

Design-Neuroscience: Interactions between the Creative and Cognitive Processes of the Brain and Design

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Abstract. This paper discusses the rapprochement between Design and Neuroscience at the approach to the interaction between the creative and cognitive processes of the brain and design. Presents the importance of mental images in mediating these processes. Articulates the parallels between instances of design: imaging, presenting and testing and brain: interpreter, actor and comparator. Proposes the relationship between the spiral development of the brain and of the design as an interactive action beyond the iterative condition, able to support innovative and open perspectives for projective methodologies in design.

Keywords: Design, Neuroscience, Creative Process, and Cognitive Process.

1 Introduction

The rapprochement between the areas of research design and neuroscience is still underexplored by researchers in these fields of knowledge. Neuroscience as a relatively new science that deals with the development, chemistry, structure, function and pathology of the nervous system [12] may open perspectives for research in design, since in this context cognition is investigated from the properties of the brain, or by assigning specific brain structures to all forms of behavior and experience, even if only approximately. In other words, changes in brain structure imply changes in behavior and experience, and therefore the interaction with products designed by design.

In turn, the design field as "essentially hybrid that operates the junction between body and information artefact, user and system" [4] can bring significant contributions to the neuroscientific questions, especially those directed to the understanding of brain functions, including memory, learning, perception and spatial orientation. At this meeting, on the one hand, it is assumed the combination of the biobased properties to the cognition, on the other biological phenomena and mental are considered products of the cognitive structure of the system itself [18] in co-evolution with the environment in which it is inserted.

Researches in neuroscience [5]; [6]; [9]; [10]; [16] indicate that the human brain is particularly suited to design things - concepts, tools, languages and places. Thus the

human brain may have evolved to be creative - to imagine new ideas, put into practice what they invent and to critically analyze the results of human actions. In other words, the brain creatively builds senses to its context, as well as designers create products that reconfigure these contexts and stimulate the brain to reconstruct the senses existing or build new.

The natural urgency to investigate and resolve problems that designers have dedicated is rooted in problem-solving brain circuits. The brain, to promote reflection and action, subsidizes the desire for organization to attribute meaning to things in their respective contexts, as well as underpinning the planning and taking decisions intrinsic to the design. This interaction and coherence also corroborate the definition of our self, of who we are in relation to the context.

Thus this paper aims to focus on how the creative and cognitive process of the brain interacts with the creative and cognitive process of design, since the understanding of the structure and neuronal processes in the brain by the design, can lead to a more favorable environment for the creation and development of projectual proposals.

2 Mental Images: Mediation between Creative and Cognitive Process

The construction of images consists in a fundamental brain process, at the base of the formation of thoughts, perceptions, memories and plans. The factual knowledge required for reasoning and decision-making comes to the mind in the form of images [7].

It is possible to identify three different types of images that form in the brain associated with the time of the action: images that represent the present; images that represent the past and those related to the projection of a possible future.

The images that represent the present, also known as perceptual, are those formed in the brain resulting from actions taken and felt at that moment, for example, when contemplating a landscape, touching the surface of an object, smell a flower, tasting a wine.

In contrast, those associated with the past, as recalled images, invoke thoughts and memories related to actions that have already occurred. In other words, shapes, colors, movements, sounds, smells and flavors experienced in the past return to the brain by the present stimuli.

And finally, the images that emerge in the brain as the result of plans designed such actions in the future be it near or far. They are also referred by Damasio as "memory of a possible future". Just like when a desired trip is planned, for which consolidates the "memorize of this fiction" [7] in mind which may or may not occur.

By its very nature, these images formed during the planning of actions to be implemented in the future, they have become closer than we understand as the design process. However, this instance is not dissociated from perceptual images and recalled images. Rather, the images constructed as potential future existence invoke and articulate with the constituted at present and those recovered from past acts and revived in present.

Thus, the images formed in the mind are the result of interactions between individuals and between them and the objects in their contexts. Such interactions are mapped into neural patterns and constructed in accordance with the organism [6] being under the control of sensory receptors driven to the outside of the brain - the retina -, or under the control of dispositional representations - arrangements - contained in within the brain in cortical and subcortical regions [7]. Therefore, the images are based directly on neural representations, and only those that occur in early sensory cortices and are topographically organized [7].

However, images are more than figures internalized in the minds of individuals. They represent subjective knowledge, used to develop and organize ideas in such areas as architecture and design [20], visual perception and learning [3], language [15], child development [13], and economics and politics [2].

In the design's field, mental images represent not only the starting point of the creative process that guides the development projectual but a recurring instance that supports and permeates the whole cognitive process in a repetitive cycle in which each return adds complexity to the previous moment.

Like an engine, the use of mental images impels the designer thinking about objects in space, allowing the solution to the given problem is "viewed" in your mind. As the scientists Faraday and Maxwell that mentally viewed electromagnetic fields as tiny tubes filled with fluid. Kekule who saw the benzene ring as mental image projected from the reference of snakes biting their tails. Watson and Crick turned mentally models of what would be the double helix of DNA.

Mental simulations that allow relive many experiments simultaneously, from which new images emerge. Einstein summarized the importance of mental images for creative and cognitive processes when he says "my specific skill lies not in the mathematical calculation, but in visualizing effects, possibilities and consequences" [14]. A parallel with the work of the designer is identified here and it'll be explained below.

3 The Parallels among Imaging | Interpreter, Presenting | Actors and Testing | Comparator

Imaging, presenting and testing consists of the instances that are articulated to configure what is known as the creative process in any individual. Such instances are also seen as elementary activities analytically distinct and intrinsic to the design field. And for which corresponding instances are identified within the brain processing: interpreter, actors and comparator, respectively.

Imaging is the ability to go beyond the information presented. The process of see something where nothing seemed to exist before [3] or the ability to construct mental images of a fragment of the world. In design, these images provide a broad experimental framework in which is possible to engage and disengage specific parts to problem solving, yet internalized in mind.

The designers apply those mental images to better define the problem they are working on and guide their search for answers. This process reveals a cooperative scenario where the design is improved, as the images will be more elaborate.

Such activity in design - imaging - finds its parallel in brain processing in the action of the interpreter [20], dedicated to manufacture, fantasize, and create ideas and concepts. Concentrated in the left hemisphere of the brain, that mental function - interpreter - is dedicated to inventing stories, myths and concepts to explain the experience through the development of explanatory models, either descriptive or fanciful.

These pre-mental representations play a key role in the creative process and design as it provide creative leaps in identifying new connections between existing elements, in the unfettered realm of ideas, preceding what will be, and therefore still disconnected from any liens that may cause their physical feasibility.

Presenting refers to the ways in which designers externalize and communicate their mental images. Besides the presentation of ideas and concepts, this implies in choosing the best medium for this representation, considering the moment in which the design process lies.

Not restricted only to this that choice also extends to the selection of imagery that will gain visibility in the eyes of the designer himself and other individuals. A paradoxical process because while it reduces the field of imagined possibilities of design - with increasingly specific projectual detailing - expands the scope of new problems related to the new projectual delimitation. "Designers present not images themselves but the implications of images" [17], resulting in representation of a problem with the simple purpose of achieving transparency necessary for obtaining a solution.

Within the brain processing, this function - presenting - is played by the actor [20], involving several brain areas such as the occipital, parietal and frontal lobes, in a process of continuous adaptation to the stimuli received from the environment. Such stimuli are perceived by sensory organs, decoded and interpreted by the brain, giving them meaning, as recognized information (perception) and / or performed action (motor response). Thus, external representations assume their meanings - their intentions and extensions - from the inner meaning, mental states and actions of the people who built and use them [8].

And finally, testing relates to the various ways and means used and applied by designers to verify consistency between the proposals, which were presented as a result of the interaction between the imaging and presenting instances, and objectives intended as a product.

Such activity requires an analytical and critical posture of the designer in front of the object outlined until then aiming to confront it with the different factors involved in the whole design process for the achievement of its purposes - the first ideas proposed by the designer from formulated mental images; needs, desires and expectations of the client, the relationship between the projective elements, social, cultural, economic and even political issues, beyond those directly related to the user experience in their relationship with the product delivered by design, such as their emotional, sensory, ergonomic, neurophysiological aspects, among others.

Considering the cerebral perspective, this activity - testing - finds its parallel in the action of the comparator, concentrated in the frontal lobe, and dedicated to compare the hypotheses raised by the interpreter with the perceptions and motor responses conducted by the actor in order to identify possible disconnections so enhance the development of the emerging image.

The continues relationship among these pairs - Imaging | Interpreter, Presenting | Actor, Testing | Comparator - and among their instances that comprise the activities of design - Imaging, Presenting, Testing - as well as among those that make up the brain functions - Interpreter, Actor, Comparator - resulting in what we call a interaction between creative and cognitive processes of the brain and the design, as explained below.

4 Brain's Designer and Design: Interactions between Creative and Cognitive Processes

"The Brain's Creative Development Spiral" diagram, as proposed by John Zeisel, understands that when one has a perception, develops a plan, or reacts to the environment, the mind uses the same iterative process that designers use in their design process, as detailed previously. In other words, the brain uses an interactive process of repeated cycles of imaging, presenting, and testing to make sense of the world and ourselves in it [20].

The "Design Development Spiral" presents the metaphor of design as a spiral process and it can be applied to model how various design elements connect. A spiral process reflects the following design features: (a) backtracking, (b) repeating, and (c) combining that permeates all the design elementary activities.

(a) The designers backtrack at certain times instead of moving forward, aiming to foster problem solving [20]. In other words, over a design project, a designer returns to the problem already studied to revise or adjust earlier decisions [1]. Every decision made by the designer, even though he considers being his final decision, generates consequences for future stages of the process, as well as the previous steps, as new problems arise as the previous decisions are reviewed [11].

(b) By repeating the same series of activities successive times, designers solve new problems, since each repetition relates to a different problem [20]. In each cycle of a design project, designers conceive, present, test and redesign answers to a set of related problems. And the time devoted by the designer to each one varies, as each activity in these cycles has not its beginning and ending at a specific point. Each contains remnants of the previous action and roots the next.

(c) Such seemingly multidirectional movements together result in a movement directed to a single action [20]. In other words, the combination among return movements, repetitions at different levels and cycles progressively connected result in a single motion directed to the goal of an acceptable projectual response.

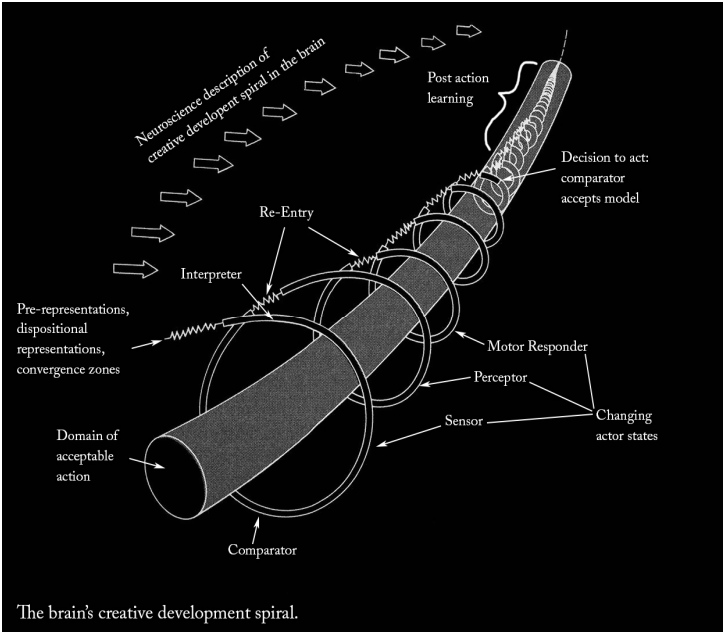


Fig. 1. Diagram "The Brain's Creative Development Spiral"[20]

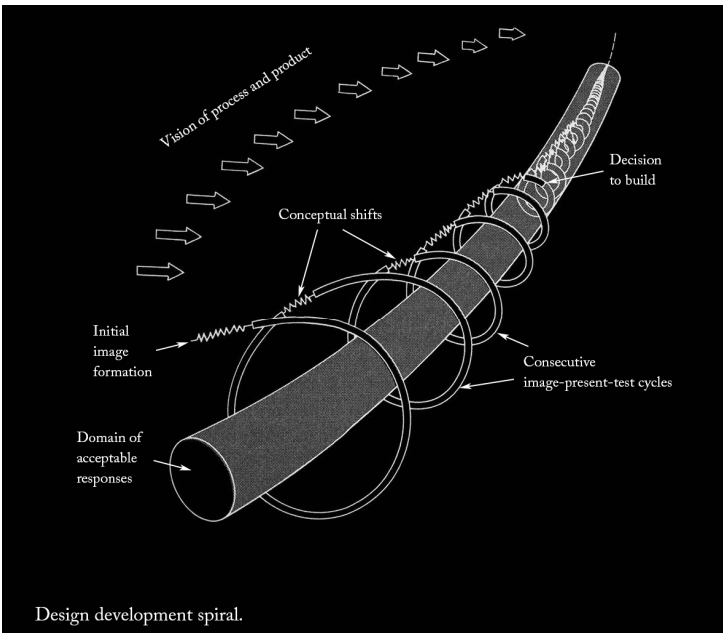


Fig. 2. Diagram "Design Development Spiral"[20]

Such brain and design development spiral as well as iterative they are also inherently interactive, since they change mutually in a process of continuous communication between the creative and cognitive spheres, which both have influence on one another. An organism forms neural representations which can become images, be manipulated in a process called thought, and influence behavior by helping predict the future, plan accordingly, and choose the next action [7], as a need to create a sense of coherence and continuity allowing the emergence of a unified belief system [16].

5 Conclusion

The design-neuroscience relationship proves to be a fruitful field of research, especially in relation to the creative and cognitive processes. In this context, the mental images play a key role in the formation of perceptions, thoughts, memories and plans, as well as in mediating between the creative and cognitive spheres of the brain and design.

From the perspective of design, three instances are outlined as basic activities that permeate the states of creation and cognition present in the design practice: imaging, presenting and testing.

As part of brain processing, these same three instances find their parallels in the mental functions of the interpreter, actor and comparator, respectively.

Such instances of design and their brain pairs articulated in a spiral flow in continuous adaptation to the stimuli from the surrounding environment in which the designer and product design are modeled each other in the actions of backtracking, repeating, and combining.

This understanding broadens the role and responsibility of the designer in front of the products designed by him, since the brain activity involved in creative and cognitive processes of design are understood as the underlying basis and at the same time, the reflection of their actions. This implies one similarity between the structure of activity of work (exterior) and the structure of mental processes (inside) [19].

Thus identifies the existence of a neuroscientific basis able to support and open innovative perspectives for projective methodologies in design, contemplating the association between creative and cognitive processes of the brain and design in the project and development of products.

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