is to communicate and integrate research into language change, innovation, shift, and extinction, which until today have in the main been produced separately in mutual ignorance of each other. We need to understand much better how linguistic reproduction is possible, how and why language structure can be maintained to such a high degree, how this evolves and for what reasons, etc. It goes without saying just how important studies of the evolution of language contacts and of the phenomena to which they give rise become (pidginization, creolization, emergence of new forms, reorganization of systems, etc.).

2.5 Human Beings: The Centrality of the Mind/Brain

We are beginning to understand the game, but we still know nothing about the player.

P. Vendryes[9]

Up to this point we have seen the various challenges and innovations that the sciences of matter and living organisms have made over the 20th century and which I believe must be adopted without fear by linguistics and integrated in our basic conceptualization. The other great revolution that we await, however, is the conquest of the understanding of the human being by the classic non-material disciplines. As Ilya Prigogine points out within the field of physics, "the human sciences have long been attracted by the model of the exact sciences. As long as the only model of the exact sciences was deterministic, the tendency was also

[9] Cited in Morin 1980:111.

towards a deterministic model in the human sciences. Now that we see that even in the Universe there are non-deterministic models, that time is a reality, we have other possibilities to envisage human action" (see Spire 1999:76).

Now, therefore, that the model *par excellence* of the exact sciences has incorporated elements that are clearly useful and closely related to socio-cultural and communicative phenomena, challenging long-established principles that had been adhered to precisely by the disciplines closest to human realities, it is time to revise our very foundations. In the light of the new bio-physical-chemical paradigms, the developments in the cognitive sciences and innovative research lines in linguistics, we should be bold in imagining new theoretical landscapes which, integrating all that has been achieved to date, would allow us to advance resolutely towards a much greater intelligibility of linguistic phenomena and communicative phenomena in general.

The time is ripe for the whole of scientific knowledge to advance towards an understanding of this human plane, now that the foundations of intelligibility of the physical-chemical and biological processes have been laid. The great challenge now is to understand what might emerge from the interaction of these planes with the world of human operations. It is clear, however, that this theorization of human behavior requires a much greater degree of complexity than that which to date we have been capable of formulating with respect to the world of 'nature' – understood until now in a reductionist sense, excluding from it any human socio-cognitive phenomena. Scientists have tended to look at the 'external' material world, then at organisms and natural ecosystems, and now they ought to turn their attention to what are more properly speaking the human dimensions, although they belong just as much – albeit as 'emergents' from a distinct level – to the 'natural' world.

One of the main questions for scientific thought is, therefore, the integration of the mind/brain. As mentioned above, it is included as the necessary 'origin' of all scientific knowledge – there is no science without an observer, as Heisenberg said – but the challenge is to understand its activity globally in the plane of the phenomena that exist in and between human-beings-in-society. We must, therefore, make the leap from the mind that comprehends to the mind that is comprehended.

To make this leap we must first perhaps rid ourselves of those assumptions that we have held onto for so long because they suited the phenomena of the non-mental material plane – simpler and of quite distinct properties – but which will act as a break on our advancement if we continue to adhere to them for understanding socio-cognitive phenomena. Some have already been called into question by investigations in theoretical physics into the plane of micromatter. The 'particle *vs*. wave' problem that we mentioned above also highlights the limits of Aristotelian logic and points to the need for new distinct logics, such as those currently being developed (for example, fuzzy logic). In the socio-mental world this is crucial for critically examining the principle of contradiction (see De Bono 1994). Things are not in one place *or* in another, things are not this *or* that, but rather they can be – in their own way – in two places at once and can have two distinct categorizations. When I observe someone, this person is both within me and outside me, in my mind and in my physical area of perception. I can have an identity 'X' without

ceasing to be 'Y' also, given that we are dealing with conceptual categories and not physical material objects that occupy space. Thus, the things of the mind can be one within the other, interlaced, at times proving very difficult to distinguish. In the mind, distinguishing with the use of conceptual labels should never directly imply a separation or independence, as they are typically used in the classic world of matter. The mind, therefore, might need other less disjunctive logics and ones that are more firmly based on the 'and' than on the 'or', as the paradigm of complexity rightly advocates.

John Searle (1985) pointed out some years ago four traits of mental phenomena that are not readily included within the scientific conceptions derived from the study of the 'material' world: consciousness, 'intentionality' -"the feature by which our mental states are directed at, or are about, or refer to, or are objects and states of affairs in the world other than themselves"-, ontological subjectivity and, finally, mental causation. The traditional scientific approach fails to tackle each of these phenomena – considered quite real by all parties – because they present characteristics and properties such as being 'externally' unobservable, the reality as representation, the subjective interpretation of the perceptions, the teleological decisions of the system, etc., which are not easily understood from within the classical paradigms. In fact, the socio-cultural sciences, in general, cannot satisfy three of the ambitions achieved by the natural sciences, namely, prediction, regulation and quantifiable precision (Commission Gulbenkian 1996:56). However, the new scientific paradigms come to our aid by also recognizing that absolute predictability does not exist in the material sciences. Thus, one of the great tools of the new sciences is the concept of the "inherently unpredictable situation" and not only because of the limitations of its observer. We can therefore propose that we go right ahead with this specific scientific approach to human facts, given that "unpredictable does not necessarily mean 'unintelligible'" (Turner 1997: xiv).

The mind-brain processes, then, can and should be the object of, if possible, suitably renewed, scientific attention in its procedures and assumptions so that we might account for the transcendental phenomena that occur in this dimension. "If the fact of the subjectivity runs counter to a certain definition of 'science', then it is the definition and not the fact which we will have to abandon", John Searle would say (1985:30). We can and should examine just how 'meaning' is possible, how it is related to the audible physical units that we utter to each other, what relations are maintained with the rest of the perceived reality, how language intervenes in the interpretation of reality, how inter-subjective 'communication' is possible, etc., etc. It is in this direction that we should seek to broaden the lines of research that Chomskyian thought has successfully been exploring to date (see Chomsky 2000).

Likewise, the centrality of the mind-brain is diaphanous if we wish to understand human (inter)action, given that, as Searle also declares, "what the person is really doing, or at least what he is trying to do, is entirely a matter of what the intention is that he is acting with" (1985:77). We are unlikely to be able to explain and understand human behavior if we do not bring the mind-brain – whatever this might turn out to be – into the foreground of our analyses, as it is where reality is perceived, processed cognitively and emotively, and where – consciously or

otherwise – the courses of action that an individual takes are decided. In the human plane, we must never forget the centrality of what is qualitative: as Max Wertheimer writes, “living organisms do not perceive things in terms of isolated elements but in terms of *Gestalten,* that is, as meaningful wholes which exhibit qualities that are absent in their individual parts”. A quotation by Tagore clearly illustrates the peculiarity of man: "There is the reality of paper, infinitely different from the reality of literature. For the kind of mind possessed by the moth which eats that paper literature is absolutely non-existent, yet for Man’s mind literature has a greater value of Truth than the paper itself. In a similar manner if there be some Truth which has no sensuous or rational relation to the human mind, it will ever remain as nothing so long as we remain human beings" (taken from Prigogine 1992:39).

2.6 Interdisciplinarity

Progress in the sciences is linked not only to disciplinary specializations
but also to the transgressions of specialization,
to the construction of general theories and, today, to multidisciplinary groupings.

Edgar Morin[10]

Another of the more important aspects in which new scientific paradigms can renew our way of seeing things is in their questioning of disciplinary divisions in the academic world. Excessive specialization and compartmentalization can eventually be counterproductive for the progress of knowledge. Cutting up a highly interdependent and overlapping reality into different sections can lead to absurdity, and eventually nowhere, if it is not complemented by a broad vision of phenomena and by the study of their mutually sustaining integrations. We should, therefore, *distinguer sans disjoindre*, as Morin would say.

Distinguishing, focusing, emphasizing, but without separating, without breaking what is real, is one of the great challenges facing the socio-cultural sciences and those of communication in the contemporary world. To continue with the division and the all too frequent lack of communication between the various scientific communities is to engage in a sterile activity and can lead to an enormous delay in our understanding of the phenomena that interest us. This is clearly visible in the case of human phenomena, and even more so in the psycho-socio-cultural dimensions in which the cutting up into different and distant faculties and departments leads us to failure and to an inadequate intelligibility of realities of this type. That sociology can be broadly unaware of psychology or vice versa, that linguistics can be unaware of sociology and vice versa, or that the cognitive sciences can overlook the contributions of anthropology or sociology is clearly of no benefit to anyone. But even more grave is that within linguistics itself the lines of specialization follow parallel paths with virtually no communication or interchange, and, for example, that there is very little dialogue between the scholars of interpersonal communication and those of mass communication.

[10] Morin 2001:176.

This highly fragmentary approach is unjustified today in any discipline since in all fields of knowledge there is an obvious need for a contextual and systemic perspective that takes into consideration the environment in which the phenomena and their interconnections with other planes and facts of reality occur. Economics needs to include the natural environment and human beings; equally medicine needs to include the biosocial environment and people's cognitive-emotive dimensions, as well as having an awareness of the interdependencies of the different subsystems acting in human beings, which are currently compartmentalized in different specialties, etc. Likewise, the socio-cultural sciences have to be able to reintegrate themselves so as to become aware of human phenomena. Linguistics should not be afraid of taking these steps and the field should advance with resolve towards a greater communication and exchange between its specialist branches, identifying the interconnections in the process of emergence that leads to the linguistic-communicative phenomena.

Nor should it be afraid of entering into contact with other co-lateral disciplines – as it has already begun to do so – so that they might be mutually enriching and integrate mutual knowledge. It is important to enter into or maintain a constant dialogue with biology, psychology, the cognitive sciences, sociology and anthropology, but also with history, law and the political sciences, on subjects of mutual interest. In the linguistic sciences, moreover, interdisciplinarity is paradigmatic and constitutive, given the ubiquity of and the interconnections displayed by our phenomena with many other aspects of reality. In fact, as Norbert Elias also pointed out, "sooner or later it will become necessary to examine critically the present division of labor between the human and social sciences", since "the nature of language cannot be properly explored by a type of psychology that is centered on the individual. Nor does it fit into mainstream sociology which to date has neglected the paradigmatic information which the 'knowledge-language-memory-thought' complex requires" (quoted in Bastardas 1996). A new unified paradigm needs, therefore, to emerge, one that is capable of showing an awareness of the complex character of linguistic phenomena and communication in general.

As for matters of methodology, socio-cultural research requires that qualitative strategies complement those of a more traditional quantitative nature. Thus, in linguistics, depending on the research questions and the state of the investigation, the two should be combined. While the quantitative methods can give us the necessary 'extension', handling large quantities of quantified data using computerized systems of support, the qualitative methods provide us with 'intention' and depth, by analyzing in detail the cognitive-emotive experience of individuals. Quantification takes us into the framework of statistical data procedures, providing us with essential information about the relationships between factors and phenomena; qualitative methods allow us to take a phenomenological and interpretative approach to human experiences and meanings. Here, I am in favor of a marked eclecticism *à la Bourdieu*, assembling the results provided by the different strategies and putting them at the service of the intelligibility of the phenomena that we wish to understand (see Bourdieu 1979, for example).

I suspect that we still have a long way to go in developing our qualitative methodologies and, in particular, in obtaining the type of data that we wish to evaluate. Further, the level of the emotions and feelings is still looked on with excessive scorn in the academic world and, thus, ignored, when, on the contrary, it is my belief that it plays a transcendental role in the configuration of reality and in human behavioral decisions (see Damasio 2000; Barbalet 2001). The task here is made much greater by the confusion regarding the nature of the science that should be practiced in the socio-cultural sciences, given that for many researchers it remains closely tied to the classical approach of the natural sciences. The situation is very similar still to that described by Norbert Elias: "The mere fact that the type of theory that I have sought to develop is different from what is traditionally considered as a theory based on models of physical sciences still creates enormous misunderstandings. But I genuinely think that future models in the human sciences will be more in the direction that I have taken than towards physical models" (1991:93).

The development of valid, widely accepted scientific models for the socio-cultural sciences and those of communication will not, in all probability, be a straightforward task. Thus, while the qualitative nature of the phenomena that we seek to understand presents major difficulties, further problems, frequently derived from the mental facts, have to be added to the task. Thus, the multitude of variables that intervene in the social reality and their interdependencies, the rapid and constant social changes, the potentially different behavior of individuals with respect to these variables, the meaning of social acts, and the qualitative and non-quantifiable character of many aspects of the social reality represent considerable obstacles to our obtaining a degree of intelligibility comparable to that obtained about the phenomena in which the human mind is not directly present. Moreover, the very fact that the researcher constitutes an additional variable – given that he or she seeks to understand the world based on their inevitable mental action as a subject, the difficulties of applying experimental techniques and simulation methods, together with the problems of the reproducibility and repetition of research, makes the attainment of rigorous and carefully contrasted knowledge of these phenomena particularly costly and complicated. However, as human beings we cannot renounce our own intelligibility. The challenge is clear and we should respond to it.

3 Linguistics and Complexity

A noology considers the things of the spirit as objective entities. But this by no means excludes the consideration of these 'things' from the point of view of the human minds/brains that produce them (...) or from the point of view of the cultural conditions in which they are produced (...). While each one remains irreducible by the other, and risking becoming antagonistic if each ones aims to be the central point of view, for us they are absolutely complementary.

Edgar Morin[11]

[11] Morin 1991:10.

From the above discussion, it seems to me that we face a fascinating challenge, namely, how to define a new unifying paradigm for linguistics and the sciences of communication for the 21st century. Following – once more – in the wake of the theoretical and conceptual evolution undergone by 20th-century physics as well as that of other disciplines, including biology, ecology, the cognitive sciences, and the contributions and perspectives provided by systems and complexity theories, and based on evolutions in different lines of research in our own fields, we need to initiate a creative and imaginative dialogue so as to attain a new theoretical, integrative and holistic unification.

This reintegration needs to be presided over by an awareness of the non-fragmentation of reality, realizing, in this way, the uniquely 'emergent' and multi-systemic nature of what we call 'human language'. To paraphrase Morin, we need to found our thinking on the recognition that linguistic forms are in human beings, in society and in culture, all of which are, in turn, in the linguistic forms. We should strive, therefore, to provide an integrative account of grammar, the interpretation of meaning and linguistic behaviors, given that all these phenomena form part of an inseparable whole (see Bastardas 1999, 2009).

One of the most felicitous consequences of incorporating the perspective of complexity within the study of linguistic phenomena is that it puts an end to discussions about the *locus* of language: for Saussure fundamentally social, for Chomsky basically mental. For us, today, it can be social *and* mental at the same time, without any contradiction, both integrative and emergent, given that, as we have pointed out already, in socio-mental phenomena, objects do not have to be in just one place or belong necessarily to a single order of things. In fact they can be at the 'intersections', in the 'nodes' of things and in distinct planes, as a 'betweenness' event (McGilchrist 2009), in a similar way to which Òscar Vilarroya views the *locus* of knowledge: "Knowledge (...) isn't in books, nor is it in Arkadia, but rather in the *complex* formed by books, Arkadia and the community" (2002:164). I believe that we should see 'language' and 'linguistic phenomena' too, therefore, as a *complex*, and not as 'objects'. In the 'language' complex, not only the structure or (closed) 'linguistic' system participates, but what is absolutely necessary is the interconnection with the individual's cognitive-emotive apparatus, and the rest of the natural and social world. Thus, the brain-mind eco-auto-co-organizes its communicative knowledge/behavior in accordance with its innate properties. And it is here, in this joint emergent and interconnected space, like a fabric that loses all its shape if its constituent parts are cut away, where we find the linguistic phenomenon. Not in just one or other part, but in the interconnected complex of them all. Without cognition there is no language, but without language there is unlikely to be the cognition that we have recourse to; without language, highly organized human societies would not exist, but without human societies we would not have the languages that we know. The 'language' is, *in turn*, noosphere, *and* psychosphere *and* sociosphere, as Edgar Morin pointed out. In all probability we should modify our perspective of languages, and begin to see them as a *network* rather than as 'systems', taking the same path as immunology (see Capra 1997:272).

As I already introduced in my precedent chapter, an image that allows us to conceptualize this idea of the network, as well as incorporating its dynamicity, is that of the orchestral score. The most interesting thing of a notation of this type is that it enables us to observe its *(dis)harmony*, the fact that the performance of each instrument cannot be understood if taken one by one, in isolation, given that its causality is in the harmonic whole, in its interdependence with the other instruments in producing an emergence, an act of new character, that is, the whole piece, to be perceived by humans beings who will also interpret it in their minds as a perceptual whole. The image of the orchestral score can be used to fulfill various ends in linguistics. On the one hand, it can account for the various organizational dimensions that intervene in a simultaneous and integrated manner in the production of linguistic meaning – phonetic-phonological, morphosyntactic, tonal, gestural, cognitive, sociopragmatic, etc., which gives us considerably more power of intelligibility in explaining linguistic productions. On the other, if what we are concerned with is the incorporation of higher dimensions that intervene in decisions involving (socio)linguistic behavior – group, political, etc., it is also very useful given that we can capture the harmonies and disharmonies caused by social and political events of all kinds, their evolution over time – the adaptations or reactions produced in the other dimensions, etc.

A linguistics that sees language as a *complex* and not as an 'object'[12] has a much greater chance of succeeding in the task of making linguistic and communicative phenomena intelligible. It should also be able to take account, in an integrative and realistic manner, of the meanings of linguistic forms -incorporating the 'signifier'-, of their acquisition and use -since human beings will be well integrated in society-, as well as explain their changing historical vicissitudes -by not renouncing the dynamics of the phenomenon-, and even the disintegration and/or disappearance of linguistic systems -by situating them in a logical and natural way in relation with political, economic, media, demographic, ideological, events, etc.

In this framework, I believe that linguistics can proceed without fear towards the expansion of its original pentagrams – fundamentally directed at an 'internal' system – and accommodate those dimensions which to date have been seen as 'external' but which undoubtedly participate in the realization of communicative acts. If we place ourselves in the theory of systems, we would say that we need to incorporate the socio-mental supra-systems in which the linguistic phenomena occur, that is, their general ecosystem, in whose framework the latter can exist, develop and change, and which in turn constitutes a fundamental element in their functionality.

Thanks to the contributions of Chomsky and his followers, linguistics took an enormous leap towards a consideration of the cognitive features that are essential for a correct understanding of the phenomenon. But it should not be forgotten that human minds are always minds-in-society, minds-with-other-minds which create a world both individually and collectively, which are organized socio-culturally, and which evolve according to their situations and the vicissitudes of life that they

[12] We ought, perhaps, to be able to imagine another type of 'object', entities distinct from those recognized to date, since, as Michael Talbot, for example, points out, "electrons don't exist as objects exist" (1986:78).

experience. Alongside this generativist vision we should place, as well as the cognitive, the essential pragmatic-socio-linguistic perspectives so that the landscape can be more complete and coherent. This multidimensional and dynamic integration is the task that awaits us for the 21st century.

This paradigmatic renewal should help establish, once and for all, the taking into consideration of the mind-brain fact in all its human amplitude, from meaning to emotion, and from interpretation to the teleologically-influenced behavioral decision. Thus, we can rule out for good the metaphor of the 'container' in the conviction that, although it might not appear to be so at first glance, it is not the words – in the same way as other perceptible things – that 'mean' but rather we who give them meaning, in accordance with our previous experiences fixed in our cognitive tank and/or with the ideatic innovations that we wish to create. There is, therefore, neither sign nor meaning without a signifier. As Vilarroya quite rightly points out, "the word is a switch for the virtual world in which the kontent is integrated, and not its symbol" [sic](2002:180).

I firmly believe that we should cease concentrating solely on the 'speaker' or the 'emitter' and incorporate more adequately the 'receiver' or the 'interpreter'. We spend much more of our time as 'interpreters' than as 'speakers'. And, as such, we see how our activity of granting meanings to our perceptions is incessant, just like our flow of conscience. In fact, expression presupposes comprehension, which is still the great unknown. When we interpret the linguistic productions that we perceive we do so on the basis of the meaning that we presuppose in the other, given that what is important is 'guessing' what my interlocutor wants me to interpret. The 'other' is always present in our interpretations, as in our actions. We speak and/or we take courses of action seeking to keep in mind the interpretations of the people with whom we are relating, since we always know that, like it or not, 'we will be interpreted'. Understanding the existence and functioning of 'meaning' and 'interpretation' is one of this century's great intellectual goals, and linguistics can and should be at the forefront in resolving this problem.

Seen in this light it is my belief that we should seek the effective promotion of a 'linguistics of meaning', in parallel with a 'linguistics of forms'. In other words, from the 'whole', which for linguistic phenomena would mean human-interpreters-in-society, to specific linguistic forms, taking the path in the opposite direction to that which has generally been followed by the discipline. This perhaps would allow us to reach a comprehensive general theorization more rapidly than if we were to simply continue climbing up the rungs of the ladder from the sounds. Moreover, as we have already arrived via this route to what are certainly interesting and important planes, the focal point, as I mentioned earlier, might not be too distant, so that the discipline as a whole would come out winning. My wish would be, therefore, as I have explained elsewhere (see Bastardas 1995, 2006), to advance as rapidly as possible towards a holistic, more comprehensive and general, perspective for the whole set of linguistic and communicative phenomena.

The road based on an eco-phenomenological 'linguistics of meaning' is today perfectly legitimate following the crisis of the positivist 'truth', as pointed out above. If the mind is the center of any understanding of the world: Why can we not accept that we can start from this point in order to explain the phenomena that

interest us, even those that make narrow reference to the functional possibility of a mind? What function, therefore, do the linguistic structures have in the existence of human meanings? In reality how does inter-meaning occur between people? Today it is clear that the 'communication' between a human emitter and receiver should not be explained using excessively simple models solely applicable to messages that are emitted between mechanical entities. The attribution of meaning to a perception – in this case intentionally produced by another person – does not derive directly from what is perceived but rather from the interpretation that will be assigned to it once we have seen the cognitive tank, the situation, the interlocutor's probable intention, the rest of the actions that accompany it or which have preceded the linguistic emission, etc. Acts of communication are, therefore, complex phenomena that should be explained by taking into account all the elements that intervene in them.

The framework of communicative acts is formed by social interaction, our day-to-day relations. And it should be noted that this interaction is highly ordered and full of meaning, played out in a series of established sequences and scripts that are recognizable to all their participants, provided, of course, they share the same cultural assumptions. Adhering or not to the expected script, fulfilling or not expectations, is significant. As is performing in the "correct" order and quantity. Someone who on meeting an acquaintance does not say "hello" or who does not greet him fails to fulfill the expected act and will activate the interpretation – in this case probably conscious – of the non-greeting. Equally, meeting an acquaintance and repeating the word "hello" fifteen times would be somewhat shocking, given that it does not follow the prescribed interactions for a certain cultural space.

The fact that the scripts by which we play out these interactions are prescribed and expected facilitates their social meaning –in other words, their interpretation- so that we can use them to send 'messages' to the interlocutor. For example: if I always kiss you on arriving home, but today I don't kiss you, I know that you will have to interpret this absence of an action that is acted out each day. In this way, too, silence, the non-form, can acquire meaning, since it contrasts with what is expected, with what should occur but does not occur. The mind, therefore, not only interprets what exists but also what does not exist (but which should exist). Its centrality to human action is, of course, plainly manifest.

Neither is it necessary to postulate a particular interpretative activity for the mind as regards linguistic forms. The mind here acts in a similar fashion as with other sensorial sources of information - visual, tactile, olfactory, gustative. The linguistic forms make up part of the individual experience together with all the other perceptions, which are also subject to the interpretation of the cognitive system. We perceive and we assign interpretations to images of flowers, houses, streets, objects, clothes, cars, animals, to the roughness of a surface, the aroma of coffee, the stench of putrefaction, the noise of a train, the taste sensations produced when sampling a slice of cake, or an aromatic herb, etc. Each of these perceptions can activate an interpretative assignment and, can, as such, 'mean', given that the meaning is not an inherent property of the objects and forms perceived but rather it is granted by our mind. Not only does our and other languages mean, but rather we find ourselves before a fully 'natural' activity of the brain, which is that

of gathering the emissions that the senses send to it so as to construct 'experiences' based on them. And these will be deposited in the cognitive system and used to interpret subsequent perceptions, in the framework of existence in the natural and socio-cultural world.

How this cognitive-interpretative system might be organized is still largely unknown, although we can begin to identify certain characteristics. For example, the *hierarchy* that exists between the different perceptive orders in human relations: the gesture is above the word; as is the visual reality – if there is no coherence between what we perceive visually and what somebody tells us we will tend to give preference to the visual, believing it to be more 'real' than what the other tells us; the situation is above the interaction; the phrase above its constitutive elements taken in isolation, etc. There is still much to be learnt but the results should be of great interest for linguistics and for that group of disciplines in which the study of the human socio-cognitive complex is currently divided. A linguistics housed within the framework of the paradigm of complexity can, thus, advance towards theoretical unification. What we have to date referred to as strictly 'linguistics', psycholinguistics, pragmatics and sociolinguistics can advance towards their harmonious integration based, for example, on Morin's three-way division, between the *psychosphere* of the individual's mind/brain, the *sociosphere* of the cultural products of the interactions of the mind/brain, and the *noosphere* of language, knowledge and the logical and paradigmatic rules (1991:121). By preserving the necessary level of autonomy for each of these planes – distinguishing without separating – we can foster their theoretical coordination and unification, at the service of a better understanding of the interwoven reality of these phenomena and of the communicative happiness of human beings.

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12 The Fuzzy Complexity of Language

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Abstract. Fuzziness is understood here as one of the properties of complex systems. An epistemological reading of fuzzy set theory reveals that the general principles of classical logic become exceptional under fuzzy logic, and a reading of language as a fuzzy phenomenon uncovers new characteristics of the complexity of language systems. Using this approach, the current paper identifies strategies of intentional and unintentional language manipulation adopted to eliminate or at least to reduce this fuzziness. These strategies are explained in terms of indefiniteness, categorization, dichotomization and conceptualization, offering paradoxical examples and examining questions such as the indefiniteness of definitions and the resources used to reach supposedly crisp definitions. Nouns and adverbs are shown to be elements indicative of fuzziness, as elements of *imprecise precision*. The paper concludes with a consideration of the growth of fuzziness in the context of globalization and the emergence and development of hypertext.

1 Fuzziness as a Property of Complex Systems

Theories and research on complex systems in a range of scientific fields have brought to light various irreducible, endogenous properties that constitute the qualitative aspects of such systems, such as their *chaoticity* and *fractality*. In my view, *fuzziness* is another of these aspects.

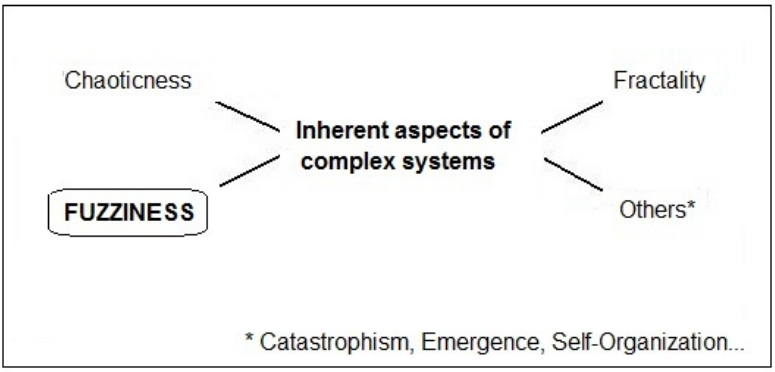

Fig. 12.1 Chief properties of a system with strong complexity.

When these properties are taken as an integrated whole, they offer a new vision of complexity, which we could call *strong complexity*, and capture its epistemological sense as a knowledge paradigm that goes beyond the dominant understanding prevailing in Western thought since classical or post-archaic Greece. Strong complexity supersedes the ancient but still reigning paradigm of simplicity (Munné 2004 and 2005).

This epistemological focus on complexity builds on systems theory and first- and second-order cybernetics and it leads us to see non-linearity at the core of complexity, because non-linearity is the common denominator of the theories involved. Non-linearity in this context must be taken not only as mathematical but also in its epistemological sense as a disproportional relationship between cause and effect. Viewed in this light, complexity is an entirely qualitative concept, which depends more on interactions and feedbacks among a system's elements than on the number of elements. This distinguishes complexity from complication, which is a quantitative concept.

Currently, the most fruitful of the theories feeding into the complexity paradigm is chaos theory, the most surprising is fractal theory, the most disputed is catastrophe theory, and the most subversive is fuzzy set theory. This subversiveness makes fuzzy set theory extremely troublesome for scientific thought and may well explain why it is the most neglected, when not entirely ignored, by nearly all chaos and fractal theorists. It is precisely on fuzziness that this paper intends to focus its investigation into aspects of thought and language.

Lofti A. Zadeh, an Iranian by background and an electrical engineer by training, proposed a theory of logic based on fuzzy sets in the nineteen-sixties while he was a professor at the University of California, Berkeley. Initially, Zadeh was thinking of technological applications, but soon the theory gained ground in other fields as well, including language.

Leaving aside other forerunners, the fundamental characteristic of this logic (close to Eastern thought) is that, unlike Aristotelian or Boolean logic (although Aristotle did envisage the possibility of such a logic), it is not bivalent, but rather polyvalent. The starting point appears to be straightforward: the relation of an element belonging to a given set. In classical logic, the relation is of belonging or not belonging and that is sufficient, while in fuzzy logic it concerns a question of degree.

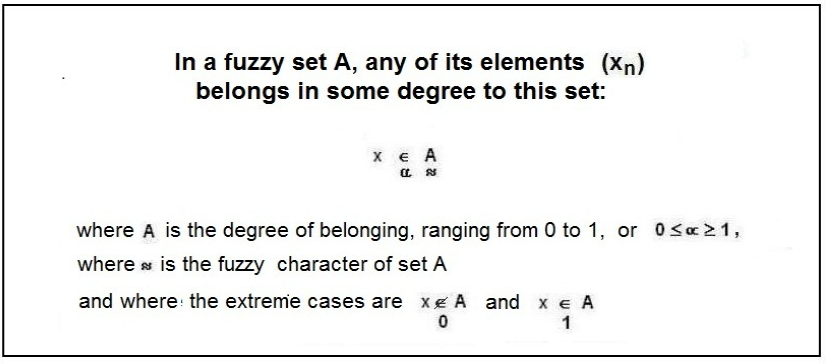

Fig. 12.2 The fuzzy relation is a relation of belonging "and" not belonging (not "or").

Frequently, fuzzy logic is viewed as a type of multivalent logic. Epistemologically, however, this view is not sustainable. The nature of fuzzy logic differs nearly as greatly from multivalent logic as it does from classical logic. In mathematical and programming terms, binary logic only works with "0 and 1", while multivalent logic can have intermediate values, for instance, 0, 0.25, 0.50, 0.75 and 1.00. By contrast, fuzzy logic moves "*between* 0 and 1", where the *possible* values are infinite.

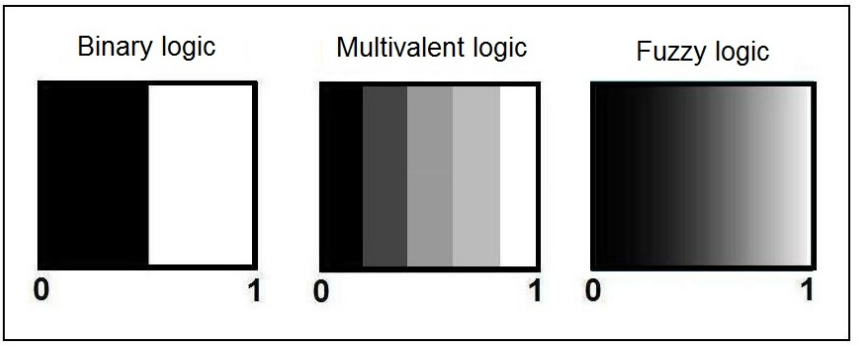

Fig 12.3 Visual difference in values according to three fundamental types of logic.

This difference is striking when observed in black and white. In the first box, the two colours are pure. By the third box, however, they are reduced to the linear limits touching the sides, while the shades of grey in the second box correspond only to specific vertical lines in the third box. Bivalent logic could be called a logic of dichotomy and multivalent logic a logic of discontinuity, while fuzzy logic is a logic of continuity.

2 Inverting the Laws of Aristotelian Logic

As a result, choosing fuzzy logic to study the complexity of language goes a long way toward overturning the ancient and undisputed laws of Aristotelian logic that have fed Western thought. Comparing these Aristotelian laws with their fuzzy equivalents, we find that: 1) the law of identity, by which A is A, becomes A can be A *and* not-A at the same time; 2) the law of contradiction, A or not-A, expressing bivalence, becomes A *and* not-A; and 3) the law of the excluded middle, A and not-A and no other possibility, becomes the law of the included middle, i.e., between A and not-A, other possibilities exist.

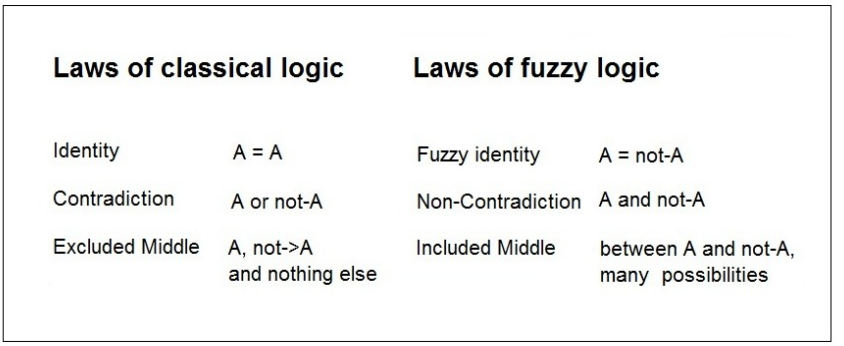

Fig. 12.4 Fuzzy logic inverts the principles of classical logic, which become exceptional or singular rather than general.

Does this dispense with the three Aristotelian laws? No, but it does mean that they hold *only* in the extreme or boundary cases, when the criteria of belonging are total and absolutely clear. The classical laws become exceptional or singular, while the fuzzy laws become general. This shift subverts the established logic and the thought based on it.

3 Language as a Fuzzy System

By the mid-1960s, Zadeh began to see the issue of fuzzy sets as a language problem as well. In an interview, he put it like this: a basic characteristic of the human brain, held more or less in common with other information-processing systems, is its limited ability to manage classes with a large number of elements, and when this ability is exceeded, the boundaries of sub-classes become fuzzy. For this reason, natural languages, which are of a higher level than programming languages, are fuzzy, while programming languages are not. Developing these ideas through the nineteen-seventies, Zadeh (1978) designed a formal language called PRUF (Possibilistic Relational Universal Fuzzy), which permitted fuzzy meanings, but his interest was limited to artificial intelligence. In my view, Zadeh's perspective has been superseded today by the notion of fuzziness as one of the properties of complexity and, in the case of language, as a property of language systems.

Fuzziness is a chief feature of daily language. In fact, fuzziness may even be its *conditio sine quan non.* Thanks to fuzziness, we understand each other without any problem when we utter, for example, a routine greeting like "Hi, how are you? I'm good, how about you?" or when we say "let's sleep in a little" without adding another word. Words, as William James said, have a fringe of indeterminacy that makes communication possible without an attention to detail that would become otherwise intolerable (Stebbing 1950).

Fuzziness is potential. We use language in the degree of fuzziness necessary and sufficient to each case in order to understand or influence another person. It is

a tool that we use carefully, often without realizing it, drawing on analogy and metaphor, symbol and , double meanings, misunderstanding and implication, tone and expression. Fuzziness makes it possible to interpret and apply the explicit and implicit rules of social life efficiently. Consider an example from daily life: at the *express* check-out lanes in supermarkets, a sign informs customers that the lanes are for "up to 10 items" (or a similar amount). The check-out assistant can treat the rule with a literal inflexibility or with a fuzzy richness. In this case, the check-out assistant must decide whether or not 10 products are *always* 10 products, whether two units of the same product count as one or two items, whether a 2x1 offer counts as one or two items, whether or not a customer with 11 or 12 items may proceed when the other check-out lanes have queues or no customer or only one customer is waiting in the express lane, and so forth.

If we view a language as fuzzy, how many words does it have? From the perspective adopted here, it is not only difficult, but impossible to respond (just as it is impossible to respond to the famous question posed by Mandelbrot, the father of fractals: "How long is the coast of Britain?"). This is because any response obscures the fuzziness of the language system. The data given by dictionaries stretch and shrunk like the folds of an accordion. The number of entries and senses vary widely by dictionary and edition.

However, by way of response, suppose we accept the words contained in a given dictionary. Then, let me propose an imaginary game in line with the thought experiments much loved by our early quantum physicists. Let us call it "the dictionary game". Now, supposing that we do not know the meaning of the words, let us select a word randomly from the dictionary and immediately look up its definition within the dictionary itself. "Surprisingly", we see that this definition has more words, so we decide to look up the meanings of each one in order to understand the original definition. However, it turns out that looking up the meaning of these words leads us to yet more new words, for which we need to look up their meanings. And this sequence goes on indefinitely. Under the uncertain assumption that the dictionary gave the meaning of all the words it contained, at the limit (in mathematical terms) we would have gone round "all" of the words, completing an immense vicious circle. Is it possible that we can only understand what the words mean by leaving them behind, by stepping beyond them? I will return to this topic, because at this point Gödel's theorem casts a long shadow…

If each word is defined by other words, we have a self-defining set. This calls to mind the well-known drawing by Escher of two hands sketching one another, feeding into one another. In our case, Escher's hands are the words that signify what the words themselves mean. And this leads to a few reflections:

1) If I am not mistaken, what we have in the "dictionary game" is a dual system, at once linguistic and meta-linguistic, and both systems provide mutual feedback, self-regulation and self-organization. As in a game of ping-pong, two players hit a ball back and forth. Turning from the game back to reality and offering a generalization, we can deduce that a language system tends toward mutual feedback, self-regulation and self-organization. This is paradoxical, because it occurs despite the effect of *disruptive* elements extraneous to the system

(dubbed "noise" by Heinz von Foerster, who introduced the second cybernetics, and by the biophysicist Henri Atlan). These *disruptive* elements, which both restrict and strengthen these processes, include experience and thought.

2) Although the dictionary game is a closed system, the language system is open, because the meanings also flow from usage, tone, expression and the like.

3) Lastly, the language system is a Gödelian system in the sense that it is incomplete. The subject who looks up a word in the dictionary finds more and more words, until sooner or later the subject again finds the original word, running into an inevitable and insurmountable paralogism. The dictionary game winds up becoming an exchange of words, but an exchange of words across two levels of meaning in the system: the level of the word being defined and the level of the other words used to define it, which then give us more words to define, and so on. This returns us to our original observation: the system, because it is self-defining, can only *complete* its meanings taking external elements from within the same system, demonstrating that it is not self-sufficient or rather that it is incomplete.

These characteristics point to an indefiniteness or fuzziness of language, leading us to one of two responses: 1) adopting an *as if* attitude (in the sense of Hans Vaihinger's *as if* philosophy), that is, accepting the fiction that this is clear enough; or 2) resorting consciously or unconsciously to strategies of logic and thought that enable us to manipulate language in order to reduce the fuzzy complexity of the world around us. Of these strategies, I would distinguish three as basic: delimitation, categorization and dichotomization.

4 Delimitation: Reducing the Fuzziness

An example of a fuzzy set appears in the figure below:

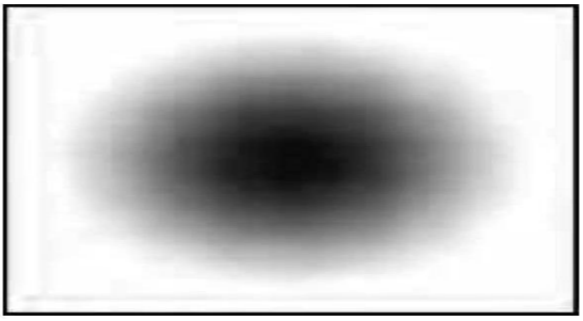

Fig. 12.5 A fuzzy set also has limits, but they are not crisp.

We can observe that the fuzziness in the figure has limits, but not crisp ones. Limits? Yes, there are limits in the sense that we eventually reach what is not included in the set. Here, the limit is an area that becomes gradually blurrier and occupies nearly the entire set, with the exception of the central point (in Euclidean

geometry, a point has no dimension, we should recall), and the central point is where the intensity is at least theoretically maximum or pure. It is interesting to observe that this figure produces an intriguing optical effect, which is intelligible from the perspective of fuzzy complexity. If you stare at it, you will see that the focus gradually dissolves and the limits press inward, *as if* the lack of precise limits forced us to reject the figure.

This does not occur in crisp sets, where the limits are clear-cut. We can test this by reproducing the figure as a crisp set, taking the core or relatively dark area and reducing the set to a dichotomous whole. It occurs even when expanding the limits, while preserving the crispness.

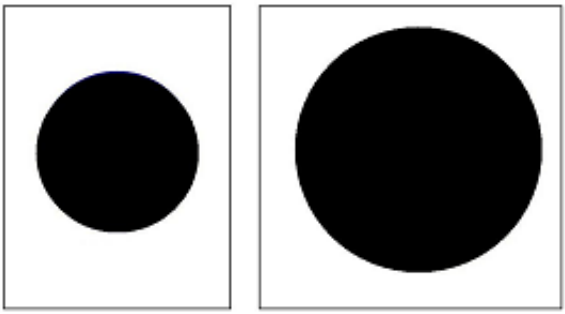

Fig. 12.6 The "breathing" effect is lost in a crisp set created by putting any arbitrary limit on a fuzzy set.

Fuzzy sets contain a paradox. The question of where they begin and where they end has no answer. The best way to grasp this phenomenon is in the chromatic spectrum, which is a natural paradigm of fuzziness. The rainbow, which is in effect the same thing, contains colours that gradually shift towards the right and left until, imperceptibly, black becomes red, red becomes yellow, yellow turns to green, then blue, then finally black again. If we ask ourselves where each colour begins and ends, we find no answer. We can only point to the area where one colour changes into another and say, "Around there". While crisp colours do exist in a rainbow, they exist only in the singularity of the line (which is one-dimensional!) running through the centre of each band. There *are* different colours, but they fade and vanish.

The aim here is not to claim that fuzziness abolishes limits. To the contrary, fuzziness gives limits a leading role in thought and language. Nor is the claim that crisp definition vanishes, but rather that it becomes a singularity, an extreme case, an exception. What is normal, however, is fuzziness.

Now I think we can understand the price that we pay when we establish rigid limits. We gain in clarity, but lose all the fuzziness that is precisely where the vast richness of the phenomenon is found. To lose fuzziness is to create discontinuity and generate "missing information". This expression, which was introduced by the physicist Joseph Ford, is one of the most interesting concepts in the epistemology

of complexity. It captures the *lost* information that paradoxically led the meteorologist Edward Lorenz to discover the phenomenon of chaos.

Returning to the notion of fuzziness, fuzzy, imprecise, vague, inexact areas are considered uncomfortable or bothersome not only because they complicate things, but also because they are seen as undesirable, unnecessary. However, if we eliminate all fuzziness from the chromatic spectrum and reduce it to small boxes of crisp colours, moving from fuzziness to multivalence, the amount of missing information is enormous. It is necessary to note that if we do not want to lose so much information, the solution is not to make more areas that we might call pure or crisp. The cost would be to complicate the question without effectively resolving the problem of fuzziness. Rather, the solution is simpler than that: assume fuzziness.

Before progressing to the next point, it may be useful to provide an example of the question of limits in the case of a company, comparing a crisp conception with a fuzzy one.

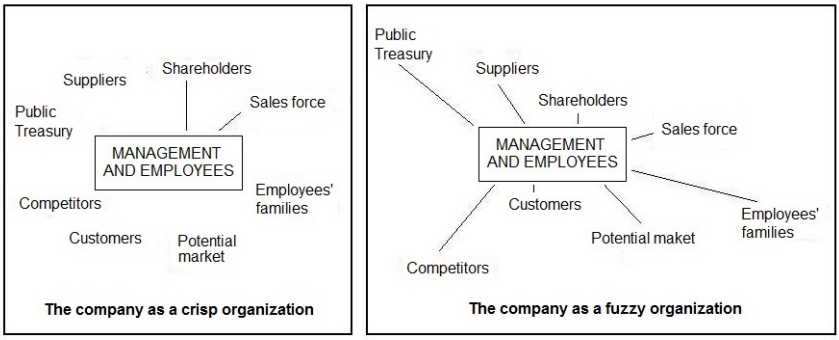

Fig. 12.7 The company as a crisp or fuzzy organization.

In the crisp conception, the company is limited to the management and employees and, at a stretch, to the shareholders and sales force. In the fuzzy conception, all of the elements *are* the company and their greater or lesser proximity to the centre shows their degree of belonging as a function of the degree of the organization's dependence on them. Moreover, in order not to reduce the complexity, each element is itself fuzzy. For instance, if we take the employees, a new employee is not the same as an employee who is on the verge of retirement.

5 Categorization: A Resource for Definition

Categorization is a way of defining sets of things so that they can be compared and classified according to their differences and similarities. It creates divisions based on belonging and non-belonging.

Classification as an empirical scientific activity was institutionalized by the Swedish naturalist Carl von Linné (known as Linnaeus), who created the first modern taxonomy, based on various hierarchical levels, especially the levels of genus and species. From his contribution, we can draw three lessons of an epistemological nature.

The first lesson is summarized in his motto *"Nomina si nescis, perit et cognitio rerum"* (*Metamorphosis plantarum* 1755), or in other words, "If you know not the names of things, the knowledge of things themselves perishes".

The second lesson comes from his magnum opus *Sistema Naturae* (1735, continually revised and reprinted until 1770), in which he classified the plant and animal kingdoms and even the genus *homo* or human beings, which he differentiated into *homo aeuropeus*, *homo asiaticus*, *homo americanus*, and *homo afer* (for *africanus*). However, finding that some human beings did not share the traits typical of these four classes, Linnaeus added the class *homo ferus*, and then because he encountered further cases that were so strange he did not know what to do with them, he created a final miscellaneous category that he dubbed *homo monstruosus* (Bitlloch 1996). The lesson is that from that moment onwards there "existed" human beings classified as *monstruosus*. This clearly points to the fact that no activity of classification and categorization is ideologically neutral. Rather, such an activity invites us to fall into the trap of taking epistemology for ontology.

Fig. 12.8 From *homo monstruosus* to "black sheep".

The third lesson can be deduced from the second. Already in the time of Linnaeus, it was said that *Deus creavit: Linnaeus disposuit* (God created, Linnaeus organized). Certainly Linnaeus organized our understanding of nature, but this act of organizing was just as much as act of recreating. Simply put, to classify is to create reality, because established types can become models for constructing reality and this constructed reality can eventually take hold and flourish.

Many years ago, within the context of cognitive psychology, Eleanor Rosch (1973) made a claim for "natural" categories in her theory of prototypes (Rosch and Lloyd 1978). In the standard version, she took a prototype to be the best

representative or ideal example most frequently associated with a category (it was therefore a criterion based on statistical use). This made it possible to take account of graded proximity to the prototype, which acted as a cognitive reference point. In response to criticisms, Rosch offered a new version, which according to Kleiber (1990) breaks with the earlier version and is less accepted. In it, the prototype is no longer the sole foundation and origin of a category, but rather a shared property (prototypicality), which brings to mind the Wittgensteinian category "family resemblance".

From my perspective, both versions are consistent with fuzzy set theory and the need to grasp, directly or indirectly, a more or less singular core that can support the categorical fuzziness, that is, a focus from which knowledge can expand or blur, and in the opposite direction, grow more concentrated until a core is reached. (It is fanciful and tempting to be carried away even farther and look for common ground with Moscovici's theory of social representations, Jung's archetypes or Eliade's transhistorical paradigms).

Nonetheless, what is crucial in fuzzy knowledge is not the core but the indefinite edges. We recall that the core is the exception and the edges are what make it possible. The very possibility of categorization reveals that the fuzzy set has a core that marks its identity, i.e., the singularity in the fuzziness. The figure below features a dark focus, which in this case shows a significant non-symmetrical or non-concentric expansion, but one which is biased toward one side.

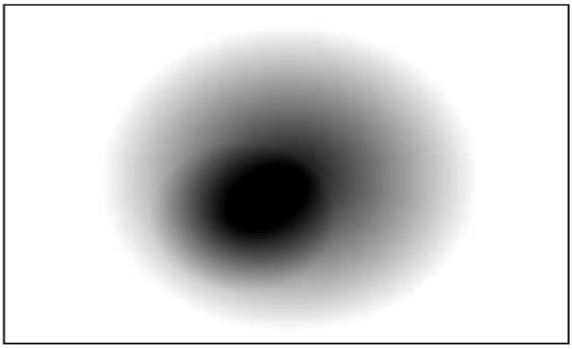

Fig. 12.9 An identifying singularity may not centralize the fuzziness.

6 Dichotomization: Glossing over the Fuzziness

The easiest way to gloss over the fuzziness of concepts is to establish their limits and categories so crisply that they achieve what magicians or conjurers call a "misdirection effect", distracting attention from something else. How does this happen? Through a reduction to two categories or, in other words, by establishing a dichotomy. The limits are closed and no third possibility is admitted. A polarized question can only be understood from one of two poles. The fuzziness disappears "magically".

The tendency to make dichotomies is reflected in a joke that used to do the rounds in Northern Ireland in the midst of the clashes between Irish Republican Catholics and Unionist Protestants. It goes like this: a foreigner arrives in Belfast, the capital, and he does not want to get drawn into the conflict. So he has an answer ready for anyone who asks him, "Are you a Catholic or a Protestant?" When the first person poses the question, he quickly answers, "Me? I'm a Jew!" But the person just as quickly replies: "So you're a Jew, huh? … But are you a Catholic Jew or a Protestant Jew?" We might just as easily recall that other joke of the unfortunate Catalan cartoonistPerich. Seated at the bar next to Perich, a customer turns and asks him, "So, are you with the right or the left?" "I'm a member of the Socialist Party (PSOE)!" Perich replies. But his questioner (raising doubts about how left-wing the PSOE is), goes on, "Okay. But, like I said, are you with the right or the left?"

Beyond their show of wit, these occurrences confirm the resistance to giving up dichotomies, because dichotomies simplify knowledge to the utmost. Science and religion agree on this issue: both are enamoured of the dichotomy "truth *vs*. error". Clearly, the greatest amount of missing information arises from this dual categorization, because it creates an empty space between two poles where the presumably insignificant information is left abandoned, discarded.

Can we say that to think in dichotomies is doing "half thinking"? No, because every dichotomy ends in a monopoly: it leads to total, if not totalitarian, thought. Only by considering each pole as an extreme limit of thought can we destroy the dichotomy and see what is or what might be between its poles. Only in this way can we be aware that dichotomies are an extreme way of thinking.

Dichotomy generates contradiction: the choice of a pole negates the other pole. The concepts "happy" and "unhappy", understood *tout court,* imply that one who is happy is not unhappy and vice versa, which (apart from the *definitio per negatio)* gives rise to the folly that one can only be completely happy or completely unhappy and that being partially happy or unhappy has no meaning. Only in the fuzzy conception of happiness/unhappiness does the question become one of degree. The problem with dichotomous thinking and disjunctive logic is that they contain the trap "this is true because that is false" and vice versa. Dichotomization sets three varieties of trap.

Plato's Socratic dialogues are clearly manipulated pseudo-conversations between a very sage Sage (Socrates), who is in possession of the Truth and has an ability to lead people where it suits him, and a very ignorant Ignorant man, made so if not already. It is a situation with no room for half-measures. The concept in question must be clarified without the poor victim becoming aware that his leg is being pulled with respect to a notion that is fuzzy. If he did catch on to the trick, he would smash a guitar over Socrates' conceited head.

Another trap of dichotomies appears in Shakespeare, where he makes Hamlet fall for it. Once the Dane poses his situation in terms of "to be or not to be", his doubt becomes unsolvable and pathological. What we might call "the Hamlet syndrome" is to a question with no way out, as in Greek tragedy. Hamlet's soliloquy presupposes that nothing else exists between being and not being. Hamlet's only solution would be to acknowledge the fuzzy complexity of the

situation and dispense with the bravado, that is, *between* being and not being is precisely where the possibilities of fuzziness lie. Of course, if Shakespeare had admitted half-measures, Hamlet would no longer be Hamlet … and Shakespeare would certainly not be Shakespeare.

Another trap of dichotomies lies behind the character created by Stevenson in *The Strange Case of Dr Jekyll and Mr Hyde* (1886), the terrifying tale of a doctor who chances upon a strange potion that enables him to separate two aspects of himself and turn them into two people. The Uruguayan writer and poet Mario Benedetti has characterized the tale's protagonist as the archetype of the morally and physically split man. Adopting a fuzzy reading of human beings, however, we might situate the success of the tale less in its splitting potion and much more in its fiction of a polarized good and evil, two absolutes, in which the good is Good and the evil is Evil.

7 Words as Fuzzy Concepts

The question we must ask ourselves is whether there have been or could be any concepts without a single dose of fuzziness. Because if we want to send a scientist or professional *cul-de-sac*, we need only ask for a definition of one of the fundamental concepts in his or her branch of knowledge (in short, the underpinning concepts). Ask the mathematician what the unit or number one is. Ask the geometrician what a point is or the physician what energy or force is. Query the meteorologist about the concept of temperature, the biologist about life or the doctor about health. Ask the psychologist to define "intelligence" or the economist to define "money". And so on and so forth. Every one of these concepts will cause deep and endless debate. This will also occur with concepts – perhaps not fundamental but certainly key ones – in the scientific fields, particularly in the human sciences. For instance, take "cognition", "emotion", "intelligence", "disease", "madness", "person", "mind", "influence", "group", "social class", "social control", "public opinion", "social institution", "unemployed", "delinquent", "drug addict", etc.

Moreover, the same thing occurs with everyday concepts. Considering adults, for example, the concept of "young" could be applied to anyone between 20 and 30 years of age. The concept "tall" could be applied to anyone measuring over 1.85 metres. Of course, it is always possible to say that a person who is 19 or 29 years of age is almost "young" or still "young", while somebody who stands 1.84 m is nearly "tall". It is tempting to reach the conclusion that only concepts considered in terms of their fuzziness keep their naturalness and all the richness of their content. Let us look at some instructive cases.

What is a gene? The concept of a gene, which is currently in the news because of issues such as transgenic foods, animal cloning and the manipulation of the human genome, has been widely discussed in prestigious scientific publications. In 2002, the French journal *Monde Scientifique* posed this complicated question to 18 experts whose responses registered strong disagreements. Some of these responses deserve to be mentioned here:

A biophysicist gave 12 responses and went on to criticize all of them.

Two molecular biologists could not agree with each other and one of them confessed not to know.

A geneticist avoided responding and chose only to recall that 11 different concepts had already been proposed in the nineteen-seventies.

A virologist gave three different responses and concluded by saying that it was a matter of intuition (?).

A biotechnologist sidestepped the question, offering only an unexpected but realistic observation: any response affects the patent wars (!).

Nor is that the end of the matter. In 2010, *Scientific American* dedicated a special issue to the same question. However, in not one of its articles, which examined various aspects of genes, was the question that appeared in bold letters on the cover ever answered: What is a gene?

The conclusion is amusing: the people working with genes do not know what they are working with. Unsurprisingly, when the first of the journals mentioned above, *Monde scientifique,* had asked what a gene was earlier, in 1996, Jean-Jacques Perrier, an in-house science journalist, headed his article with that famous line of Groucho Marx: "A child of five could understand this. Send someone to fetch a child of five!"

Why is it not possible to respond "dogmatically" to the question of what a gene is? The answer probably lies in the fact that genetic or biological reality is a vast fuzzy complexity and the semantic field of the word *gene* corresponds to a set of meanings open to a concept that has, to put it in other words, a "variable geometry".

However, what is interesting and revealing is that, in spite of the fuzziness of the concept, genetic biology not only keeps advancing, but is now enjoying the most spectacular successes of its short history, successes that were unthinkable only a few years ago. Fuzziness appears to be no impediment to understanding nor does it frustrate research. Rather, it seems to encourage the advance of knowledge.

Take another example: what is a"book"? In the nineteen-eighties and nineties, the social psychology establishment was rocked by a headlong assault from a sector of critical social psychology. Kenneth Gergen (1991) argued that it was through the different uses of language that we went about constructing social reality. One of the examples offered in support of this thesis was the concept of "book". Certainly, Gergen explained, the basic purpose of a book is for reading, but it can also feed a fire, act as a hammer, provide toilet paper, serve as a paperweight and so on. This led Gergen to denounce the modernist tradition, which, in his view, stifled all these alternatives without stopping to consider that if a book were *really* a book, we would not be able to do anything with it except reading.

However, if Gergen had put on "fuzziness glasses", he would have seen that the explanation that could account for the multiple meaningful uses of a thing can be found in the fuzziness of the signifier. Mark Twain is credited with the anecdote about a woman who asks him how many books he has in his home. To this, Twain gives a droll reply: "The more books the better, because books are indispensable. Look, if a piece of furniture wobbles, I need a book to put under its leg. The walls

of my office have cracks and I use stacks of books to hide them. If I weren't tall, I would need to put one or two books on the seat of my chair to be able to eat or work at the table. And when my dog makes me angry, I throw a book at its head …". Twain was able to give this response not because the concept of book has different linguistic uses, according to Gergen's thesis (although, of course, it does have), but because of its possible factual uses as an everyday object, which turn the concept into a fuzzy set rich with meanings, without leaving aside a core meaning given by its primary, original use. It is not necessary to invoke linguistic construction to understand that a book is not just for reading and nothing else.

Let me add a third example that is polemical because it affects our individual and social identity. Who am I? According to the model that I have proposed based on the perspective of complexity (Munné 1997 and 2000), a person is a self-referential system that has four "facets": self-esteem, self-concept, self-realization and self-image. These "facets" correspond to the affective, cognitive, volitional and interactive aspects of any individual. Graphically, we can picture these aspects in the "diamond-shaped" model below.

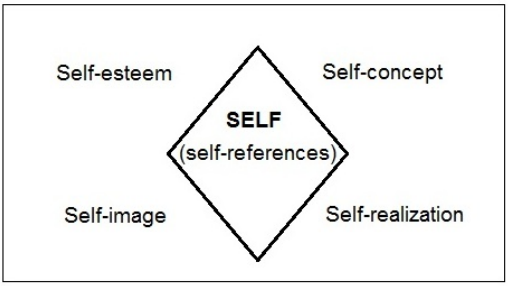

Fig. 12.10 The four facets of the self.

These aspects blend together, becoming fuzzy in the answers to the TST or Twenty Statements Test, the well-known personality test of Kuhn and MacPartland. The subject is asked twenty times to respond freely to the question, "Who am I?" and must give a new response each time. For example, the subject replies: I am Albert, bold, a good father, an executive, a swimmer, jealous, a smoker, diabetic, a lover of jazz, and so on. According to the paradigm of complexity, the subject gradually sorts through the fuzziness of who he or she is (Codina 1998 and 2005), while "jumping" from one facet to another facet of his or her *self*.

Interestingly, the same questions may later give rise to more or less different responses, because the context has changed (e.g., Albert is older, has a new job, or his marital status has changed) and the self-perception of the subject has also changed … without ceasing to be who he or she is. In other words, the fuzziness of the human being leads him or her to say, in opposition to the principle of contradiction, that I am *and* I am not the same as I was yesterday or will be tomorrow.

This statement is a paradox that is difficult for the traditional mindset to digest. It is related to self-resemblance, a characteristic of the fractal property of our complex system that would lead us away from the subject at hand. This paradox also gives rise to the question of where a person begins and ends, a question with no answer, certainly no crisp answer, just as the colours of a rainbow or the length of the coast of Britain has no crisp answer. Nor does it have a physical, psychological or social answer. Obviously, acceptance of this point also meets with stiff resistance.

8 Words and Definitions

If we return to the dictionary game, we see that it has a trick: the words are both defined and defining. And this is possible thanks to the system of concepts that acts as an intermediary, facilitating fuzzy references.

The Catalan dictionary *Diccionari de la Llengua Catalana, de l'Institut d'Estudis Catalans (DIEC)* gives the first meaning of the word "define" as "to make the limits (of a thing)", while the Spanish dictionary *Diccionario de la Lengua de la Real Academia Española (DRAE),* exercises an ingenuous decisiveness in saying that "define" is "to fix with clarity, exactitude and precision the meaning of a work or the nature of a person or thing". The DIEC seems more sensible or more prudent that the DRAE, depending on how you look at it and certainly without knowing it, much like Molière's *Monsieur Jourdain*, because the DIEC does not exclude, at least not explicitly, the possibility of fuzzy limits in a definition. By contrast, the DRAE shows a total allergy to fuzziness in a definition that is at once naïve and ostentatious. Because speaking of a clear, exact, precise definition makes no sense. Such a definition would have to be total, absolute, perfect, and none of these attributes is possible. Demonstrating greater intuition and experience, lawyers cite the *Digest* of Justinian (Lib. V, Tit. XVII, law 202), which says,*"Omnis definitio in iure civile periculosa est; parum est enim, ut non subverti possit",* or in other words "Every definition in civil law is perilous; but a little may reverse it". And this notion does not hold only for civil law…

To define is not to define. Let me explain: if by defining, we understand delimiting a concept as crisply as possible, then the greatest amount of missing information is generated. In other words: thanks to what we do not say, to what we keep quiet or do not define, we can say, speak and define. In this respect, language lies in the very heart of what we say and do not say. It is speaking and not speaking. Inevitably, every definition is a lack of definition.

Not acknowledging the fuzziness of concepts creates "as a problem" the endless multiplicity of definitions that emerge not only from differences in criteria and perspectives, but also especially from the fuzziness of their limits. Take this example from social psychology, a focus of mine for several decades: the crisp definition of what a human group is gives rise to debate over dozens of definitions,

leading many to think that it is not worth the effort to pose another definition, because it would simply make matters worse, more entangled. Certainly, it would complicate matters. Seen from the perspective of complexity, however, definitional pluralism reflects fuzziness and, as a result, enriches the concept.

Bearing that in mind, it would be a hasty conclusion to deduce that fuzziness hampers the crispness of definition. What it does do is that it reduces the definition to a core and makes it possible to arrive at definitions by convention, negotiated definitions, implicitly or not, around this core as a function of interests, needs, ideas, beliefs, desires, commitments, etc. To avoid fuzziness in definitions, criteria are reached and established expressly or tacitly and these criteria can always be renegotiated. In 1791, the metre was defined in Paris as one ten-millionth of the distance from the equator to the north pole, that is, one ten-millionth of the length of the Earth's meridian along a quadrant through Paris. By 1983, after its ultimate renegotiation, the definition of the metre became the distance travelled by light in a vacuum during a time interval of $^{1}/_{299,792,458}$ of a second. The question "what is a metre, *really*?" can have many answers; what it does not have is *only one* answer.

Consider another example of definition by convention, which reproduced the category problem of *homo monstruosus* in another sense and in a different branch of science. In the seventeenth century, the Sun and the Moon were ruled out as planets when planets were classified as all those heavenly bodies that revolved around the Sun in more or less (fuzziness!) circular orbits. With the discovery of Neptune, significantly smaller bodies were excluded and a new category was created: asteroids. Then, in 2006, the question was raised whether Pluto was a planet or an asteroid. Provisionally, Pluto was reclassified in a new category: "dwarf planet". However, the current definition of planet requires three conditions: 1) the object has sufficient mass to pull it into a roughly (fuzziness!) spherical shape; 2) it revolves around the Sun on an orbit resembling (fuzziness!) a circle; and 3) it has cleared the neighbourhood around it of other celestial bodies (how many? to what distance?: more fuzziness!). In the case of Pluto, the third condition is not met, because Pluto's orbit passes through the Kuiper Belt, which contains more than 70,000 bodies with a diameter of less than 100 kms. So it could not even qualify as a dwarf planet! The International Astronomical Union has left any decision in abeyance, because a hidden question lurks in the background, apparently foreign to science, like the patents war in the case of the gene. As it happened, the change in classification had unsuspected "collateral effects": the astronomers and general public of the United States mounted pressure against the change, because it meant eliminating *their* planet, that is, the unique discovery of an American, specifically made by Tombaugh in 1930 (Weiss 2010).

Definitions by convention make dictionaries possible. The fuzziness of the different meanings of terms reveals the internal debates of Spanish Academicians. In late 2008, the Royal Spanish Academy of the Language was at work on a new definition and meanings for the word "culture". Some of the details of the debates

or negotiations were leaked. The psychiatrist Castilla del Pino wanted the definition to say explicitly that culture was the "set of behaviours that characterize a group, for example, drinking culture, drug culture, Hollywood culture or Andalusian culture" and recalled that the sociologist Georg Simmel had written about "women's culture". Francisco Rico that this was good, but wanted to add the case of "corporate culture". By contrast, Luís Goytisolo thought it would be more appropriate to add "wine culture" and rejected the inclusion of "drug culture" and "drinking culture" (referring to the Spanish idea of the *botellón*). Pérez Reverté came down in favour of gathering the noble meanings and the more vulgar uses, such as "drug culture" and "culture of violence". And not to keep going on, Alvaro Pombo interjected that more than one concept dealt with a semantic field. In addition, the reported discussion made mention of a "transcultural" dimension, after making comparisons with the authoritative dictionaries of other countries, such the Oxford Dictionary, the Larousse, the Zingarelli and the Great Russian Encyclopaedia Dictionary (Ruíz Matilla and Constenla 2008.)

The artificiality of consensus cannot eliminate the natural fuzziness of words. But are there no crisp definitions at all? Yes, by means of the reductionist strategy of operational definitions, constructed with the *ad hoc* manipulation of fuzziness, to take a specific case. As I said at the start of this paper, when I noted what was understood by complexity and fuzziness here. Operationally defined concepts are delimited *hic et nunc,* even though they continue potentially to be fuzzy or indefinite. Any of us in another context could give an operational definition that is more or less different for the same concept or word. The fiction of saying how many ill people or poor people there are in a country at any given time admits different versions and all of these versions respond to the complex reality.

Earlier, I noted that fuzzy set theory is the most subversive of the theories of complexity. Can this statement be better understood if we take into account that the fuzziness of concepts has a particularly strong effect on concepts that we might call "sensitive" in the areas of social and culture life, such as politics, law, and morality? In these areas, convention makes little sense and has little to do with the matter. It is relatively easy to reach agreement on the metre as a unit of length, but what sense would there be in negotiating what "Democracy", "Homeland" or "God" means? These are concepts that, when treated "as if" they were crisp, lose all of their interest and certainly their meaning.

9 Indicators of Fuzziness

Despite definition, categorization and dichotomization, are there indicators of the degree of fuzziness in language? That is, just as definitions try to indicate crispness, are there (grammatical) elements that indicate and maintain imprecision?

Language renders the fuzzy shape of everyday life. Colloquial language is fuzzy because, unlike scientific and technical languages, it does not typically require a great number of elements of exactness. Fuzziness has its linguistic rendering in the use of concepts, in the form of nouns, verbs, adjectives and other grammatical elements. For example, we say: "bring it to me *right now*"; "I'll finish *in an hour*"; "come to my office *at once*", and so on.

Adverbs seem to constitute a separate world. They were already an object of attention for Zadeh (1971), when he observed that natural languages have linguistic variables given by elements capable of modifying or transforming one fuzzy set into another, such as adverbs that indicate one mode at the same time that they indicate the possibility of another mode and, therefore, open up a field of semantic possibilities that can be represented by an applicability curve or a possibility distribution curve in reference to the imprecision or fuzziness of a given expression or concept.

In my view, adverbs and adverbial locutions play a more basic role in language fuzziness. The most interesting aspect of adverbial function is that, in general, an adverb specifies a circumstance, modulating the conceptual limits of the word that it accompanies. This is a paradoxical function, because it specifies without restricting the fuzzy area of the semantic field. In a sense, it produces an "imprecise precision" in response to a wide array of circumstances of: place, time, manner, quantity or degree, comparison, exception, number, similarity, equality, affirmation, negation, doubt, union, division, addition, exclusion, order and so on. Particularly in colloquial speech, the wish to specify what is imprecise can lead to the construction of genuinely fuzzy adverbial chains, such as: *hurry over here right now already* and *the house is not far over there on the right*.

Taken literally, some adverbs can be highly "precisor". Examples include: *only, not at all, always, by no means, merely, exclusively* and, especially, *exactly*. Also, the adverbs *yes* and *no*, when they conceal no doubt, can come to have only a potential fuzziness. In principle, they are absolute limits, such as the terrifying *no* that brings down the curtain on the final scene of *Le malentendu* by Albert Camus. Even so, this last example contains a latent fuzziness, according to the playwright's own explanation of the scene. Camus writes: "The character of the old servant does not necessarily symbolize destiny. When the survivor of the drama (Marta) cries out to God, he is the one who responds to her. But *perhaps* this is another misunderstanding. If he says *no* to the woman asking for his help, it is because he does not, in fact, have the intention of helping her and because *amid a certain amount* of suffering or injustice nobody can do anything for anybody and sorrow is solitary." (The italics are the author's.) Ambiguity? Without doubt, but with the support of fuzziness.

One way to study the fuzziness of adverbs might be to observe the effects of deleting them, adding them, changing them, moving them and so on; in other words, manipulating the fuzziness and observing the effects (on interpretation, behaviour or interaction) in the recipient.

Some adverbs of quantity (*more, less; enough, a lot, a little, none*) are "precisors" adverbs that have been used since the nineteen-thirties to give ratings in well-known psychometric scales of attitudes and opinions like the Likert scale. These rating scales may seem to apply multivalent logic, but the fuzziness comes in with the quantitative value of each response variable, because is not discrete, but rather fuzzy. The scales that are most completely fuzzy are based on a continuum, such as when the subject is asked to rate generic political thinking anywhere on a right-centre-left axis. If we moved to the right or the left of where the respondent has marked their rating and asked, "Would you go this far?", we would be putting the respondent in the diffuse problem of marking the limits conventionally.

We can relate fuzziness to the missing information not only of words, but also of fuzzy phrases and clauses, and it is particularly interesting to bear fuzziness in mind in discourse analysis. Lasaga Millet (2005) has put forward a method for analysing texts that respects and emphasizes the fuzziness inherent in language and in the communication process, incorporating the principles of fuzzy logic to the grounded theory methodology of Strauss and Corbin by means of the QSR Nvivo software program.

10 Expanding Fuzziness: Hypertext

A highly suggestive aspect of the fuzziness of language in today's setting of globalization is *hypertext*, which is a new addition to the classic *text* and *context*. Hypertext is a kind of text that has a potential context that globalizes the indefiniteness. With new technologies, the fuzziness has grown to new dimensions and become hypercomplex.

The relational dimension of fuzziness was addressed, albeit occasionally, by Michel Foucault (1969), who wrote that the margins of a book are never clear or rigorously cut, beyond the title, the first lines and the final period, beyond the book's internal structure and the form that makes it an independent object; it exists within a system of references to other texts, to other phrases, a node in a network. Today, inevitably, this reference to context extends to hypertext in the Internet.

The original idea for what we now call hypertext was conceived by Vannevar Busch in response to a concern over information management. In 1945, Busch published an article significantly entitled *As We May Think*, in which he proposed a new system (called Memex) to store and classify information not sequentially, as it was done then, but by association, because "that is how the human mind works". Twenty years later, the computational scientist Theodor Holm Nelson gave the name *hypertext* to a "body of written or pictorial material interconnected in a complex way that cannot be represented conveniently on paper", insisting on Busch's idea that traditional writing is sequential, while the structures of ideas are not (Lamarca Lapuente 2009).

As a system, hypertext is a non-linear organization of textual information (Tolhurst 1995), in which any text is *potentially* related to any other. That is what differentiates it from other systems of information organization.

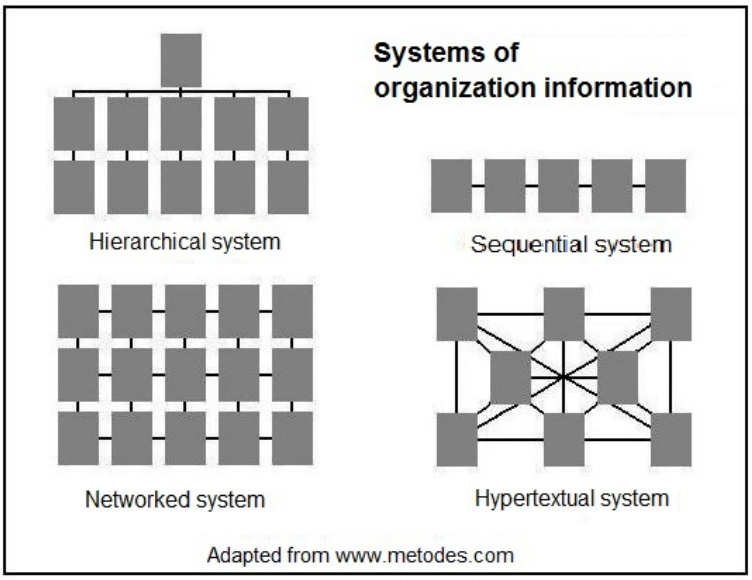

Fig. 12.11 Hypertext is a complex system of organizing information while keeping its fuzziness.

Connections between texts occur through links and tags that are not simple cross-references, as in traditional bibliographical referencing. The links and tags lead to other texts that are extensions of the original text, which turn out to be again extensions of the text. In this way, they form part of an illusive, indefinite web, with a high degree of fuzziness; a web in which the missing information is constant, changing and always very rich. The complexity of hypertext is emergent and self-organizing. It allows a text to be handled in multiple possible contexts, wandering off the beaten track as Heidegger does in his *Holzwege*, following a non-linear path that might lead us to unexpected, ever-different places. The hypercomplexity of hypertext goes beyond fuzziness, demanding attention to the different properties of complex systems, such as their "chaoticity" and "fractality".

Oddly enough, we began by talking about the dictionary game and now, in the end, the enormous potential field of hypertext once again evokes the game in reference to the Internet. What role does fuzziness play here? Might it increase the complexity and complication of the chaosystem? It appears not. At least in terms of search results obtained with Wordnet, a large-scale lexical database with sets of synonyms (synsets) that take the structure of a network of semantic associations. With more than 150,000 words (nouns, adjectives, verbs and adverbs) and their

possible relations, Wordnet was designed to capture how we acquire and organize knowledge.

Sigman and Cecchi (2002) analysed the organization of Wordnet (taking a base of 66,000 words) and found that any two randomly selected words would give rise to word chains (e.g. between *lion* and *stripes* appears the word *tiger*), as well as triangles and other local associations. The whole network turned out to be "a small world (Milgram 1967), because the average distance was 7 degrees (or steps) of separation and there was a large number of triangles; further, it was a scale-free network because the most interconnected words were the words with the most general content. The most interesting aspect is that deleting the polysemous words did not make Wordnet more efficient, an outcome that the absence of redundancies might lead us to expect, but instead raised the average distance to 11 degrees and the triangles dwindled 300 times. This means that polysemous words give an extraordinary coherence to Wordnet, enabling navigation (degrees of separation in the interrelations) and local association (triangles). Thus, paradoxically, the ambiguity introduced by polysemy does not produce inefficiency, but rather makes Wordnet much more fluid. Subsequent studies on other networks, such as *Thesaurus*, confirm these observations (Solé 2009).

As Pajares Tosca (2004) has written, the hypertext paradigm in the end not only reconfigures the literary paradigm in all its aspects, theoretical, creative and educational, but also, hypertext links have a political, ideological and theoretical dimension. We think they can be, and in fact they are, ways to direct or redirect a path forward often without anyone taking notice!

11 Returning to Where We Began

At the very beginning, I noted that the analysis of complexity is an analysis of its aspects, including fuzziness. We have seen a number of questions arising from a treatment of language systems as fuzzy systems. Delving more deeply into this aspect, however, requires that we do not uncouple it from the other properties of complex systems. For example, what missing information signifies is not only a question of fuzziness, but also has profound connections with "chaoticity" and "fractality", emergence, self-organization and so on.

That question, however, remains for another occasion. In the meantime, I invite the reader to reflect on the question that I posed in another article (2007): "Should the explanation of human behaviour (which, in this case, is language behaviour) be the simplest possible or the most complex?" I think that this current exploration of the fuzziness of language is a step in the direction of the latter choice.

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13 The Emergence of Complexity in Language: An Evolutionary Perspective

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Abstract. Like an increasing number of linguists and other scholars especially interested in the evolution and/or the ontogenetic development of language, the author claims that languages are complex adaptive systems (CAS). These have been characterized as reflecting complex dynamics of interactive agents, experiencing constant instability, and in search for equilibrium in response to changes in the ecologies of their usage. Putatively, thanks to self-organization, transitional moments of apparent stability obtain during which patterns and systems emerge, and evolutions obtain from the alternations of periods of instability and stability in seemingly unpredictable ways. The author addresses the issues of the many interpretations of 'complexity' applying to language(s), of the description of the interactive agents that produce the above characteristics, of the emergence of complexity in language(s) from the point of view of language evolution, of the kind(s) of evidence that support(s) the various interpretations of 'complexity' that are conceivable, of the way in which complexity in language compares with complexity in other non-linguistic phenomena, and of the causes of the "chaos" which prompts languages to reorganize themselves into new systems.

1 Introduction

The scholarship on the evolution of language has come a long way since the earliest speculations in Antiquity and even since those of the 18th and 19th centuries. While it was commonly assumed that speech had evolved from natural cries similar to animal vocalizations (which is not totally groundless), it was also assumed incorrectly that the transition from the "cries" to modern languages involved no intermediate transition(s). Today, influenced by Darwinian theory of gradual and ecologically-driven evolution of species, including hominins, modern students of the evolution of language assume gradualism. It matters little that there is still a great deal that we do not know, and certainly no consensus, on the specifics of the

evolutionary trajectory.[1] The present essay is in line with this Darwinian approach, focusing on the emergence of linguistic complexity, which has itself become an elusive notion over the past few years. As I show below, it can be interpreted in diverse ways which are not mutually exclusive.

Most of the recent publications in linguistics have focused on what Dahl (2004) calls "constitutional complexity" and DeGraff (2009) characterizes as "bit complexity," having to do with how many units (e.g., the size of the phonetic inventory) and rules/constraints a language possesses.[2] The rules/constraints specify what combinations of units are allowed and under what specific conditions some of the combinations are not permitted. (See also Nichols 2009, though she hesitates about the inclusion of constraints.) Adding to the complexity, which must be considered more dynamically than statically, are also pragmatic conventions specifying when particular forms or constructions can be used and when they may not.

The "bit complexity" approach, which may also be claimed to be structural, has generally been comparative, leading to the conclusion that a language with a larger inventory of units and rules/constraints is more complex than one with a smaller one. Like Dahl (2004), Nichols (2009) adds that this can be measured by the length of the description that can account for the language, assuming of course that the same framework of analysis has been applied to languages being compared. In reality, the comparisons have focused on subsystems, making it easier to claim that a language has a more complex phonetic inventory or phonological system than another, though it has also been observed that most languages fall within

[1] In Mufwene (in press-a), I argue against monogenetic phylogeny, which is still assumed by many, if not most, of recent publications. The current paleontological evidence does not support monogenesis, especially with the fossil evidence dispersed all over in East Africa. It is not even necessary to assume it in order to account for the common features of human languages. By homology, these may be considered as natural consequences of the particular mind which co-opted the same anatomical structures in all hominin populations for the local production of various languages. This position makes typological linguistic diversity more natural and easier to account for, without having to invoke unmotivated systemic changes. Because no particular population ever selected the full range of sounds they could produce (Maddieson 2006) and because there are alternative ways of handling linearity that followed from the adoption of the phonetic technology (see below), there is plenty of room for cross-systemic variation, which is evident already at the level of dialectal variation within the same language. *Mutatis mutandis*, the same is true of signed languages, where the primary technology is manual. In this essay, my alternating between the singular and plural in speaking of the emergence of language(s) simply reflects alternative emphases on either the common features or the variable peculiarities of languages.

[2] As noted by Givón (2009), it is the fact that units and rules maintain, respectively, space and functional relations to each other which justifies interpreting this aspect of language as complexity. This feeds into the dynamical interpretation of complexity that I develop below.

the average range of complexity (Maddieson 2005a, 20085, 2005c). It has been difficult to show that overall one language is more complex than another, though some students of the evolution of language are exploring this possibility (e.g., Nichols 2009, Wang 2011, Hombert 2011). Because, as noted by Nichols (2009), no comprehensive comparisons of all modules have been undertaken yet, the question remains open.[3] Besides, even if there are comprehensive studies of some languages, the comparison can be difficult to undertake fruitfully if they are not written in the same framework of analysis and are not equally informative about details of the (sub)systems.

Overall, the "bit complexity" approach has been at variance with discussions of complexity in studies of emergence outside linguistics. "Complexity theory," as the scholarship on emergence is often referred to, has focused on interactions between agents, which keep the ever-emergent "system" in constant search for equilibrium (e.g., Dooley 1997, Heyligen 2009). Complexity arises from the adjustments the "agents" (i.e., interacting units) make to each other, how the adjustments modify the overall properties of the emergent system, and how the properties of the latter fail to amount to the sum of the properties of its components.[4] There is thus a lot of emphasis on self-organization, which generates structures that have been planned by nobody. We may term this "interactional," "dynamical," or "systemic complexity" (Mufwene 2009), which, in the case of language, does not deny the value of "bit complexity" but simply shows another aspect of language that is equally worth (better) understanding.

Interactional complexity is given more attention in this essay, because it helps us best understand how human languages differ from animals' means of communication, to which the term *system* can apply only loosely. Human languages, both spoken and signed, are multi-modular. The interactions of their modules, which run concurrently during the production and processing of utterances, generate complexity, just as do intra-modular units in their paradigmatic interrelations and

[3] To me, this line of research is like comparing the architectures of two or more computers doing basically the same kinds of jobs, or can be adapted to do each other's jobs, but are using different (combinations of) algorithms. I think that, from the perspective of the phylogenetic emergence of language, it is less informative regarding the aspects of human languages that distinguish them from animal means of communication, as I show below.

[4] An issue arises from the interpretation of the term *agent*. According to complexity theory, the agents can be nothing but the units/components which self-organize into an emergent system. These are the counterparts of units and rules/constraints in languages. On the other hand, languages are like viral species, whose characteristics emerge from the communicative activities/behaviors of the communicators, who shape them in the process. Is one therefore justified in assuming, as do Lee *et al.* (2009) and Beckner *et al.* (2009) that the agents are speakers/signers? Or should one assume, consistent with emergentism, that self-organization applies the same way in languages as in other "systems," especially since speakers/signers have no foresight of how things fall in place in the emergent linguistic systems? This is a question that practitioners of usage-based grammar cannot dodge.

syntagmatic interactions.[5] In this respect, even those linguistic systems claimed by some linguists to be the very simple, such as child language and incipient pidgins (e.g., Bickerton 2010, McWhorter 2001, but see below), exhibit a level of complexity that is not evident in, say, primates' vocalizations.

I argue below that the main reason for this difference between human languages and animal means of communication lies in the fact that nonhuman primates' vocalizations are holistic signs; they do not have discrete/digital structures and do not lend themselves to compositionality. Though long vocalizations are modulated prosodically, they simply cannot be segmented into constitutive units. This fundamental difference alone has exponential consequences, including the fact that, as far as we know, sequences of apes' vocalizations do not display syntagmatic relations (unlike long utterances in human languages), let alone the kinds of inter-utterance relations identifiable in conversations or other forms of discourse. Yet, it is possible to identify syntagmatic relations in child language and pidgins (though these lack complex syntactic structures). As explained in Mufwene (2010), it's not evident that Bickerton was justified in characterizing them as "protolinguistic," though they are transitions to full-fledged linguistic systems (communal rather than individual in the case of pidgins).

Another fold of linguistic complexity emerges from the communal aspects of languages, as their norms represent the convergence of idiolectal systems towards structures that are more similar to each other. It may be characterizes as "social" or "socio-interactional complexity," associated with the various accommodations that speakers make to each other in order to streamline mutual intelligibility, by reducing idiosyncrasies among them.

There is a whole lot we can learn about interactional and social complexities that can be revealing about the phylogenetic emergence of languages and the particular ways they differ from other animals' means of communication. I approach languages as hybrid and modular technologies (see below), which emerged through the co-option of human anatomies, and whose primary function has been to facilitate communication (Mufwene, in press-b). As is evident from other

[5] Sadock (2012) captures this adequately in explaining that the modules are separate subsystems, each dedicated to its own job, such as the syntactic organization of smaller units into constituents of various sizes in sentences (syntax), the combination of small meaning-bearing units into words (morphology), or the basic arrangement of sounds into acceptable words (phonology). The relations between the different modules are not isomorphic, as each of them has categories that are independently suitable to itself. Mismatches arise during the interfacing of the modules, for instance, semantics, morphology, and syntax, because clashes arise from their respective combinatorics. There are also exceptions to rules ("patterns" in emergentism); and all these add to complexity, as the modules keep up with each other during the production or processing of utterances. The mind processes concurrently, in the different modules, complementary aspects of the production of utterances, making sure that they all converge toward a meaningful and well-formed utterance, in accordance with norms which are partly culture-specific (as suggested by typological diversity) and partly universal. Universal principles may be consequences of the particular anatomical technology used and of the mind that has produced this.

animals, communication is anterior to language, which only made it richer and more explicit, as I explain in the next sections.[6]

2 Languages as Technologies

In this essay, as in Arthur (2009), technology need not be understood as a tool or machinery planned and designed by a group of experts (in a laboratory) to solve a particular set of problems. Languages are unplanned tools of communication that emerged incrementally, with different interactants innovating and contributing different pieces at different times (not without particular constraints!) when necessary, under specific social pressures to express and share their thoughts or feelings. They are outcomes of successive responses of the human mind to social-ecological pressures to communicate; their norms have been shaped by particular social interactive dynamics driven by speakers'/signers' disposition to cooperate.[7]

In a nutshell, as social life exerted ecological pressures for hominins to communicate, the mind co-opted what it could use in the their anatomy, especially the buccopharyngeal structure or the hands, to produce phonetic or manual symbols, which function as the hardware of the technology. The software of the linguistic technology consists of the principles regulating how to combine the phonetic and manual signs to form meaningful utterances: words, phrases, sentences, etc. In the case of speech, on which this paper is focused, the basic materials to work with are sounds, prosody, and silence/pause, the expected or perceived position of the latter being used to mark boundaries of words and larger utterances, which facilitates the processing of the strings produced by the speaker. Diamond (1992) is correct in observing that we do not always perceive it, as is made more obvious when we listen to utterances in languages we are not familiar with. I submit that part of developing competence in a language is identifying those positions where silence, or a pause, can occur to mark word or other, larger constituent boundaries.

Linguists have usually explained the structure of utterances as hierarchical (barring a few languages that are said to have flat structures), which means that sounds combine into morphemes or words, while the latter combine into larger constituents associated with predicate, argument, and adjunct functions, as they

[6] There are indeed several publications in the past decade that have been devoted to linguistic complexity, including the following books: Dahl (2004), Hawkins (2005), Miestamo *et al.* (2008), Sampson *et al.* (2009), Givón (2009), Givón & Shibatani (2009), Pellegrino *et al*. (2009), and Faraclas & Klein (2009). Because they typically focus on bit complexity, I will not refer to them in the present essay. Besides, most of them do not even define complexity, let alone problematize it. Studies such as Givón (2009) and Nichols (2009) are still limited to bit complexity only. Dahl (2004) is perhaps the only one that has adopted an emergentist approach, akin to that developed here.

[7] The role of cooperation, like that of joint attention, in the phylogenetic emergence of language is well explained by Tomasello (2008) and Corballis (2011), among others. I submit that it is the driver of communal conventions in linguistic communities, through the mutual accommodations that speakers/signers make to each other, reducing, if not eliminating, the variation that can impede mutual intelligibility (Mufwene 2001).

collectively form sentences. It is thus tempting to assume that language emerged likewise phylogenetically, even though we should know from naturalistic language development that words are acquired first and their morphological structures emerge at a later stage, just in the reverse order of morphosyntactic analyses. (See also Givón 2009 for a similar discussion.) One can imagine, incorrectly of course, that Homo erectus abandoned the original ape-like vocalizations to produce individual sounds and then combined them at a later stage into words, while Homo sapiens would combine them much later into sentences. Such a scenario would suggest that there would have been no (vocal) communication for a while, a contradiction and undoubtedly frustrating evolution during a protracted period in which hominins (from Homo erectus to modern Homo sapiens) were developing the phonetic phonology just to respond to current social pressures for more explicit and richer communication than just kinesically, with gestures, and with holistic vocalizations.

An alternative scenario, inspired indeed by how a child develops language seems to be more plausible, which probably also answers partially the question of the passage from vocalizations to speech.[8] Once the hominin mind became more complex and Homo erectus or early Homo sapiens could organize more complex social structures, the pressure to do more than naming entities and events must have increased. Attempts to modulate the vocalizations would have led to the production of vowels as discrete segments separated perhaps initially by the glottal stop and later by consonants for easier distinction of syllables. Larger inventories of both vowels and consonants would permit what MacNeillage (2008) calls "syllabic variegation."

Though I believe that the emergence of modern phonetic inventories must have been protracted, I will not explore here the question of which sounds emerged first and which ones later. It is safe, however, to speculate that social and cognitive pressures to increase the vocabularies must have called for larger inventories of sounds. On the other hand, phonotactic combinatorics would have made it unnecessary to keep inventing new sounds past a particular threshold, since the vocabulary could be increased by modifying sound combinations and/or the number of syllables per word. Thus, for instance, although Hawaiian has a small phonetic

[8] Although ontogeny does not recapitulate phylogeny, it can provide plausible hints about the latter, as also argued by Givón (2009). Tomasello & Call's (2007) and Corballis' (2011) observation that apes' gestural communication is closer to human language than their vocalizations is not *ipso facto* an argument against the position that human speech evolved from ape-like vocalizations. As indeed observed by Corballis (2011: 67-70), vocalizations are controlled by the same mirror-neurons and the same parts of the brain (F5 among the apes and the Broca's area among humans) that control gestures. Vocalizations appear to have been the transition from gestural communication to speech (though they did not displace gestures), an evolution that occurred after the buccopharyngeal structure had undergone some changes (Corballis, *ibid.*), including the sinking of the root of the tongue (Lieberman *et al.* 1972, Fitch 2010). The question is whether we can explain how the transition from the ape-like non-digital vocalizations to the digital structure of speech took place. I attempt an explanation below.

inventory, it can produce a large vocabulary by having long sequences of syllables in which two or more vowels can alternate as syllabic peaks.[9]

There's been controversy in the literature (on the one hand, Carstairs-McCarthy 1999, Wray 1998, 2002 and, on the other, Tallerman 2005, 2007; Bickerton 2007) over how specifically the transition from the non-digital vocalizations to discrete speech took place. The transition is an issue if one assumes that there was a sudden shift from no phonetic inventory to full-fledged phonetic inventories (Mufwene 2010). It is not if one assumes gradual evolution by slight modifications of vocalization patterns that would produce just a couple of distinct vowels in the beginning and enable enough distinctions for a vocabulary that grew only gradually and in a protracted way. It seems even more plausible to assume syllabic variegation first, with the number of segments needed for this state of affairs increasing only as pressure for more lexical oppositions also increased. The rest of the evolution would only be consistent with emergence, as communicators would capitalize on what they could do already in order to produce new elements. It would not be difficult to innovate a new vowel or a couple of additional ones after two or three vowels were already in place, combining with a couple of consonants, to produce some words. This is when the question of the order in which the segments may have emerged arises, a question that phoneticians are better placed to address.

So, the phonetic inventories of the world's languages appear to have emerged as a consequence of the gradual emergence of larger vocabularies as human social structures, material cultures, belief systems, and knowledge of the surrounding physical ecologies became more complex. Note that phonotactics is a consequence of linearity, which is itself a consequence of the phonic materials used in the speech technology. No two sounds can be produced concurrently, bearing in mind that coarticulated sounds are special cases of mixed single units involving two concurrent points of articulation. In other words, there was no other choice but to domesticate the ensuing linearity of the speech technology and to adopt constraints, some of them probably arising from the hominin anatomy itself (Maddieson 2006), on how to combine sounds into words, and then words into larger constituents. As noted above, pauses (and prosody in some languages) do the job of marking boundaries between words and between larger units. Syntax too is thus the consequence of the domestication of linearity, with some of its principles (such as word order) being culturally determined and therefore variable from one language community to another, while some constraints assumed to be universal may have a cognitive basis.

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[9] As pointed out by Maddieson (2006), variation in the size of the phonetic inventories has no bearing on the size of the vocabularies that different populations can produce. Different populations did not have to settle on the same norms for combining the sounds either, though there are sounds and combinations thereof that appear to be favored as opposed to those that populations tend to avoid because they require more energy or are found too difficult. Otherwise, the culture a particular population has developed determines the size of the vocabulary they need to talk about various aspects of it. The size of the vocabulary reflects the communicative needs of the relevant population of speakers/signers, not only regarding what they find useful to name but also what degrees of distinctions they think necessary to keep between some related concepts, such as between ARM and HAND, LEG and FOOT, between different kinds of hair (*cheveux* vs. *poil* in French) or between HOLE and SINKHOLE.

As the knowledge required to communicate became more and more diverse and the mind had to handle many operations concurrently, language self-organized into modules, at least from the emergentist perspective assumed in this essay.[10] Since languages do not really have agency of their own, what this means is that the minds producing them organized the structures of the emergent technologies modularly, in ways that would facilitate, for instance, the selection of concepts, the production of sounds, and, hierarchical structure of an utterance concurrently. While the production and processing of utterances became multilateral, the overall architecture of languages also became more robust, as the whole system need not collapse if a module malfunctions. This reality is evident from the various cases of aphasia, which involve only partial loss of the patient's linguistic ability. This evolution into modular architecture also fostered the emergence of systemic complexity, regardless of the size of the phonetic inventory in a language.[11] I discuss this topic in the next section.

3 The Phylogenetic Emergence of Complexity

3.1 The Nature of Linguistic Complexity

With regard to system emergence, interactional complexity seems to have arisen in two fundamental ways in language.[12] First, as the inventory of phonetic units

[10] Givón (2009) is right in observing that the process was probably facilitated by a mind that was already handling various cognitive processes modularly. After all, there is no part or network of particular parts of the brain that is specialized for language only. The same parts of the brain and modules of the mind appear to have been exapted for language. For instance, the same Broca's area and mirror-neurons that were already controlling mastication, gestures, and other sensorimotor activities were coopted for speech production.

[11] Modularity is what also led Hockett (1958) to assert that the total grammatical complexity of any language is about as complex of any other. There would be inter-modular compensation especially between the computational and the formal aspects of the linguistic technology. Like the speculation that some languages (not counting transitional stages such as incipient pidgins) are more, or less, complex than others, Hockett's claim too needs to be verified by more comprehensive comparative studies.

[12] I speak of *arise* because, as suggested above, the hominins who developed language were more interested in establishing explicit and rich communication than in devising a system with some foresight of how the different components would be integrated together. All adjustments have been ad-hoc, taking place in the *hic-et-nunc* of communication without any anticipation of what the overall system would look like at some point. Every innovator must have striven for easy recognition of his/her innovation and, in the case of units other than sounds, for their adequate interpretation through inference. What makes languages so interesting from the point of view of emergence and brings up the question of interactional complexity is that systems have emerged nonetheless, as if the different units and principles had some agency in negotiating their distinct(ive) positions and functions within the emergent systems. This led Dahl (2004) to analogize coexistent linguistic units, which continually calibrate their spaces and functions relative to each other, to agents in the "emergent systems" of complexity theory.

and symbols (individual meaning-bearing units) increased, it became necessary for the perceptual and semantic spaces of neighboring sounds and symbols respectively to be calibrated next to each other. Sounds had to be kept distinct from each other, to ease perception and processing. In some cases, their production had to vary according to the phonetic environment, such as with the voiceless stops in English (where they must be aspirated vs. where they should not or cannot) or the voiced stops in German (when they are devoiced and where they cannot). The negotiation of phonetic space and the stipulation of principles regulating allophonic variation produced paradigmatic complexity. This is a kind of interactional complexity that may be considered structural and is closely related to bit complexity. It helps the meanings of related words (e.g., body parts, kin relations, color hues, or motions) to remain differentiated as clearly as possible, though these relations can change over time when the ecologies of language practice change. Adjustments are constantly being made regarding the paradigmatic position and function of every unit and principle relative to others with which they cannot alternate freely, i.e., without changing the meaning and/or pragmatic effect.

Second, complexity arose from all the principles/constraints (really the outcomes of habit formation) on what units can combine together and what rules can apply concurrently, but what particular combinations are disallowed (i.e., not considered normal). This may be termed "syntagmatic complexity," which compels the speaker to be aware of the complementarity of several units and principles within subsystems or modules. If the structures of languages could be reduced to these paradigmatic and syntagmatic relations alone, human languages would still be more complex than the vocalizations of our primate cousins, which can be interpreted just as limited vocabularies (i.e., inventories of labels) for a closed list of situations and emotions but have no internal structures (unlike spoken words, which consist of concatenated sounds and sometimes morphemes) and no syntagmatic relations, and certainly no (hierarchical) constituent structure in the sequencing, generally repetitions, of the vocalizations. Except at the earliest developmental/evolutionary stage, even child language and incipient pidgins show (some degree of) this hierarchical constituent structure in utterances.

As linguists have always assumed, units are not of the same kind, nor are the principles (rules and constraints) that apply when we speak. Moreover, while units of the same kind are paradigmatically mutually exclusive (a consequence of the linearity of the phonetic technology) principles of different kinds typically apply concurrently. This is made possible by the modular architecture of the system. As the vocabulary expanded and communication involved more than just naming entities and events, the emergent systems became more and more crowded and harder to manage without any kind of integrative structure. Units and principles that worked jointly towards the same goal, like producing words or sentences, were thus allocated to different modules, not because speakers thought deliberately that they should organize their languages this way but probably because the mind was capable of carrying out the necessary tasks concurrently and found it useful to adopt a division of labor. As noted above, this modular structure fostered speed and efficiency in processing language. For instance, while the semantics module is busy with the selection of the correct word-meaning pairs and relevant

combinations into larger meaningful utterances, the phonetics module deals with how the segments that the words consist of must be pronounced. At the same time, the syntax module handles the particular ways that words are combined together, regarding the order of constituents and their dependency relations (expressed hierarchically in a language such as English). The modules interact inevitably with each other during the process, with the interfacing generating interactional complexity.

The Complexity arises especially from the synchronization of the complementary activities of the modules at every significant step of the linearized production of utterances. The reverse takes place during the perception and processing of utterances, though a certain amount of delays and backtracking is often necessary for accurate interpretations.[13] What is particularly significant about this interactional complexity is that even the most rudimentary utterances produced by a child or the speaker of an incipient pidgin involves it. This characteristic makes more evident how the architecture of human languages differs from that of animal means of communication, though, as several experts have been pointing out, there may be nuances in how these differences must be specifically articulated.

Note again that my focusing almost exclusively on interactional complexity is not a denial of bit complexity. The latter, which has typically received exclusive attention from linguists, has its place too in discussions of the emergence of complexity in the phylogeny of human languages. One may in fact argue that interactional complexity as explained above is a consequence of the emergence of bit complexity and the ensuing modular structure of languages. Typological variation among different languages also highlights the fact that languages are cultural artifacts after all, reflecting particular options chosen by those who speak and fashion them. Although the basic principle in having different vowels with their own respective articulatory and acoustic properties is to maintain segmental distinctiveness in ways that vocalizations cannot, languages vary regarding the specific (numbers of) vowels included in their inventories and how the perceptual distances between the segments are articulated. As noted by Maddieson (2006), whether a language has five vowels, seven, or more has little bearing of the size of the vocabulary that the relevant language can develop or the syntactic principles that underlie the production of sentences. Likewise, as long as a language permits predication, it does not matter whether or not the head of the predicate must always be a verb or whether the verb is phrase-initial or phrase-final. Languages also vary regarding the specific categories into which particular semantic domains such as kinship and furniture are organized, just as they vary regarding both the particular syntactic conventions that have been adopted to form larger utterances from words and how words can break non-arbitrarily into morphemes.

[13] This sets languages as "complex adaptive systems" (Mufwene 2001, Beckner *et al*. 2009, Cornish *et al.* 2009, Lee *et al*. 2009) apart from complex manufacturing enterprises (like the computer and automobile industries), in which the components that will go into a machine need not all be produced all at the same time, nor even in the same factory. There is no room for such asynchrony in language, although the processing of utterances can be revised in mid-course, just as utterances themselves can be repaired, thanks to a feedback mechanism within the speaker/hearer, which adds another fold to the interactional complexity.

On the other hand, while it is obvious that one particular module in a language may exhibit more, or less, bit complexity than its counterpart in another language, it is not evident yet that the architecture of a particular language can be claimed to be generally more complex than that of another. Only comprehensive comparisons will answer this question that, as noted above, seems to have preoccupied some linguists of late (Nichols 2009, Hombert 2011, Wang 2011). What claims regarding the simplicity of child language and incipient pidgins seem to show is that the architectural complexity of a language reflects the extent of its communicative functions. Social interactions in which a limited, if not simply a closed, repertoire of information is exchanged do not generate complex means of communication. Rather than being protolinguistic fossils (Bickerton 1990, 2010), child language and incipient pidgins represent that transition to full-fledged systems capable of expressing, through various adjustments, an infinite array of information. They represent the onset of modular architecture and interactional complexity.

The linguistics literature that has focused on comparing bit complexity across languages has simply contributed to our understanding of typological diversity. It's like comparing computer programs in terms of the details they include to do fundamentally the same kinds of jobs. Consistent with the Darwinian evolutionary position that I have assumed since the outset of this essay, I will soon speculate on how both bit and interactional complexities emerged in language.

However, because languages are discussed in linguistics as communal phenomena, we cannot ignore an important communal, also interactional and equally dynamical, aspect of complexity, which plays an important role in how norms emerge and how languages change. Let's identify it as "socio-interactional complexity." It is the consequence of the fact that linguistic knowledge is born in individual speakers' minds and is fundamentally variable from one idiolect to another. The variation among idiolects is a consequence of the fact that languages are learned by inference in social environments where every individual (perhaps twins excluded!) has a different interactional history (Mufwene 2008) and is anatomically different, which affects their perception and reproduction of sounds, for instance. Besides, as with other sociocultural skills, speakers are not equally gifted for language. It is thus amazing how in the same network or the same community of practice idiolects are more similar to each other than they may be expected to be. The reason is that speakers are cooperative and constantly calibrate themselves to each other, which reduces differences between them (Mufwene 2001). The socio-interactional complexity lies in the mutual accommodations they make to each other in order to facilitate mutual intelligibility, as noted above. It has to do with the fact that interactions are typically dyadic or triadic and the sets of interactants change frequently. How does every speaker keep track of the variation and how do members of a community of practice ultimately converge toward common norms on individual variables?

How speakers decide whom to accommodate or not and how their respective accommodations lead to the emergence of communal norms, thus reducing the presence or significance of idiosyncratic features, involves complex dynamics that practitioners of complexity theory are perhaps better equipped to explain than linguists can. It is not clear that nonhuman primates do not do this too, as social

convergence is a fundamental feature of social interactions. Aside from the fact that there is not much to accommodate in communicative practices that are innate (rather than learned), the difference must lie first in the extent of complexity that follows both from the extent of systemic complexity in human languages, starting with idiolectal systems. It also lies the larger sizes of communities of practice among humans, more broadly, in the sizes of language communities, in which individuals are likely to interact with more other members, depending on the extent of mobility and population structure. Modeling may help better understand the dynamics involved in the emergence of communal norms.

3.2 How Did Complexity Emerge Phylogenetically in Language?

According to the current scholarship in paleontology, hominins did not acquire the requisite anatomical structure for speech until late Homo erectus or early Homo sapiens (500,000 – 200,000 years ago). Modern language itself did not apparently emerge until modern Homo sapiens about 50,000 years ago (Corballis 2010, 2011; Lieberman 2010), around the time of the dispersal out of Africa. The period coincides with the appearance of rupestrian paintings, which suggests that modern Homo sapiens had developed the mental capacity to represent (complex) concepts, which is part of what is involved in syntax, which allows the composition of (more) complex concepts from those associated with individual words. This capacity involves not only combining denoting terms together but also showing the respective roles of the different participants in situations or events described or queried about in utterances, as indeed in pictorial representations.

The emergence of syntax this late in the human phylogeny means that even if Homo erectus had had a buccopharyngeal structure similar to that of modern humans, they could not have done much without a mind capable of co-opting and domesticating this particular structure for complex communication. They may have developed a (limited?) phonetic inventory which enabled them to name entities and events vocally but were apparently not able to take the next step of combining them into more complex utterances. This accomplishment means what Hockett (1959) identified as "displacement," the ability to talk not only about the *hic et nunc* of the interaction but also to reminisce about the past and to plan the future together. Such discourse entailed situating events and states in time, expressing one's attitude toward what is depicted verbally, and specifying reference, viz., indicating the number or quantity of participants in the different thematic roles, showing whether they have been previously identified, are assumed known already, or are being introduced for the first time, etc. These semantic specifications entailed being able to modify nouns and verbs morphosyntactically with other materials. It appears that there must have been an explosion of strategies, about 50,000 years ago, for expressing complex thought, with of course quite a bit of variation from one culture to another. After all, our hominin ancestors did not all live in one village in East Africa, and their fossils have been found in places quite distant and isolated from each other.

Whether the explosion meant sudden, non-gradual evolution is an open question. However, it is hard to imagine that any aspect of the above manifold

evolution would have started without the basic idea of predicating about particular individuals, about other entities, and, later, about states of affairs.[14] As the mind of modern Homo sapiens made him increasingly capable of domesticating his physical ecology and it became more and more necessary for members of communities to be better organized and cooperate toward common goals, pressure also mounted to develop richer, more sophisticated, and more explicit communication systems. It was no longer enough for the communicator to name individuals, entities, and perhaps situations and to have the addressee guess what was intended. Communicators had to express the contents of their thoughts and the nature of their sensations and feelings as explicitly as they could. While hominins had always been able to express their emotions nonverbally (a property we continue to share with other animals), they now also had to share their thoughts or what they wanted their kin or associates to do and how. This included commenting about individuals and entities around them. Therefore speech had to evolve from mere ability to name individuals, entities, and states of affairs to predicating about them.

Although child language and incipient pidgins have made it obvious that elementary verbal communication can take place by just combining undelimited nouns and verbs or other predicative items into sentences (with a minimal set of function words), we also know that no full-fledged human language has remained stuck at that level. Every language has developed strategies for situating in time the states affairs being reported or queried about, although the specific morphosyntactic strategies used and the distinctions made within this domain of grammar vary from one population/culture to another. Likewise, every language has developed strategies for specifying reference and quantifying, although the specific morphosyntactic strategies used are not identical, just like the relevant distinctions within this domain, which vary crosslinguistically. These are important aspects of linguistic communication that had to evolve as a consequence of the ability to predicate. Some populations have also found it necessary to be explicit about thematic functions with such devices as case markers or postpositions. The emergence of all such strategies in linguistic communication already increased bit and structural complexities.[15]

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[14] Predicating about states or events entails embedding a clause within another. This strategy was enabled by by recursiveness, which, according to Lieberman (2006, 2010) is a general cognitive property not specific to language.

[15] I still maintain that ontogeny does not recapitulate phylogeny, largely because the human infant and child are already endowed with modern Homo sapiens' mind, though this still needs to mature to adult stage before it can command all the strategies available in the language of their social environment. However, I submit that the order in which the child "acquires" these linguistic strategies is suggestive of that in which they and their typological variants developed phylogenetically in language. Those emerging the earliest in child language are phylogenetically the most deeply entrenched and resilient, the ones most likely to survive the reductions observed in motherese. Some of them are those that correspond to cognitive priorities in hominin communication, the kinds of strategies that our species would have found essential to explicit communication, though the modern child only has to learn them.

It must not have been long before the relevant hominins found it necessary to modify and delimit nouns and verbs or predicate phrases. It is more informative to be able to discriminate otherwise similar individuals, entities, and events/states of affairs from each other and, more fundamentally, to specify how nouns used in an utterance single out individuals, entities, or states of affairs in the universe of reference, and also to situate the activities or states being described or queried about in time. It was thus necessary to introduce the relevant grammatical strategies, which also vary typologically, according to whether they are affixes or free morphemes and whether they precede or follow the noun or the verb. The morphosyntax of adjectives and adverbs also varies crosslinguistically, as does the modification of nouns with clauses, for instance whether or not they precede the head of the phrase and whether or not there is a dedicated connector between the head and the modifier.

This evolution to more structural complexity was in the interest of systemic economy and productivity, making it unnecessary to invent new terms and phrases for any individual, entity, or state of affairs that is slightly different from another to which it is fundamentally similar. It may have called for more interpretive rules, as a matter of fact, which produces computational complexity. Pidgins such as Tok Pisin do not lose in interactional complexity by making maximal use of modification to keep a great deal of their vocabulary transparent, such as by using the cognate of the English word *grass* not only literally but also for what grows on the human scalp, body, and chin, as well on animal body and for birds' feathers and then showing the semantic differences by modification. The online dictionary of Tok Pisin (October 2011) lists the following oppositions among others: *gras* 'grass' or 'fur', *gras bilong ai* 'eyebrow, eyelash', *gras bilong pisin* 'feather' (*pisin* [< *pigeon*] 'bird'), *gras bilong sipsip* 'wool' (*sipsip* 'sheep'), *gras nogut* 'weed(s)', *maus gras* 'beard', and *gras bilong het* 'hair'.

It is very likely that systemic complexity evolved in language to meet the kinds of semantic distinctions that communicators wanted to make during their interactions. Grammatical morphemes, which have been the focus of "theories of grammaticization" over the past few decades, evolved to further satisfy the need for explicit communication, making clear which specific roles are assumed by the individuals and/or entities being talked about and what constituent modifies what (for instance, in a combination of nouns), and even what clause functions as a complement or modifier of something else. Overall, grammar in any language increased in complexity in response to pressures to package more explicit pieces of information in utterances. The strategies used to achieve this increased the computational aspect of language, while reducing the burden on the capacity to memorize more different signs.

The alternative of modification would have been to invent a new noun or verb for every new nominal or verbal concept that is somewhat different from another to which it is related or similar. The consequence would have been an increase in bit complexity and a greater demand on memory. Human populations have generally opted for a few rules/principles that rely on the speaker's/hearer's capacity to compute the new meaning working with a smaller inventory of symbols with less specific meanings. To be sure, languages probably vary on a continuum regarding

the seemingly complementary distribution between bit and systemic complexities; but this is speculation on which future research can rule. Languages such as Tok Pisin seem to instantiate the culmination of the modification strategy, working with a limited basic vocabulary and exploiting compositionality to the max in order to produce apparently more specific concepts or express richer meaning chunks.

If child language development gives us any reliable hint about the phylogenetic emergence of language, it appears that structural complexity emerged incrementally, starting with basic predication. Whether the evolutionary trajectory followed the order suggested here or that discussed by Heine & Kuteva (2007) and largely supported by Givón (2009) is another issue.[16] What is certain is that none of all this systemic complexity could have happened outside a social mode of existence that exerted pressure for humans to socialize and cooperate toward joint goals (Tomasello et al. 2005, Tomasello & Call 2007, Corballis 2011) and to be more explicit in the information exchanges, notwithstanding the emergence of a mind that made such social life possible in the first place. The same mind was thus also capable of developing the right strategies for meeting the social demands for sometimes quite detailed communication. Much of all this phylogenetic evolution appears to have occurred over the past 200,000 years or so (maybe just 100,000 years), during the transition from Homo erectus to modern Homo sapiens. Based on Lieberman (2010) and Corballis (2010, 2011), the greatest part of it started with the ability to predicate, no sooner than 50,000 years ago.

I'd like to emphasize that it is only for reasons of expository clarity that this discussion has been oversimplified and developed as if languages were organs, allowing no internal variation within their structures, i.e., as if all idiolects that they are extrapolated from (Mufwene 2001) were identical. As has been made quite obvious by the variationist sociolinguistics literature (well summed up by Labov 2001, 2004), even idiolects display internal variability, which is governed by structural and/or sociological principles, depending on the case.

An important reason for this state of affairs is that the development of an idiolect instantiates what is known in biology as polyploidy, as the learner receives inputs from different sources and the variants thus absorbed usually wind up coexisting, some in a latent state, with each other. The learner ranks them, according to which is dominant in the population, which is more transparent, which is more

[16] These are the evolutionary stages proposed by Heine & Kuteva (2007: 310): 1) One-word utterances; 2) Mono-clausal propositions; 3) Head-dependent structures; 4) Elaboration of phrase structures; 5) Temporal and spatial displacement, the beginning of clause subordination; 6) Obligatory expressions, elaboration of clause subordination. Givón (2009: 10) proposes: a) Words before clauses, b) One-word clauses before multi-word clauses, c) Single-clause discourse before multi-clause discourse, d) Chained clauses before subordinate/embedded clauses, e) Nominal objects before clausal complements, f) Single-word restrictive modifiers before clause-size modifiers, g) Pre-grammatical (pidgin) communication before grammar, h) Manipulative speech-acts before declaratives and interrogatives, i) Deontic modality before epistemic modality, j) Non-displaced spatio-temporal reference before displaced reference.

regular, etc. in their community of practice. He/She selects the variant that will prevail in his/her system. The fact that speakers develop idiolects that are different from each other produces and sustains natural variation in the community of practice, as their communal language is truly nothing but a set-theory union of idiolects that are similar on the family resemblance model. Although speakers understand each other most of the time, there are nonetheless cases when communication between two individuals fails for no other reason but the variation between their idiolects.

Independent of polyploidy and from a phylogenetic or historical perspective, it is noteworthy that, as noted above, speakers are physiologically and mentally not identical, which entails that they do not perceive and reproduce identically the signs and structures which they learn by inference. This state of unfaithful replication (Lass 1997), which is heightened by the noise factor, generates or sustains variation. It is evident that innovations are not copied and propagated faithfully, which makes allowance for more variation to be generated. I speak of "more variation" because the innovations themselves are not necessarily identical from one innovator to another. Two or more individuals expressing the same new idea in different speech events and communicative settings may not exapt exactly the same current materials; thus, they may produce alternative expressions or structures for the same thing (Mufwene 2001, 2008). As these alternatives become available to other speakers with similar communicative needs, competition arises: one of them is preferred by a particular copier because it is easier to pronounce, or because it is more consistent with other expressions that he/she is already familiar with, or because its meaning is transparent, or because it is more impressive/fashionable, etc.

It is noteworthy that the copiers may not converge in their preferences, though eventually some convergence will arise in a community of practice, which still leaves room for variation within the overall language community. A variety of regional and sociological factors (age, gender, ethnicity, profession, etc.) may also influence the selection, so that patterned variation may arise within the population, though there are often also cases where just one alternative is dispreferred. These outcomes arise from multiple, temporally overlapping dyadic or triadic interactions in which speakers learn from and accommodate each other. In the language of Complexity Theory, the outcomes are "emergent patterns" produced by self-organization, though this term belies the complexity of the interactional histories that produce both distinct idiolects and communal norms.

So, from the point of view of variation, language communities or communities of practice constitute feature pools in which the variants are subjected to competition and selection through the accommodations speakers make to each other as they seek to establish common norms in the production of units and structures (Mufwene 2001, 2008). Because interactions usually take place in usually changing dyads or triads, the tacit negotiations that speakers are engaged in produce socio-interactional complexity.

4 Conclusions

Languages display more than one form of complexity. Bit complexity, consisting of units and rules that populate a(n emergent) system, is only one of them. It is evolutionary interesting in that, in the first place, it shows the extent to which human languages exhibit richer inventories of signs and principles (rules and constraints) than animal means of communication. It is also typologically interesting, as it shows how different languages have managed to serve their communicative needs adequately with smaller or larger inventories of sounds, with smaller or larger vocabularies (ignoring Tok-Pisin modification style), and with sets of combinatorial principles that are not identical. Traditional cross-linguistic comparisons, which have typically been partial, cannot show whether a language is phylogenetically more, or less, evolved or complex than another. It is not evident either that a comprehensive comparative study can be undertaken that covers all the communicative needs that the language may be adapted to.

To date, all languages reflect their capacity to satisfy the communicative needs of those who shaped and use them. It is undeniable that child language and incipient pidgins display some simplicity compared to adult and full-fledged languages, but they are transitional stages whose simplicity reflects the kinds of communication they are used for. Nonetheless, they exhibit more complexity than animal means of communication. They are also true to their characterization as complex adaptive systems (Mufwene 2001, Cornish *et al*. 2009, Beckner et al. 2009), because they can adapt to new communicative needs by increasing their vocabularies and innovating new structures by exaptations of current ones (Heine & Kuteva 2007). Typologically, they are not interesting, because they represent transitions to full-fledged vernaculars. They are more interesting from a phylogenetic perspective, because they give us hints about the gradual evolution of language in mankind, having started with less rich communication and less elaborate systems. Just from the point of view of vocabulary, we can assume that, evolutionarily, the systems became more crowded as the speakers' cognitive capacity increased and it became more and more necessary to discriminate among denotata with different labels. This progression is likely to have been gradual, because the evolution of the hominin line has been gradual and the communicative needs to satisfy were not equally important quantitatively at the different stages.

Another form of complexity is interactional, which emerged from the modular architecture of languages. It arose both from the coexistence relations between the different units and rules, as they determine their respective spaces or functions, and from the interfacing of the modules as they operate concurrently during the production and processing of utterances. It can be characterized as dynamical or systemic complexity. It is the kind that makes human languages significantly different from animal means of communication, even at their rudimentary stages such as child language and incipient pidgins. It reflects more of the evolutionary stage of the minds that produced human languages.

These aspects of complexity can mostly be surmised and modeled now; we still lack the necessary theoretical tools to describe the patterns of the interactions that

generate them.[17] As illustrated with the Tok Pisin example, with regard to populating the lexicon, a community of speakers may opt for an opaque system where different symbols that may be unrelated morphologically are used to designate items that are conceptually related. Another population may alternatively choose to be very transparent and exploit either morphology or compositionality, combining basic lexical items with each other or other morphemes into composite words or phrases that express the same concepts. It is hard to determine whether combinatorial strategy, which entails more computing at the conceptual level, is less complex than a system that opts for distinct lexical items that are morphologically opaque or less transparent.

How this system complexity emerged phylogenetically is another story, which must explain how hominins evolved from having no phonetic language to having one with modern structures. It is unlikely that phylogenetically it all evolved wholesale and "overnight." As explained above, syntax must have started with simple predication. Then pressure arose to specify reference and situate the states of affairs being described in time. After that, anything could have been added to further complexify the emergent systems by way of modifying nouns (with adjectives, other nouns, or clauses) and verbs (with adverbs or adverbials). The question is whether we may conjecture that recursion and adpositions emerged concurrently. Or could adpositions have emerged separately, as an alternatives to case marking, to specify semantic-syntactic roles, e.g., AGENT/SUBJECT, PATIENT/OBJECT, BENEFICIARY/DATIVE, POSSESSOR, LOCATIVE, and ADJUNCTS? Their emergence earlier may have paved the way for modifying a noun with another noun (thus making it possible to distinguish the modifier from the head noun) or with a clause. However, could the latter strategy have happened without the prior emergence of clause embedding, which enabled the subordinate clause to function as the object of the higher/main clause? Unlike Givón (2009), it is not evident to me that predicate serialization is not just an alternative to subordination (Mufwene 1990).

I have succeeded more in showing how structural complexity emerged than in proving the specific order in which it did, except perhaps in showing how the emergence of some strategies must have presupposed that of others, in ways not fully consistent with what Heine & Kuteva (2007) and Givón (2009) suggest but not completely different either. Though Heine & Kuteva show that grammaticization undoubtedly played an important role in the emergence of structural complexity, a notion that I am having a hard time articulating clearly as different from both systemic and bit complexities, they do not show convincingly that the order they suggest is fully plausible, largely because they do not articulate structural interdependences between these grammatical strategies.

Be that as it may, we cannot overlook the other form of complexity that arises from the communal aspect of language. Languages as discussed in historical, genetic, and evolutionary linguistics are collective productions, with various

[17] Note that invocations of self-organization by complexity theorists to account for emergent patterns just shift the focus to the outcome, providing no explanation about the workings of the mechanisms that generate them.

speakers contributing their innovations on different occasions to their communities' feature pools and other speakers selecting among competing variants and thereby spreading their preferences. As explained above, these selections are not so simple processes; they involve numerous multilateral tacit negotiations that produce communal norms. Such considerations have led to the conclusion that languages are complex adaptive systems (Mufwene 2001, Beckner *et al*. 2009, Cornish *et al*. 2009, Lee *et al.* 2009), raising the issue of what the agents producing the complexity are: materials within the systems themselves, speakers, or both. Modeling and complexity theory give us some hope here, especially as they are combined in Steels (2011). A time may come soon when we can articulate these complex dynamics explicitly, but so far the relevant scholars working with "language games" have been using oversimplified abstract systems that are far from approximating real linguistic systems.

In any case, it is evident that linguistic complexity is manifold. One must clarify which particular fold they focus on and for what purpose. This is one particular reason some of us have been reluctant to accept that some languages, especially creoles and pidgins, are, according to McWhorter (2001), the world's simplest languages. DeGraff (2001, 2009) has made a convincing case about creoles, which in fact applies also to expanded pidgins. Incipient pidgins are transitional phases in the history of a language, just like child language is a phase in the development of a native speaker's competence. Both reflect the kinds of interactions in which the variety is used, meeting the communicative needs of its users fairly adequately. Their systems expand as the communicative needs also increase in complexity and variety.

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14 The Ecology of Pressures: Towards a Tool to Analyze the Complex Process of Language Shift and Maintenance*

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Abstract. We assume that every human action is caused by some pressure. Thus the notion of pressure is central to our model. Different pressure levels occur in the interplay of the interests of individuals and the immediate environment, which we call "state of the world". The state of the world influences pressure and is modified by action. We aim to expand the model to use it for the analysis of communication in multilingual everyday multilingual situations. To obtain a tool of analysis for linguistic actions in multilingual situations it is necessary to classify pressures. The first level comprises pressures that mainly depend on the interest of someone who is carrying out a speech act, pressures that are more state of the world dependant. A second level involves identifying some of the interests' origins. Finally, we focus on communication tools. The concept of competence is criticized and a more suitable concept is proposed: "common routine" and "utmost common routine", which triggers the use of a given code in a specific conversation.

1 Introduction

The decline, shift or death of languages that are replaced by other dominant language is a phenomenon that gradually entered, during the past decades, the mind of speakers, as part of the contribution of globalization to the extinction of minority languages. Given the accelerated pace of this shift, it was increasingly perceived as a problem, and accordingly, research conducted to identify its causes and the processes followed by language shifts. However, trying to find a general explanation for this problem is difficult. This may be because studies on this phenomenon are interpreting other social dynamics. This is, the shift of a language may be the apparent effect of many other deep social processes. In this chapter, we will try to demonstrate that language shift actually involves multiple side effects

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of other core processes which, at the same time, differ between them and have various causes.

While the speakers of endangered languages are becoming increasingly aware of the shift phenomenon, other problems related to this phenomenon are also increasing, such as the loss of ethnical and cultural identity. This is, people who thought of themselves as an ethnical or linguistic group different from other groups, are no longer considered so. This process is perceived by the members of the group themselves when their language or dialect acts as a core value (Smolicz 1999) that symbolizes their belonging to such ethnical group. In some cases, a language may be lost, and it would rather be the effect of a social change; in other cases, such language being lost would simply add to the multiple causes and effects of the loss of identity.

Our starting point is the premise that communication is a part of human action, and within such action, shift takes different positions, so that sometimes it will be rather a cause, and some others, an effect, depending on the situation and awareness of all participants. At the same time, speakers become increasingly aware and think more whenever they identify a negative change in the social organization of their group. This means that the loss of a language depends on the communicative acts within the complex system of human action in general, according to a relationship of mutual influence that nonetheless fails to make it possible to set clear limits between cause and effect. In order to analyze a phenomenon as complex as that of language shift, it is fundamental to conduct an interdisciplinary study.

The need emerges, then, for a model that may allow us to analyze the various factors involved in such process and resulting, as in an ecological system, in situations which are more stable at times, and more dynamic at others. This model should be based on complex systems (Munné 2005, Bastardas-Boada 2009, 2012).

The concepts behind the notion of "linguistic ecology" vary considerably depending on the author that uses it. Without further probing into the concept of ecology, we find that it is commonly understood as a balanced and static system that must be protected against any influences that may alter such balance. However, we underline the dynamism of ecology as a system influenced by various forces, acting as vectors that push towards different directions. Such forces may be in a more balanced situation with little noticeable modifications, or in a more unbalanced situation, causing modifications to appear at an accelerated pace in the short term. As a consequence, a system with great dynamics and under permanent modification, even to the point of self-destruction, would be included in our concept of ecology.

Our purpose is to contribute to the development of theoretical and methodological tools to analyze complex systems such as linguistic ecology. Thus, we propose a model to analyze the shift of minority languages that will be able to explain the various processes of such shift, and its various causes, as well as the effects of such causes, which in turn will become new causes incorporated again into the process.

The aforementioned model was developed over the past years, and has been published from various approaches on several occasions (Terborg 2006; Terborg and Garcia Landa 2011), based on the idea that every human action originates

from pressures. We will present below some of the most recent developments in the construction of such model, after revisiting previously published concepts.

Our premise was that all human beings feel some kind of pressure to communicate and use a particular code. Some of those pressures are in conflict, and others are not. Communicative actions are the result of a summary of pressures. One of our purposes is to find out which pressures are dominant in each particular situation. In order to answer this question, it is important to have a tool to classify all pressures involved.

We generally consider that a model such as the one we are proposing must be useful to explain a) the actions performed as a consequence of the various pressures in conflict, b) micro and macro pressures, both individual and collective, c) actions with immediate, medium- and long-term objectives depending on reflexivity, d) why different people may experience diverse pressures, e) the difference between inequality and disadvantage, f) power relations in specific and general situations, and g) the model must be able to classify the various dominant pressures that determine most actions of the members of a community.

This work focuses on a possible classification of pressures to analyze empirical data obtained from concrete situations. If we identify the elements that cause pressures, we will be able to find a tool to classify them. We agree with Bastardas-Boada that an accumulation of empirical studies would not contribute itself to the development of theories within the framework of complex systems. Accordingly, this work will not present empirical results, but rather examples used as an illustration of our proposed classification for pressures involved in communicative efforts.

Whenever we use the term 'ecology,' we will not mean an ideal and static state in a force field, but a dynamic process between forces that are in continuous movement (Munné 2005). The dynamics of ecology become decreasingly stable and increasingly dynamic as pressures on a sector of speakers increase in contact situations. That is to say, an alteration in pressures occurs first, and therefore, this can be also characterized as ecology of pressures Thus, it is necessary to find an answer to the following questions: how do pressures appear? How do pressures change? And how can we classify all different pressures?

We assume that pressure is the origin of every human action within a context that we call “state of the world”. The state of the world influences pressure and is modified by action. If we aim at creating a tool to analyze linguistic actions within multilingual situations, it will be necessary to classify pressures. We first classified pressures into pressures that depend mainly on the interest of the person that performs a speech act, and pressures that depend more on the state of the world (see Figure 1). We will propose below a more detailed classification by identifying the origins of such interests. We will now probe into pressures arising from the state of the world, limiting our scope to communication tools, i.e. competence. We will include reviews and propose a more appropriate concept for our objectives, which we will call “common routine” or “utmost common routine”, which generally accounts for the use of a particular code in a conversation. Finally, we will present, as an example, a brief analysis of a bilingual community in Mexico.

2 The Origin of Actions

The importance of the concept 'pressure' appears at different times to explain why a person or a group should act in a certain way. Many authors use this idea but fail to explore it in depth, as was previously the case many times with the notion of ideology (Zimmermann 1999; Hagège 2001). There are different kinds of pressure, such as social pressure or cultural pressure. However, not many works elaborate this concept to explain linguistic processes. We will attempt to define the concept of pressure, explain how it appears, and how it influences action. Finally, we will propose a classification for such various phenomena.

For purposes of this work, pressure will mean the pressure experienced by an individual or group to act in certain way or, if applicable, to avoid an act. Human action is always deemed to respond to some pressure. Thus, every human action emerges from pressure.

In many cases in our daily life, we can compare pressure to 'feeling like' doing or not doing something. 'Doing something' may have a specific purpose or a final state, or only a temporary objective that constitutes the action itself. Whenever a person is willing to go to a specific place, he or she experiences the pressure of the action of 'walking', in order to finally be in the place he or she is willing to be. Such action leads to a final state. However, if someone feels like dancing, the sole pressure we can identify is the action itself. There is no final state.

If we define pressure in this way, we may think that we are only dealing with intentional and conscious actions. This may pose a problem, as it is difficult, if not impossible, to completely set apart unconscious actions from conscious actions. We assume that every human action is the result of a pressure. Thus, not only are the acts of eating or speaking included, but also our breathing, digestion or heartbeat. Everything is linked to pressure, even though it may not be possible, for example, to stop the heart at one's own will, like it is possible to stop many other acts. Therefore, pressure comes before both intent and action.

3 The Origin of Pressure

Then, if intent and actions emerge from different pressures, it is necessary to know: how does pressure emerge? Who can experience a particular pressure? Or why is it experienced? We are interested in pressures that lead to an action, even though sometimes actions are not performed due to other circumstances.

Such pressure, now within the context of human action, may be compared to violence against a person, as happens in a robbery. The victim feels anxiety due to the threat of losing his life. This pressure forces the person to give his money to the attacker. Seen in this way, pressure would be too narrow for the purposes of this work, because it would not be useful to analyze the action. Here, pressure is considered as a farther-reaching phenomenon, as this concept plays a key role in our reasoning. In order to analyze the pressures that cause language shift, it should

be possible for a person to feel pressure even in the absence of a violent event or other person to exert pressure. Moreover, we think that a person may feel the pressure of other person even if the latter ignores the pressure the former exerts.

The origin of pressure is 'an interest on something.' In the absence of such interest, pressure would fail to appear. In our example of a robbery, the victim would experience no pressure if he had no interest in going on with his life.

Thus, interest is a fundamental condition for pressure to arise. And in order to exert pressure on someone, it is necessary to identify such person's interests or create new interests. Generally, the latter may be achieved through speech, as happens in advertisements for a new product to be introduced into the market.

Due to the foregoing, it is not possible to state that all pressures are of a universal nature; a situation where one person experiences immense pressure may not have the same effect on other individuals, as interests usually vary in most human beings.

This may lead to think that each interest will necessarily result in a pressure, which in turn will cause an action or the suppression of an action. But there are many interests that do not cause pressure. Therefore, it cannot be assumed that in the absence of interest, a specific pressure will disappear. Many parallel and consequent interests exist that will not cause pressure. Interests will lead to pressure depending on the current state of the world. If the state of the world coincides perfectly with the relevant interest, no pressure arises. However, if the state of the world faces a risk to be modified, pressure emerges.

All such interests lie mostly in our unconscious, and may become conscious upon the appearance of pressure. Many of them are directly related to human body. The amount of functions carried out by the various organs is linked to one or more interests (see Lakoff and Johnson 1999). Similarly, the environment, where a person is at ease, also includes interests. Pressure emerges, then, whenever there is a change in the state of the world and life conditions worsen, or when an imminent change is likely to occur. That is, diseases necessarily cause pressure, as does the lack of oxygen in a polluted environment, or economic problems that threaten human existence.

Although many interests fail to cause pressure, there are also different specific pressures for every individual at each moment. Some actions cannot be stopped while we are still alive, such as breathing, digestion or our heartbeat. As it was already said above, such actions, which are involuntary in part, are dependent on pressure. We can, thus, assume that there is some underlying interest to maintain certain pressures, as their absence would represent a negative change in the state of the world for everybody, and would cause, in turn, the emergence of new pressures derived from those which individuals concerned were previously unaware of.

ECOLOGY OF PRESSURES 1

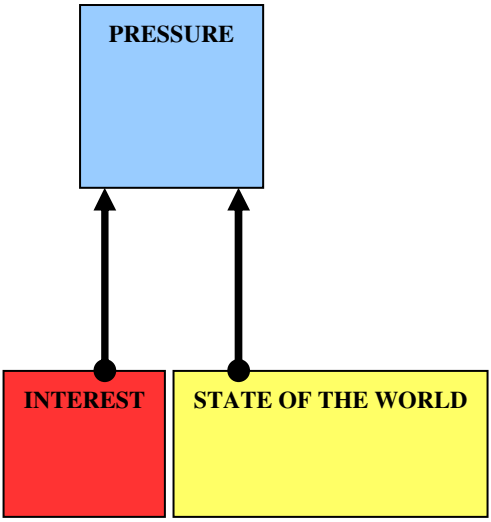

Fig. 14.1 This figure shows how interest, in combination with the current state of the world, creates the pressure that moves individuals to act.

In this sense, there are also interests that converge in the same level of pressure, that is, (if we were able to count all different pressures or interests) there are more interests than pressures. Again, whether interests will lead to less pressure or not depends on the state of the world. It might be said that several interests will lead to one single pressure if they require only one action.

Evidently, it is hard to determine whether one or more actions are involved as, for example, saying one sentence counts as one action, but it is at the same time a series of consecutive actions, because the pronunciation of each word (or each phoneme) might be deemed an action. Despite the difficulty of determining what should be considered a single action, the main idea remains, as one single action may fulfill, at the same time, several purposes.

When sending a message, a person may be interested in providing information to other person. He or she may also be interested in expressing affection to the other person, and may as well be interested in strengthening his or her identity bonds with the latter. All those different interests may be fulfilled by one action if the state of the world so permits. Therefore, all those different interests lead to one single pressure.

According to the foregoing, there are always several pressures that cause each person to act. Such actions modify the state of the world at all times. Consequently, in order to survive, human beings must modify the state of the world. During the early stages of evolution, such changes mainly involved modifications to nature. In order to survive, human beings required to know which plants were

edible, how to find them, how to hunt animals, and how to protect themselves from the dangers of their environment.

However, that knowledge and the corresponding actions would not be especially useful today to survive in many places of our planet. Moreover, the entire humankind would not be able to survive with such actions, as food resources obtained in that way would not be enough to feed the world population.

We focus here on actions as social phenomena ("joint action", Clark 1996), i.e. on communication. The state of the world, modified by this action, may also be called 'context.' Therefore, the most important elements of context in a communicative act would be the constellation of participants, their respective knowledge, the specific situation where communication occurs, and the subject such participants are dealing with.

4 Interests and Pressures

If the state of the world is thought of as a dynamic state encompassing everything, we need to ask if interest is included, or not, in this same state. Obviously, it could be anticipated that interest is a part of such state. However, in this work they were divided, as speech is of the essence for the analytical purposes of this research. In fact, interest itself – or even pressure – should be deemed included, on occasions, in the state of the world. Whether or not they should be deemed included or not, depends on the approach selected for the analysis.

To clarify this point, we will use the following example of two individuals: X and Y. If we analyze the actions and pressures of X with respect to Y, then both the interests and pressures of Y would be a part of the state of the world. If X is interested in obtaining a particular object and Y is also willing to obtain it, then X will have to find a strategy to achieve its goal. The strategy of X will necessarily end in a modification of the state of the world, which is, in part, contrary to the interests of X. One possible strategy for X may be to convince Y to change his mind and leave the object to X. This would mean that X is influencing the interests of Y. If X succeeds in this act of influencing the interests of Y, X would modify the state of the world contrary to its interests towards a favorable state. Therefore, in an analysis of the actions and pressures of X with respect to Y, the interests and pressures of Y would be a part of the state of the world.

Previous hypothesis held that pressure exists only if there is a prior interest. However, it was also stated that interests may exist even if they do not cause pressure, and even though they are acknowledgeable only through actions as a consequence of pressures. Their existence, of course, is not an isolated and occasional event. First, interests are in sets and groups within which it may be impossible to identify a particular interest, isolated from other interests. Nonetheless, each interest, if it leads to a pressure, displays its characteristics through the kind of pressures it causes. Depending on the kind of coexisting pressures, they might be in conflict.

According to what we said above, no conflict is deemed to exist between such interests. If conflict arises, it means that some interests may have caused different

levels of pressure. But the characteristics of such interests are also variable, and such variables determine pressure together with the state of the world. Thus, it is evident that some interests are immediate, and some are permanent. Both are the extreme points of a continuous line. No interest may be absolutely immediate or permanent, but they all show a variable trend towards one of such extreme points. This is why permanent interests are defined as those related to a long-term objective, while immediate interests are related to a present objective. Thus, an interest caused by hunger leads to the pressure of being fed: this is the consequence of an immediate interest. As opposed to that, the interest of following a certain diet to recover from a disease would be an example of a permanent interest. Similarly, giving a message is based on an immediate interest, while learning or passing on a language is based on a permanent interest. It is generally believed that those interests depending more directly on human body (see Lakoff & Johnson 1999) are also more immediate, as opposed to interests arising from ideologies. Likewise, there is a continuous line between personal and common interests. The former aim at an objective related to the individual, while the latter have a purpose related to the society. Both the continuous lines between immediate and permanent, and personal and common interests are important, as most conflicts arise among their respective pressures. If a conflict originates between an immediate and a permanent pressure, it depends on them being consecutive.

Both immediate and permanent interests, and personal and common interests, cause pressures, which in turn adopt the characteristics of the interests that originated them. Pressures, however, are somewhat more complex than interests, as they are also determined by the state of the world. This is why we will deal here with pressures. Certain pressures necessarily lead to other pressures upon fulfillment of their purposes. Such pressures are consecutive. As an example, we will use here the process of formal education in western societies: students not only feel the pressure of attending classes, but normally also feel the pressure of having to do some homework after school. The pressure they experience is to finish their homework, so that they can hand it in for review. They also experience pressure because they must be prepared for exams. If they hand in their homework every day, they are more likely to have the necessary knowledge as the date of their exam approaches. At a higher level, they experience pressure because they must go to the next year, and this will not be possible unless they pass their exams. In this example, the latter pressures are rather permanent as compared to the former, and all pressures are consequent, as they depend on each other without any conflict. In this case, Clark (1996:82) makes a distinction between 'joint acts' and 'joint actions,' where the former are isolated acts, and the latter are coordinated acts.

In such consecutive acts, then, it is possible to identify a combination of various immediate and permanent pressures. This variation depends, in part, on the characteristics of such interests and pressures, and they will in turn determine if a conflict will arise between pressures or not. Now, conflict may arise between all such various pressures. Being in conflict means that, if a pressure is followed by the corresponding action, it will become a barrier for the other pressure. However, consecutive pressures are never in conflict.

Some interests are related to a high need present in a person or group. They are strong, normally immediate and individual interests, and most of them depend directly on the body. However, if such interests also lead to a strong pressure, they will depend on the state of the world. In this case, a good example may be breathing. All humans need to breathe oxygen: It is impossible to survive without oxygen for a long time, and there is therefore a huge interest in breathing oxygen. However, if the state of the world is such that there is abundant oxygen, and the person suffers from no disease, then no significant pressure exists. Thus, no strong pressure exists unless the state of the world is adverse. However, if oxygen becomes scarce, or the body suffers from a disease, pressure will become more intense. As happened with the need to feed. Then, a strong interest will not always be paired to a strong pressure. The strength or intensity of pressure will depend on the interest and the state of the world.

On the contrary, a weak interest will cause a weak pressure. Therefore, weak interests will not depend on essential needs. Their origin is rather – but not always – ideological, and depends on the personal history of the individual. Accordingly, the same ideology may cause a strong interest in a person, but a weak one in another. In this sense, interests also originate in values and beliefs. Values, like ideologies and beliefs, may create interests, and interests, in turn, may create pressures that will lead to actions. There is little difference between interests emerging from ideologies and interests emerging from values or beliefs. According to van Dijk, "values play a central role in the construction of ideologies" (1998: 101). If ideologies are a set of values, we cannot always speak of ideologies, but sometimes interest is caused by one value or belief. In this sense, this latter notion should also be used, as some interests emerge from values that cannot be deemed ideologies, and some beliefs cannot be deemed values. However, the most significant difference between the origins of interests we identified lies in the difference between needs and ideologies.

Some interests lead to internal conflicts of pressures. Such conflicts require a decision regarding the pressure that will be followed, as the state of the world prevents the achievement of all visualized objectives. Hence, an individual may feel a conflict between different pressures when the state of the world places them in opposite positions. An overweight person may be a good example. As overweight is bad for health, this person may be willing to lose weight, an objective that may be achieved by following a dietary regime. At the same time, such person may also feel compelled to eat food not included in his or her diet, and which caused him or her to be overweight. In such case, there is an internal conflict between pressures, as the state of the world prevents the attainment of both objectives. A decision is then required to choose one of such pressures in conflict, and only that pressure will lead to an action. Internal conflicts may emerge both among individuals and groups.

Other interests lead to external conflicts of pressures. Such conflicts are commonly known as conflicts of interests. External conflicts emerge between two or more people or groups, and between a person and a group. When personal and social pressures have opposite objectives, and personal pressures are stronger than social pressures, an external conflict arises between the respective individual and

the entire social group. In order to analyze human pressures and actions it is necessary to understand and make a distinction between internal and external conflicts.

Actions are the result of pressures. Every human action modifies or preserves the current state of the world. Such modification needs not be permanent. It may also be a temporary modification, so that the world may later return to the state it had prior to such action. At the same time, such action may also cause permanent or long-lasting modifications in the state of the world. In both cases, the modification itself not only transforms, but it also depends on the state of the world, because it includes tools for its own modification.

Each action may have the effects that the person performing the action is looking for and, at the same time, undesired effects on the new state of the world. This is true especially with respect to intentional and conscious actions because they have a well-defined purpose from the standpoint of the person performing the action. When an action is performed, an unintentional modification of the state of the world may also occur, which is clearly contrary to the intended objectives. These are side effects, and some careful thought is required to foresee and avoid such effects.

Each action originates in a pressure, and each pressure originates in an interest. However, every pressure will not necessarily end in an action. There are always pressures in conflict, so mediation will be required, and it will also be necessary to decide which of them to follow for certain purposes.

When a person communicates with another person, they also perform an act. These are speech acts (see Austin 1962; Searle 1969), and they always modify the state of the world. This becomes somehow evident when a ritual, such as pronouncing a couple man and wife or declaring a session open, is performed. A particularly important aspect is that in communication, there is normally a combined action between two or more people. Many daily actions not related to language are individual actions, but in communication, a coordinated action, or 'joint action,' occurs (Clark 1996:3). Communication has been long considered as an individual action. Here, however, we agree with Clark that communication is a shared and coordinated action.

5 The State of the World and Pressures

As said before, the current state of the world encompasses everything, and therefore is the context of every action. If here interest, pressure and the state of the world appear as separate entities, it is merely for analytical purposes. However, it is necessary to further explain some differences in the use of this concept. The current state of the world includes every relevant element at the time of an action. Some actions are not only moving towards the future, but are also performed based on our knowledge about the future state of the world. This is, they are performed based on our assumptions about how the world will be. In this case, the state of the world includes absolutely everything: present, past, and future. In both cases we are dealing with a unique state that cannot exist in plural, whereas the 'state of things' will be the notion used to divide the state of the world. Thus, it is

possible to talk about several states of things that have a parallel existence and may or may not be relevant to pressure and action.

The state of the world implies things, as they exist separate from the mind. It must be said, avoiding a positivistic attitude, that there is a world separate from the mind (Searle 1999). This world is experienced by the mind, and then it becomes the relevant state for human actions. It is almost impossible to determine to what extent this independent state of mind is important for the present, as it becomes fully relevant through mental reality (see van Dijk 1999:43).

As previously discussed, the state of the world is never static, and it involves all relevant processes in the creation of pressures. It not only consists of the matter, and the processes to which such matter is subject, but is also formed by everything related to human imagination. The notion of 'imagination' includes both 'real'[1] and 'unreal' imagination. Thus, the state of the world includes all individual or group beliefs, concepts, abilities, knowledge and ideologies, as well as the interests and pressures that drive actions. Included in this list are all tools used to modify the part of the state of the world that could be called the set of individuals in general, that is, the society. In turn, this includes all pressures and actions affecting the society.

Languages are also a part of the state of the world, as well as the skill to use them. When a person produces a speech act, the state of the world is modified too, assuming that the emission is an illocutionary act (see Searle 1969; Lavandera 1985).

6 Competence and Common Routine

Pressures not only depend on interests, but are also modeled by the state of the world. And as pressures depend both on interests and the state of the world, the tools necessary to perform actions are a part of the state of the world, so we will now examine such tools. In the case of communicative acts, such tools are a part of language. Communicative acts are comprised of signs, so it is important to succeed in the production of such signs. In an ideal situation, success and correct use (norm) coincide. However, in a dynamic and complex system, many cases are anything but ideal. It is possible to make a correct use but fail to have success, and success may be achieved even without a correct use. To approach this problem, it is necessary to ask how does a linguistic sign work, and under which conditions do sign and interaction achieve success. This question should be asked because either sign or interaction fails in many situations.[2] Given the situation with socially homogeneous participants, the sign is at the top of a scale for acceptability, in which extreme interpretation would be blocked. Then, among less homogeneous participants, the sign would be in a lower position of the aforementioned scale (Ungerer 1991: 161). Hence, the sign should not be deemed stable, but rather an element established and approved again among participants for each communicative act. Success, then, occurs to a greater or lesser degree according to the circumstances, which depend on referential, sociolinguistic and cognitive support

[1] Imagination related to things that exist independently from the mind.

[2] Of course, the sign does not fail, but interacting parties do fail while trying to establish a 'common action' (Clark 1996).

(op. cit. 1991: 159). The internal relations of the sign stabilize only for a particular communicative purpose (ídem 1991: 171). Then, there comes a process of negotiation and renegotiation to establish again agreements already "approved" in previous occasions. According to Ungerer, highly successful communicative events are exceptional and require some special explanation. In the average case, the linguistic sign is successful only to a certain degree (ídem 1991:171).

Success in daily communication, to certain degree, is not surprising[3]; what really draws attention is failure. Thus, in order to understand how interaction succeeds, it will be necessary to observe failure while making agreements, or whenever the sign approaches the lowest point of the aforementioned scale. For such purpose, we will make a distinction between two general levels of failure:[4]

A) The message is not intelligible or is partially incomprehensible.
B) The message is comprehensible to all participants, but it is not accepted by all.

There is obviously a continuous area between both levels, and their boundaries are blurred. However, there is a difference between the two of them, and this fact is essential in this discussion. In both levels conflict is possible. The difference lies in the fact that in level A) it is also possible to have the same disadvantage for all parties involved, and this implies an action with a common objective. Such phenomenon does not exist for level B). Any failure at this level is partial within the context of a power relation, because failure implies an ideological conflict (van Dijk 1999:178).

When two languages are in conflict, it becomes apparent in day to day interaction. Both levels are important to select a certain code in interaction and therefore in the phenomenon of indigenous language shift. In many occasions it is even difficult to distinguish them. Here, level A) is deemed essential to level B), both regarding failure and success.

Depending on the subject of each specific conversation, the chances to fail increase and decrease, and more efforts are required to succeed. We will visualize a traveler in a different linguistic community. Normally, a purchase will require little effort, even if he does not speak the language of the particular community. But dealing with a more complex subject, such as a political problem, would be really difficult, even if the traveler has basic knowledge of the language. In this case, whether he deals with the subject and ends it, or prefers to quit, will depend on the mutual 'interest' and the chances of failure. The latter would represent a failure at level A).

[3] For example, in each interaction, speakers start from a common knowledge that Clark calls *common ground*. If such knowledge is really common, it will become evident during the conversation. There will also be discrepancies that will go unnoticed to the participants in that particular conversation. (Clark 1996: 49) The *common ground* depends greatly on the degree of success of the sign.

[4] On the contrary, we could also speak of success in A) and B), but failure seems more evident because it is more absolute than success. From now on, levels A) and B) will be deemed to be mentioned both with respect to failure and success of the sign.

Pressure, however, is not always balanced, and may have more influence on one of the interacting parties. As discussed above, the person with the greater interest will experience more pressure and will have to compromise more in order to reach an agreement. Agreeing to use a linguistic sign is equivalent to one or both parties learning.

Here, we can present the example of White-Thunder, a Menomini Indian mentioned by Bloomfield (1974: 274), who represents the classic case of a 'double semilingual'.[5] "He may be said to speak no language tolerably. His case is not uncommon among younger men, even when they speak but little English." This means that White-Thunder would face several problems should he live in a monolingual Menomini community or in a monolingual English-speaking community. In his community, however, many others are in the same situation. They are probably not very interested in communicating with monolinguals, so there is little

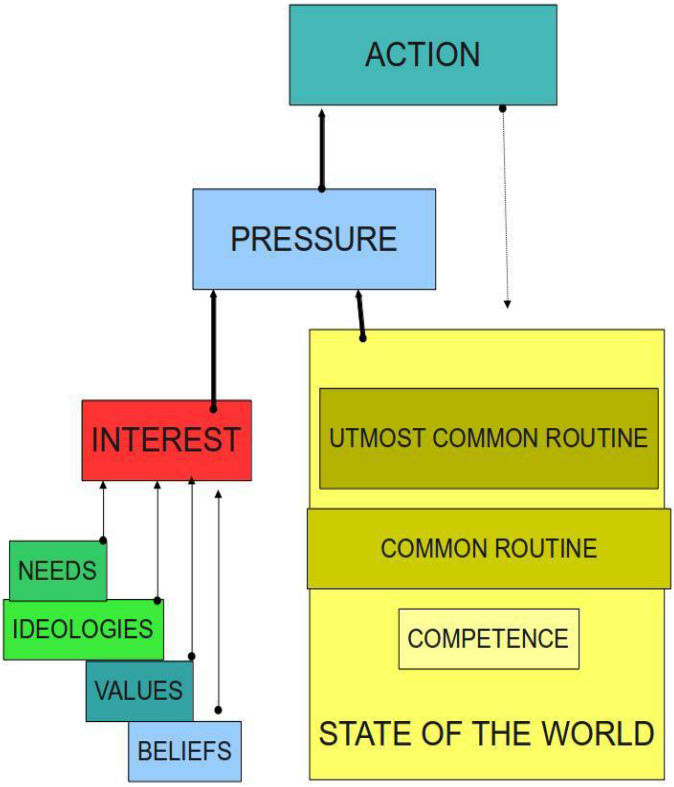

Fig. 14.2 Ecology of pressures

[5] A person is considered a double semilingual if it speaks two languages, but none of them as a native speaker. In other words, such a person fails at level B) with respect to both languages. For a discussion of this notion, see Skutnabb - Kangas 1981 and Romaine 1989.

pressure to speak Menomini 'correctly'.[6] Although White-Thunder does not speak to a satisfactory standard, he is not having problems at levels A) and B).

In this study, the concept of 'interest' includes several components which have a mainly social trait. Among such components are the various needs and identity. Selecting a speech variety (language, dialect, sociodialect) from among different possible varieties, is deemed a matter of identity[7] and accessibility.[8] In this point, the competence (tool) of interacting the parties in both languages seems an important factor to select a particular code, as well as identity, as a component of interest, originated in the ideology of the group each person belongs to (Figure 14.2).

As this study will not be based on competence, it will be necessary to analyze this concept a little more. As a result of the development of this field in communication ethnography, interest in the study of multilingual communities increased. But, not only in multilingual communities, but also in monolingual ones, competence–as the knowledge of grammar rules- failed to be sufficient to achieve successful communication. The members of each community also needed to know how to hold an appropriate conversation in particular situations.

The 'communicative competence' of Hymes (1981) may be useful to explain the behavior of speakers in a broader sense: it allows also for a comparison of different cultures and facilitates the description of singular cultures with different languages. This is how code-switching became a subject of study.

Communicative competence also became relevant in the field of acquisition and in connection with minority language problems, such as language shift. The problem of language shift is frequently associated with a lack of competence or proficiency in younger generations (see Rouchdy 1992).

Schmidt (1985) says that young Dyirbal people avoid speaking in Dyirbal with older and traditional people to escape correction mechanisms. But such young people can effectively hold conversations with their similarly aged friends in young people's Dyirbal. Is it then possible to say that there is a proficiency loss? We can only say that they are not successful at level B) when they talk to older people in Dyirbal. In spite of this, they use their version of Dyirbal (Young Dyirbal) to identify with specific groups of young people. When trying to explain this phenomenon, it is evident that the concept of competence will lead to a contradiction. There may be parallel interests between the members of such groups of young people, i.e. they have an interest in identifying with each other and also in holding a successful conversation. But the strength of the former is reduced due to the unfavorable instrument (the code), because all other young people are relatively incompetent speakers of Dyirbal. We should then ask why are young people talking to each other in Dyirbal? Hence, it is clear that competence cannot explain why they act in such a way.

Individual and social characteristics should not be mutually excluded because they are both relevant. Social characteristics have nonetheless been excluded from

[6] Of course, the term "monolingual" here has no sense, and is only used to refer to traditional Menomini speakers.

[7] Ideological issues.

[8] The speech variety demanding the least effort to communicate when dealing with a given subject, regardless of the latter.

traditional monolingual analyses. Competence should be measured before measuring pressure, but measuring competence contributes to a static view of language and culture.

If we were to explain how a person would select a code to talk to himself, the concept of competence would suffice. This person, however, while talking to himself, would not transfer knowledge. The focus of this study is on dialogical speech, i.e. when a speaker provides information by performing a verbal act. Therefore, the concept of competence is the problem that has led to so many wrong results.

In order to analyze shift we should now use a different concept, perhaps something equivalent to a social competence (see Gudykunst 1993). In spite of the criticism around the individual model of competence, a social model should also include individual characteristics.

If two individuals are mutually interested in interacting, it might be said that they experience a balanced pressure. There are various interests that form sets and lead to different kinds of pressures at several levels. Some of such pressures are linked to the use of signs, that is, to the selection of a particular code. The strength of such pressures depends on the interest of each individual to interact. If pressure is too strong, level B) -non-acceptance of proposals- will be little significant as long as understanding does not fail (level A)), even if such interacting parties are not homogeneous and cannot base their interaction on many previous agreements or shared knowledge related to the world or the code.

In a verbal act, information is transmitted at different levels of knowledge[9], among which the locutionary and the illocutionary act (Searle 1969) constitute superposed levels. If the transmission of information is assumed to occur at various levels in the verbal act, learning at various levels (including locutionary and illocutionary acts) is also clearly included. Each communicative event is a learning event that is part of a personal history, i.e. an "embodied and social history" (Varela 1990: 96). The personal history is the basis for competence. Parallel learning at the various levels acts as a negotiation in the use of speech, and as a social act, because it is shared among individuals. In the verbal act, speakers focus on a few levels of information, generally pragma-semantic levels.

If they have choices from several systems[10], the conversation reaches a balance in the system or systems (mixture of languages) that require less attention from all interacting parties present, that is, they select the system or systems that are more automated between them. Thus, by frequently using a language, the members of a social network reach a *routine* that allows them, in certain situations, to focus on few levels of information. If such routine is common, this allows both speakers to focus on a reduced number of information levels. 'Common routine' is based on the history two or more individuals have in common in a particular situation for a specific purpose, and it may reach its highest value in one end, and disappear in the other. In order to move towards the highest value, the histories in common of the participants are necessary. For example, a couple that has lived together for a long time may well reach the highest value end when discussing the future of their

[9] Knowledge or information levels are not identical to failure levels A) and B).

[10] Such systems may be languages, dialects, sociolects, registers or mixtures of languages.

children, but may also fail when dealing with subjects related to their jobs, if they have different educational backgrounds and are not used to dealing with such subjects.

When people interact, their common routines generally move towards the highest possible level in each particular situation. The common routine is based on their shared knowledge or their overlapped knowledge, which should reach a great degree of automation to determine, together with interest, pressure.

If interest includes mainly social components, the common routine is formed especially by psychological aspects. Pressure, formed by both of them, determines usage and acquisition in their interrelation. The concept of pressure is then the one that helps to explain language shift at the social and psychological levels.

To show how common routine creates a different pressure, we will compare it to competence:

1a. Competence focuses on the rules of communities as a whole and tends to regulation.
1b. Common routine focuses on interpersonal knowledge in connection with one or more communities.
2a. Competence is the relationship of an individual with a 'made up system', where the individual is trying to reach perfection. Success based on competence tends to level B).
2b. In common routine, individuals seek for the best selection of signs for a particular group of speakers who work together to develop a system that will allow them to achieve a more effective communication. Thus, success based on common routine tends to level A).
3a. The concept of competence produces some pressure to achieve what is deemed 'correct' and causes an unbalance in mutual pressures, which in turn change power relations. Power frequently causes a group of related people to suffer disadvantages and inequality.
3b. Common routine is a tool when pressure exists to achieve effectiveness. These are mutual pressures in balance, which eliminate inequalities to a high degree.
4a. The concept of competence is useful to explain the pressures that move an individual to act in a power relation.
4b. The concept of common routine explains how various individuals work together to solve a problem. Such concept is incompatible with the notion of 'language–nation–state'.

Depending on their objectives, speakers select the choice that involves less effort to develop a particular subject in a specific situation. The selected option should be negotiated as a "common ground" and automation should be at the highest possible level in all of them. Automation eliminates the need for huge efforts in attention. In this way, only a part of the common knowledge may be deemed common routine. This concept is not reduced to language knowledge, but includes knowledge about the world, provided it is shared and automated. Common routine is a

part of the 'current state of the world' that originates pressure towards an action. It partially includes competence, but competence shows no variation when a speaker, in a given situation, joins a conversation, while common routine changes depending on the members of the group that is talking. Common routine changes in each conversation, as the transfer of knowledge also involves a learning act.

7 Classification of Pressures

The question now is: how can we approach a classification of pressures against or for the usage of indigenous languages that may allow us to accurately explain the linguistic situation? We pinpointed interest and the state of the world as the origins of pressure. In order to limit a concept as wide and complex as the state of the world, we focused on common routines in general, and in utmost common routine (UCR) specifically. Together with needs, ideologies determine interests and, consequently, also influence pressures. In a conversation, the main interest may be to pass on a message, but it may well be the form of the message and not its contents. This interest is determined by the ideology of the language. In such case, the contents of the message may be rejected merely because the form fails to be appropriate.

Similarly, if the common routine causes pressure, then the participants have a common goal because they are willing to achieve success at level A). Interest, for example, includes the essential needs related to survival. The state of the world contains both the tools necessary to achieve a goal, and the conditions that contribute to or hinder their attainment. The UCR, in turn, is modified by each verbal act, which may also be deemed a learning act.

In order to analyze the pressures that may influence, both positively and negatively, the indigenous language of a community, it is necessary to classify such pressures. As previously discussed, in a verbal act pressures emerge from interests and common routine, and normally one of them determine pressure. As we showed above, interests originate, in the first place, in needs related to human nature, and second, in ideologies. Given that ideologies are very complex, some interests arise from simpler components, such as values or beliefs.

This means that we already have some elements to classify five different pressures, which are multiplied in turn by two, as some pressures are in favor of the indigenous language (IL), and others are in favor of the Spanish language (SL). Accordingly, the utmost common routine may create the final pressure that will determine the use of a specific language. On the other hand, needs or ideologies also influence the selection of a language. And so do values and beliefs.

Therefore, our scheme is divided into pressures in favor of the indigenous language (IL), which appear in yellow, and pressures in favor of the Spanish language (SL), which appear in red (Figure 14.1).

Table 14.1 Pressures in favour of indigenous language (IL) and the Spanish language (SL).

PRESSURE	Favors the IL	Favors the SL
Utmost Common Routine		
Needs		
Ideologies		
Values		
Beliefs		

Needs are associated with the well-being, employment and education of speakers. Ideologies and values are expressed in attitudes towards language. We will illustrate this using the reports of some members of the Otomi community in San Cristobal Huichochitlan.

"Because, it can't be, um, how many kilometers do you think there are between this point and Toluca? In four, or five kilometers at most, you, like, cannot find more Otomi. This is, kind of… not good. And then sometimes, like, sometimes… Even if you don't want anything to do with Spanish, you have to talk in Spanish. ... To be able to communicate with everybody else, because as I told you, it would be nice to find someone there in Toluca who could speak Otomi. That makes you feel at ease and all."

We quote here a man in his early 40s. According to his report, Otomi speakers feel some pressure to speak Spanish, because there are many reasons why they will need to go to the capital city of their state, only 5 kilometers away. Thus, the utmost common routine necessarily favors the Spanish language, as in Toluca it is unlikely that a person will speak Otomi or study such language. The way he talks about his language, however, also implies that some values favor the IL "it would be nice to find someone there in Toluca who could speak Otomi." Here, we mention "values" because it would be difficult to talk about "ideologies". Although it might be difficult to make a distinction between such two classifications, we think that more favorable experiences would be necessary to classify pressure in this other manner. This was only one example to show how pressures may be classified, as they many times are against each other; in this case, one of them is in favor of Otomi, and the other is in favor of Spanish. But in the following section we will limit our analysis to the pressure caused by the utmost common routine, and we will consider it as one of the most determining elements in the shift and maintenance of native languages (Figure 14.2).

Table 14.2 The most relevant pressures in favour of indigenous language (IL) and the Spanish language (SL) according to members of the Otomi community.

PRESSURE	Favors the IL	Favors the SL
Utmost Common Routine		
Needs		
Ideologies		
Values		
Beliefs		

8 As a Conclusion

In order to understand the shift or maintenance of a minority language with respect to other majority language, our analysis should consider as many determining factors for the use and adoption of a code as possible, i.e. the communicative action. Interdisciplinary studies considering the complexity of such situation, which is also responsible for the diversity in the various cases of shift, is also necessary. With such purpose in mind, we prepared the ecology of pressures model, where ecology is a complex and dynamic system, as opposed to a static system.

This model emerged from the idea that complex systems involve pressures that pull towards various directions and determine communicative actions. Action is the result of a summary of such pressures, among which some are more or less dominant. In order to determine dominant pressures, it is important to classify all possible pressures and tell the difference between them.

We can first separate two types of pressures experienced by communities and their inhabitants while communicating. One of them depends on the interests of the people that perform acts. The other type depends on the current state of the world, in its broader sense. That is, we do not view interests as a part of the state of the world, but as one more cause for pressures. The state of the world, together with interests, generates pressures that may be classified according to their main origin. As our analysis of this action deals with communication, we focused on common routine in general, and utmost common routine (UCR) specifically, and they both form a part of the state of the world. At the same time, we propose a detailed classification of pressures originated in interest. Using such classification and the UCR, we identified 5 different types of pressures, most of them interdependent upon communicative acts. In such acts, the aforementioned pressures determine the code to be used and, consequently, the adoption of such code. Using such classification, we analyzed the communicative actions of people.

Hence, using a code X may depend on a) the utmost common routine, b) needs, c) ideologies, d) some specific values, or e) simply on a belief of the individual willing to communicate. Values and beliefs are components of ideologies, and it is necessary to use them whenever the concept of ideology becomes too general. Many times, the boundaries between them become blurred (Munné in this volume), so their classification depends mainly on the standpoint of viewer.

More than one of the 5 pressures classified above are generally involved. Such forces or pressures may be contradictory at a group, interpersonal, and even individual level. If pressures are not parallel and have different directions, they are contradictory and one of them, therefore, is dominant. This fact has an influence on our analysis, because, as in some cases pressures may be classified without any problem, in some more complex cases, only a blurred classification is feasible. This analysis shows that two acts, which are apparently equal, may turn out to be different because they depend on different pressures. That is, if a language is no longer used due to ideological causes, needs related to survival, or because the UCR was modified in the relevant community, a shift of that language from such group may occur. Thus, the use of an indigenous language in one particular case may depend on ideology, and in other case, on the UCR. For example, as opposed to pressure based on UCR, pressure based on ideology will depend more on the reflexivity of speakers.

In many cases, a classification of pressures may also be difficult due to the fact that the resulting action depends on a conglomerate of parallel or opposing pressures, and such pressures, in turn, originate in various interests combined with UCR. In such cases, the resulting action will be a summary of different types of pressures, whether combined or in contradiction.

The complexity of this scenario depends not only on the various types of pressures involved, but also on their opposing nature, namely individual, group, immediate or permanent. It also depends on the perception of the particular phenomenon. In this sense, it allows for an approach, within our analysis, in terms of a comparison of psychological, sociological and biological factors of human nature, and biological factors of nature in general. It is necessary to analyze cultural behaviors, personal histories and shared personal histories, knowledge, as well as acquisition of knowledge, attitudes, inequalities, disadvantages and power relations. We hope that this model will be a useful tool to conduct more and more satisfactory analyses of the complex and varied processes involved in language shift, allowing us not only to analyze the surface of this phenomenon, but also the underlying causes that lead to it, expressed in the various types of pressures.

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15 Ethics and Progress in Today's World

Federico Mayor Zaragoza

President of the Foundation for a Culture of Peace and UNESCO's former director

In a book on complexity, it seems to us essential addressing ethical considerations which are central to the issue of human development. As Mayor put it, "The constitution of UNESCO speaks of 'the intellectual and moral solidarity of mankind'. That is what we must strive for. We need to attain this kind of solidarity, which is not only about giving material goods, but also and especially about having a personal interaction and an exchange of knowledge. (…) Whose progress? For what? The progress we need to make is the equality and dignity of all human beings. As long as we are incapable of doing that, we will fail as a civilization."

Contemporary society has undergone many significant changes. Chief among them are moral pluralism (arising from secularization), individualism and multiculturalism. And these changes impel us to consider ethics as essential.

The defining characteristics of human beings have a biological foundation that enables us to integrate them within the framework of our evolution as a species. Ethics, values, awareness, empathy and love are strands that articulate our mental development on adaptive grounds for survival.

From this viewpoint, we see values as a transmission of the cultural knowledge that human experience has given us. Values as adaptive tools, bolstering our human powers and accepting our limitations (see also sections 8, 9, 10 in Massip's contribution to this book).

However, few advances have been made in the biological exploration of moral sentiments. Without a description of the brain or the forces that shape human conduct, it is difficult to envisage a new ethics that is more finely tuned to human needs and rights, an ethics that takes us down a path away from intolerance of difference and beyond the naturalistic fallacy of defending our behaviour as the way we must necessarily behave.

(Àngels Massip-Bonet)

Extracts from the talk given by F. Mayor-Zaragoza on the subject of ethics for the course "A Living Being Called Language" (in Catalan, *Un ésser viu anomenat llenguatge*) in 2009:

[…] Complexity can be tackled from a transdisciplinary perspective. Therefore, we have to accustom ourselves to the fact that the truth simultaneously is and is not the case. What we need to create is a permanent path that leads ever closer to reality.

With the beginning of this century and millennium, in a world growing more and more complex, we need to end the silence. We cannot continue holding to the view that whatever happens, happens; that we are only witnesses, only spectators, rather than agents permanently locked in an institutional silence.

[...] It is as if people did not exist. [...] If we turn to history, we see only a series of events: wars, domination, power and nothing else. We say: "Where are the men, women, painters and so forth?" For they are not there. Yet time and again we are told: "Many soldiers died in this battle". Because those people had no role, they had to give their lives. Moreover, it was indisputable. It was beyond dispute that every citizen, when the time came, had to bow to the will of the strong, to their power. This power could be a power that defended causes that ran entirely contrary to their own. Still, they had to give their lives.

[In this sense], it is very important that we are able to speak of reality as it is. Reality is an astounding complexity. I know this fact as a molecular biologist and biochemist and I think that it is fantastic to relate language to living beings. It is the case that a language, moreover, is life, while silence, particularly a forced silence, is its opposite. Silence is humiliation; it is the surrender of the creative realities of each human being.

[...] Words go hand in hand with freedom. More freedom, more words.

[...] We must begin to realize that reality is highly complex. We must all strive to take a transdisciplinary approach, to facilitate knowledge of knowledge and to attain a very clear vision of the cognitive capacity of human beings. We need to keep bringing on board more people and more specialists to develop a way of approaching complex and controversial problems.

[...] In this respect, we need to say that language must be capable of faithfully describing reality. Because, in this way, we will be able to change it. Reality can only be transformed if it is understood. If it is not understood, it cannot be transformed. [...] So what do we have to do to transform it? Understand it. Go as far as we can. We will make this happen with many eyes, many thoughtful gazes.

[...] Let me tell you an anecdote. I had the good fortune to work with a Nobel laureate while I was at Oxford. One Friday evening at eight, I was there working. He had forgotten something in the lab and came back. Seeing me, he said: "Federico, what are doing here?" and I replied: "The thing is, you have equipment and facilities that I don't have in Granada, so you can see why I originally came here and why I'm still in the lab." He said to me: "From now on, you're going to take off Fridays too". He said: "Doing research is seeing what others can't see. And thinking what nobody else has thought!" That is development. Development means discovering what lies beneath. To understand reality we need to think what nobody else has thought.

Today we sometimes have too many instruments and too much information and we have too little time for this uniquely human activity, which is thinking. Once we think, in that instant we need to be able to act on the basis of our reflection.

That is one more thing that we must emphatically incorporate into the concept of education. Too often, when education is spoken of in the media or even in treatises on education, a great confusion arises between information and instruction.

[...] I want to reiterate the definition of education given in 1920 by Francisco Giner de los Ríos: "Education is for leading your own life. A person – this extraordinary being capable of thought, of feeling, capable of expressing feeling, of speaking, of being quiet, of listening – this fantastic being, is a being that needs to lead his own life and take action. After having listened, after reflection, he takes action in accordance with his own conclusions".

[...] A living being called language. "Complexity and Word": what a marvellous subject! What an excellent title! How much respect we need to give to language! Because not just every language but every word is the product of this creative activity of human beings. We must strive for [language] not to be a privilege of the few, but an ability that everyone can develop so that everyone can feel that they possess the wonder of this endowment that can be a mystery. It can also be a miracle, I do not know, but what is certain is that it is a mystery from a biological and biochemical standpoint.

This diversity is our wealth. This ability that each human being has of being unique, of being able to create, interpret and have their own way of looking at things. Then, if we can only come together around some universal principles, those principles that everyone can accept, whatever their beliefs or ideologies: justice, freedom, solidarity. The constitution of UNESCO speaks of "the intellectual and moral solidarity of mankind". That is what we must strive for. We need to have this solidarity, which is not only about giving material goods, but also and especially about having a personal interaction and an exchange of knowledge. That is what we must always strive for. Intellectual and moral solidarity based on a concept that is fundamental and that we find in the earliest constitutions and the earliest rebellions of people against "living in subjugation", living as permanent subjects. This concept is the concept of human dignity: everyone different, but with equal dignity. That is the dignity that we need to see reflected in the media, but we do not see it. We do not see it because gradually the only thing we get from the media is news.

We need to know what a piece of news is. A piece of news is conveyed precisely because it is atypical, because it is unusual, because it is extraordinary. That accounts for why it is broadcast and we are told: "Look at what happened". Then, we raise our hands to our head in despair.

We number six billion three hundred million and we only see the news, the extraordinary. We do not see anything else. Why? Because anything else is not news. With this knowledge of complex reality that is absolutely indispensable, we have to know, therefore, we have to get past what the media give us, particularly the insistent media of today, like television and audiovisual media that come into our homes. In the end, we come to believe that reality is this reality that is seen or spoken. It is this extraordinary reality, the reality of what hardly ever happens. That is why it is news. Yet that reality is not reality. We need to learn through complexity not to say things that are not the case when we know so, because language must be a reflection of reality. The reality we need to know how to see is

the totality. What the media focus on only illuminates what is exceptional. [...] In a word, we cannot say today that we understand reality if we do not think of this reality and are able to see the parts that are left invisible by the media.

Whenever I speak of the visible and invisible, I like to recall the Nobel laureate Bernard Lone who spoke of this matter in his acceptance speech. He said that we need an in-depth knowledge of reality if we want to transform it. Otherwise, we will only transform perceptions, the skin-deep reality, but not the underlying reality. He spoke of the visible. We go through life looking at the visible. Yet we shut our eyes and we think of the invisible! Lone said: "Because only to the extent that we see the invisible will we be able to do the impossible". The media do not broadcast what they think. What they do is depict what is happening on the surface, not what could happen or what is happening out of sight. We need to know how to see the totality. We need to know how to see the invisible, because only in that case will we be able to transform reality, which is the most important aim of progress. Pushing forward from a conceptual and practical viewpoint in the context of science. We have to keep knowing reality more deeply.

When we speak of progress or development, what is it progress of? What kind of development and for whom? Today, when we see progress or development expressed in terms of the social development of the past sixty years, we see a disaster. At the outset, it was a great project of people and of democracies guided by human rights. So what happened? Gradually, a group of nations said: "As for the United Nations, better the G7, the G8 and so on". Democracy was replaced by a protocracy. It was clear that they wanted to move away from a profound understanding of reality. What interested them was only to see from their own viewpoint and gradually push toward a consumer society drawing in roughly twenty percent of the inhabitants of the planet. In other words, it is calculated that at least in the nineteen-eighties and thereabouts – and today it may well be worse – twenty percent of humanity possessed eighty percent of the goods – including knowledge, which is the greatest treasure – while the other eighty percent had only the crumbs left over from this great table on which we live, on which we in this twenty percent continue living.

So my question is this. [...] Whose progress? For what? Because the progress we need to make is the equality and dignity of all human beings. As long as we are incapable of doing that, we will fail as a civilization. We *are* failing as a generation. And why? Because, as I said earlier, we have largely been silenced institutionally.

[...] We must think that knowledge is always positive. We need not fear knowledge. What may be perverse or enormously harmful is the application of science. I have already spoken of diversity and words. This has been the subject of profound study by Régis Debray. He has devoted considerable effort to the matter. It is fascinating to see that what interests us is the act of transmission, because transmission involves communication and yet at the same time it is something communicated. In other words, communication does not end with the receiver of information. The receiver conveys back what he has just received. Therefore, what is of interest to me deeply is to speak of communication and transmission from the standpoint of science. Moreover, I want to speak of participation.

If we participate, democracy can move forward. If we do not participate, if we citizens are only witnesses, then we will go nowhere. Today, for the first time in history, we citizens can participate. We can take part without even being present. This is extremely important. In my view, this fact will change many things in the world in the next ten to twelve years. Today's democracies are highly formal democracies, accustomed to the ballot box and vote tallies. From now on, however, the voice of the people will be heard much more easily. It will no longer be necessary to cast a physical vote. We will able to do so reliably through media as easily as sending a text message from our mobile telephones. That is, we need to know how to see the vital contributions of recent years, particularly in the mastery of communication, so that they can be communication with transmission and, therefore, a sustainable perpetuation of words and their expression. At the same time, however, so that it can represent genuine participation, a participation that can radically modify the very meaning of multifaceted reality.

[...] Freedom lies precisely in this ridge of a complexity that we understand and do not understand in what our intuition grasps and does not grasp. Of what is likely and what is unlikely. This ridge is where freedom thrives. We need to protect it when we elbow freedom aside with statements like "that's just the way it is". [...] The ability we have sometimes to defend things because they have been said to us all our lives is another drawback for such freedom, which needs to guide the ethics of progress and the knowledge of complex reality.

Lastly, I want to speak about a subject that highly interests me as a biochemist: diagnostics and action. Today, we surely already have a diagnosis for 98% of our problems. In some cases, the diagnosis is not particularly good, but we have it. [...] If we are capable of understanding reality and its multifaceted nature from a multidisciplinary perspective, we need to keep striving to address issues that already have a diagnosis, but that we can now diagnose better. A strong diagnosis makes for better treatment. [...] For the ethics of scientific progress to bear fruit that genuinely improve the quality of life, one of the concepts much beloved of Edgar Morin, we need to know that we must do is to have a diagnosis that enables us to act in time with any treatment that is already available. And if we do not have a treatment available, that is a reason to conduct research.

[...] I have often said that the perfect diagnostic is the autopsy. It is too late, but it is perfect! It hits the nail on the head! But an autopsy is exactly what we were trying not to have happen to us. Therefore, when we speak of analysis and we say that analysis is what we need and we talk about what we can avoid, we need to bear closely in mind that what interests us is timely action. Action taken in time to safeguard this quality of life and also to make use of a faculty that is uniquely human: anticipation. Only human beings are capable of planning ahead. Therefore, there are times when we understand and can forecast what will happen. If we can make forecasts, we can take prevention. That is fundamental.

In closing, I have already said that I do not want subjects, but rather citizens. I want to end by sharing with you something I read many years ago, maybe twenty, in a book by Jesús Massip called *Llibre d'hores*. The book has a poem with a line that goes: "*Les hores tornaran i mos trobaran fets i dòcils*" (in English, roughly, "The hours will come again and they will find us bowed and done"). And I always

respond: “The hours will come again, but they won’t find us bowed and done. They will find us standing upright for peace. They will find us ready and able to be citizens and not subjects. They will find us bursting with energy to struggle against standardization and herd mentality.

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