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NICHE BUILDERS: TOWARDS ART AS META-SEMIOTIC ENGINEERING

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Niche Builders: Towards Art as Meta-semiotic Engineering

Resumo:

Este trabalho sugere uma estrutura teórica para uma Estética Cognitiva pragmaticamente orientada, baseada na Filosofia de Processos e Semiótica Cognitiva de Charles S. Peirce. Esta abordagem pouco explorada é capaz de fornecer novos métodos e premissas para a investigação da relação complexa entre obras de arte, significado, ambiente e artefatos, paradigmas artísticos, e criatividade. Nós oferecemos: (i) uma noção de criatividade artística relacionada as dinâmicas de construção de nicho cognitivo; (ii) um modelo da relação entre significado, criatividade, artefatos e nichos cognitivos; (iii) um modelo de construção de nicho cognitivo através de semiose icônica. As contribuições desta dissertação à Semiótica Cognitiva e Filosofia da Arte incluem, principalmente: a aproximação interdisciplinar entre conceitos e ferramentas teóricas oriundas da Filosofia de Processos, Semiótica, Solução Situada de Problemas, e Biologia Evolutiva; o fornecimento de uma série de análise de exemplos incluindo dança, literatura, música e tarefas de solução de problemas; a sugestação de uma estrutura conceitual para abordar fenômenos estéticos cognitivos.

Palavras-chave: Semiose, Iconicidade, Construção de nicho cognitivo, Criatividade, Filosofia da Arte

Abstract:

This work suggests a framework for a pragmatist oriented Cognitive Aesthetics based on Peirce's Process Philosophy of Signs and Cognitive Semiotics. This little explored approach is capable of providing new methods and premises for investigating the complex relationship between artworks, meaning, environment, artistic paradigms, and creativity. We provide: (i) a notion of artistic creativity as related to cognitive niche construction dynamics; (ii) a model of the relationship between meaning, creativity, artifacts and cognitive niches; (iii) a model of cognitive niche construction through iconic semiosis. The contributions of this thesis to Cognitive Semiotics and Philosophy of Art include, mainly: the interdisciplinary approximation between concepts and theoretical tools from Process Philosophy, Semiotics, Situated Problem Solving and Evolutionary Biology; the provision of a series of example analysis in dance, literature, music and in problem solving tasks; the suggestion of a conceptual framework to approach cognitive aesthetic phenomena.

Keywords: Semiosis, Iconicity, Cognitive niche construction, Creativity, Philosophy of Art

Summary

1 Introduction

1.1 Research problem

The "aesthetic complex" is a term that refers to the "multifarious aspects of the relation between an artwork (visual, literary, or musical), its objective properties, the meaningful experience of it, and the cognitive skills and acts involved in the latter" (BUNDGAARD, 2015., p. 1). The terms of this complex relationship are the objects of investigation of different disciplines: Aesthetics and Philosophy of Art, Semiotics, Linguistics, Cognitive Science, Psychology, as well as the interdisciplinary fields of Cognitive Semiotics, Cognitive Aesthetics, Empirical Aesthetics, Neuroaesthetics. The aesthetic complex is also of central interest to Social Sciences and intrinsically related to subjects such as Cultural Evolution and Creativity Research.

Our objective is to suggest an interdisciplinary framework useful for researchers of different areas and which avoids theoretical and conceptual problems commonly found in the treatment of the relationship between artworks, meaning, environment, artistic paradigms, and creativity. In order to do so, we approximate concepts and theoretical tools from Semiotics, Cognitive Science and Evolutionary Biology, and take advantage of example analyses in dance, literature, music and in problem solving tasks.

1.2 Description of our approach:

In this section we introduce the main premises of our approach. We first characterize the notions of process and substance metaphysics, claiming to adopt a more processist stance. Next, we briefly characterize the main concepts and frameworks which guide our analysis.

1.2.1 Process

This subsection briefly compares two broad traditions in western metaphysics, which are often identified as substance metaphysics and process metaphysics (SEIBT, 2016; BICKHARD, 2011; RESCHER, 1996, 2000). We approach “process” and “substance” along our investigation as frameworks for investigating phenomena. We will adopt a processist framework ourselves, which will allow us to conceive: 1- meaning (“semiosis”) as an evolutionary process (“cognitive niche construction”), 2- the action of material vehicles of meaning (“cognitive artifacts”) as causally determining and being determined by such a process, 3- the creation of novel meaning (“creativity”) as inherent to the evolutionary dynamics of the process — and thus not product of psychological features of individual agents.

Substances in substance metaphysics are basic explanatory entities, internally undifferentiated, bearers of properties and subjects of change, which are independent and durable (SEIBT, 2016; ROBINSON, 2014). Processes in process metaphysics are coordinated and systematically causally or functionally linked occurrences of changes in the complexion of reality (RESCHER, 1996, p. 38). While a substance metaphysics take unchangingness as a default condition and emphasizes the need to explain changes, a process metaphysics understands change as the default condition and emphasizes the need to explain stability (BICKHARD, 2011, p. 5). While a substance metaphysics considers unchanging substances (e.g., atoms *sensu* Democritus) as the sole or principal bearers of properties and causal powers (thus precluding emergence of new properties), a process metaphysics is inherently relational and emphasizes the centrality of properties by virtue of organization, so that the emergence of new organizations may generate new properties, including causal powers (BICKHARD, 2011, pp. 5-7).

A substance metaphysics take as paradigmatic the well-defined boundaries which individuate *things*: “a rock, for example, has several relatively clear boundaries: e.g., a phase change boundary from solid to gas, a boundary at which it can be isolated, and a boundary at which it can be pushed” (BICKHARD, 2011, p. 7). However, this easiness to individuate what constitutes a thing can only be found at a limited number of phenomena. A traditional example is that of fire (taken by the early

processist philosopher Heraclitus as the main cosmological principle). A flame has no well-defined boundaries, cannot be pushed, can be split and merged. Processists emphasize ‘mutifarious boundaries’:

> In general, instances of processes can have multifarious boundaries, but need not, and, if there *are* boundaries, they are the products of the dynamics of the process, not metaphysical necessities of existence. To illustrate further: What is the boundary of molds, fungi and the like that absorb and re-absorb one another, or of a species of population? Why do cells, individuals, species exist at all--why not a pan-biosphere enzymatic soup? Such biological examples illustrate that, not only do boundaries exist as products of the dynamics, but that there can be strong dynamic reasons for the emergence of boundaries. (BICKHARD, 2011, p. 8, emphasis in the original)

We adopt a processist stance that permeates our treatment of semiosis, cognitive artifacts, artistic creativity, and cognitive niches, emphasizing these as situated and distributed processes. Our approach takes advantage of Peirce's pragmatism and semiotics, of situated and distributed cognition, and of niche construction theory, which are briefly introduced next. The Table (Table 1) below summarizes comparatively the tendencies mentioned:

	Substantialist trend	**Processist trend**	**Our approach**
Meaning	Concepts codified in information units	A dynamic, developmental process through which signs adapt to situational constraints	Semiosis
Cognition	Internal, abstract processing of (mainly symbolic) units of meaning (e.g., classical abstract problem solving)	Situated and distributed development and manipulation of artifacts	Mind as semiosis; Semiotic theory of mind; situated problem solving
Agent	Individualized, decision-making substance or system (e.g. a subjectivity, a single mind, an autonomous cognitive system)	Emergent social persons whose decisions are causally-distributed	Niche-builder

Creativity	A rare or unusual property of some agents (e.g. a 'gift', a personality trait, a set of cognitive skills), which can cause unexpected transformations in-- or reorganization of-- units of meaning	A natural organizational property of any process (development, "emergence"), which may include properties of agents but is not caused by such properties	Exploration of opportunities for niche construction
Locus of meaning	Well-defined (e.g., concepts in the agent's brain; message encoded in an artifact)	Ill-defined, distributed, situated	Cognitive niches
Artwork	A well-defined locus for artistic meaning, due to unchangeable intrinsic particular properties, and whose genesis is related to some agent's creativity in a substantialist sense	A stable and regular pattern of semiotic multi-level systems	Meta-semiotic engineering artifact

Table 1.1: tendencies in the approach to meaning and creativity in arts

1.2.2 Peirce's Semiotics

Peirce's semiotics provides a highly processual approach to meaning and cognition. It is concerned with sign relations, the necessary and sufficient conditions for representing, and classification of different possible kinds of representation and how they merge with one another (HOUSER 1997, p. 9). Peirce has also offered a theory of mind as the action of signs (SKAGESTAD, 2004; RANSDELL, 2003), which is taken into account here in relation to the distributed cognition thesis (ATÃ & QUEIROZ, 2014). Differently from internalist views that conceive meaning as communicative intent (BACH, 1999), Peirce’s pragmatic semiotics tells us that meaning (semiosis) is not an infused concept, but a power to engender interpretants (effects on interpreters). In concert with this idea, semiosis is a triadic, context-sensitive (situated), interpreter-dependent (dialogic), materially extended (embodied and distributed) dynamic process. It emphasizes process and development (QUEIROZ & EL-HANI, 2006). It cannot be dissociated from the notion of a situated agent (potential or effective). It is context-sensitive in the sense that it is determined by the network of communicative events within which the interpreting agents are immersed with the signs (QUEIROZ & MERRELL, 2009). It is both interpreter-dependent and objective, but is not a thing or an entity. Meaning is not in the sign, in

some semiotic-head (intracranial or neuronally-based system of signs or symbols), in the referent of the sign, or in the medium by which the sign is transmitted to its potential receiver and interpreter.

1.2.3 Situated and Distributed Cognition

Situated and Distributed Cognition take external artifacts to be a constitutive part of cognitive processes (CLARK, 1998, 2008 HUTCHINS, 1995, KIRSH, 2009). This position is formulated in the "parity principle":

> If, as we confront some task, a part of the world functions as a process which, were it to go on in the head, we would have no hesitation in accepting as part of the cognitive process, then that part of the world is (for that time) part of the cognitive process. (CLARK & CHALMERS, 1998, p. 8)

Cognitive tasks are functionally decomposed in more or less independent interactive loops between agent and environment, in which the spatial and physical properties of the environment and external artifacts are used to perform part of the task. In this sense, to give some examples, spatial arrangements can simplify choice (e.g., orderly arranging ingredients in the kitchen), perception (e.g. rearranging puzzle pieces on a surface paying attention to color patterns) and computation (e.g., using a slide ruler) (CLARK, 2008).

Situated and distributed cognition help us to conceive cognitive processes (and artistic creativity, in especial) as materially- bodily- culturally- and socially- extended processes.

1.2.4 Problem solving

A framework for investigating cognitive agency. Problem solving implicates the notion of a formal structure of a problem, composed of problem states (including an initial and an end state) and rules for moving between states (NEWELL & SIMON, 1972). Although the problem solving paradigm was born in relation to the classical cognitivist paradigm of cognition as processing of information units, we stress here two processual characteristics relevant for our approach: first, it conceives action as

space of possibilities governed by and partly determined by identifiable rules of organization; second, it conceives action as telic, goal-oriented. As Rescher points out, teleological agency is a point of contact that renders process and pragmatism to stand in "fruitful symbiosis":

> Pragmatism is concerned with teleologically efficient agency, and purposive agency is always a matter of procedure and process. In its concern for agency, pragmatism looks inevitably to procedural processes. (RESCHER, 2000, p. 47)

1.2.5 Niche construction

In biology, the niche of an organism indicates its ecological role and way of life. Niche Construction Theory (SCOTT-PHILLIPS ET AL. 2013; ODLING-SMEE ET AL. 2003) stresses the transformation of niches by organisms as having a major role in evolution, establishing a non-genetic system of inheritance that shapes selective pressures creating a feedback loop between organisms and niches. We suggest that this biological evolutionary process can be adapted to serve as a model for cultural evolution and meaning development, avoiding the main problems usually found in attempts to use darwinian evolution as a metaphor for cultural evolution (see GABORA, 2015). In this case, we are dealing with cognitive (or semiotic) niche construction: interpreting minds (analogous to the organisms in ecological niche construction) act locally according to sets of opportunities and boundaries for the generation of meaning, their action frequently alters these sets, which in turn feedbacks into the interpretation activity and the mind. An inherently relational and organizational notion, cognitive niche construction is used, in our argumentation, to conceptualize the spatial and temporal distributedness and situatedness of semiotic activity, acting as the *loci* of habits (regularity of behavior, which is historically dependent). It is the central theoretical tool used to frame the evolution of meaning, and, thus, creativity.

1.3 Chapter Overview

This thesis is composed of the pre-print version[1] of seven papers, besides this Introduction and a Conclusion. Each of the papers was originally written for a specific journal or book, and not to appear together. The Introduction and Conclusion consist in a meta-analysis of the arguments developed throughout the seven chapters. Table 1.2 below summarizes the examples analyzed and contributions of each chapter to the overall argument of the thesis, as well as indicates their original place of publication. The following subsections briefly introduce each of the chapters.

Chapter	Example(s) analyzed	Contribution to the overall argument	Published (with the same title) as...
2. Habit in semiosis: Two different perspectives based on hierarchical multilevel system modeling and Niche Construction Theory	Mainly theoretical discussion	Relates the notions of habit, multi-level systems and cognitive niche construction, all of which are of central relevance in the further chapters.	Atã, P., & Queiroz, J. (in press). In D. E. West & M. Anderson (Eds.), Consensus on Peirce's Concept of Habit: Before and Beyond Consciousness. Springer.
3. Icon and Abduction Situatedness in Peircean Cognitive Semiotics	Tower of Hanoi puzzle	Iconicity externalizes rules of a formal structure of a problem; abductive inference takes advantage of such externalization	Atã, P., & Queiroz, J. (2014). In L. Magnani (Ed.), Model-Based Reasoning in Science and Technology (Vol. 8, pp. 301–313). Springer Berlin Heidelberg.
4. Iconic semiosis and representational efficiency in the London Underground Diagram	The London Underground Diagram	The object of a sign is not a 'thing', but a problem space; meaning of a problem space enables cognitive niche construction	Atã, P., Bitarello, B. & Queiroz, J. (2014). Cognitive Semiotics, 7(2), 177–190.
5. Semiotic niche construction in musical meaning	conceptual metaphors of motion in music	The locus of semiotic forms are not agents nor artworks, but semiotic (cognitive) niches	Atã, P. & Queiroz, J. (in press). Recherches sémiotiques Semiotic inquiry

[1] Please note that some formatting guidelines, including reference formatting, follow the pre-print manuscript preparation rules of their respective journals and books.

6. Creativity as niche construction and some examples in theatrical dance	classical ballet, Merce Cunningham, post-modern dance	The emergence of artistic paradigms is related to the introduction or transformation of cognitive artifacts	Aguiar, D. Atã, P. & Queiroz, J. (in press). Proceedings of the 10th International Brazilian Meeting on Cognitive Science.
7. Intersemiotic translation and transformational creativity	Gertrude Stein	Intersemiotic translation constitutes an important strategy for transforming cognitive niches through "importation" of artifacts from other cognitive niches	Aguiar, D., Atã, P. & Queiroz, J. (in press). Punctum (http://punctum.gr/)
8. Poetry translation: An open-source platform for epistemic engineering	Augusto de Campos' translation of John Donne's poem "The Expiration"	A poem functions as an experimental lab for experimenting with language through manipulation of multi-level constraints	Unpublished. Recently submitted to a journal

Table 1.2: The chapters that compose this thesis consist of papers originally published elsewhere. Their place of original publication, contribution to the overall argument and examples analyzed are indicated in the table.

1.3.1 Habit in semiosis: Two different perspectives based on hierarchical multilevel system modeling and Niche Construction Theory

This chapter (chapter 2) relates three important theoretical tools employed throughout this thesis: habits, multi-level hierachical systems and cognitive niche construction. The three consist in ways to conceptualize organizations and relations: Peirce's habit is regularity of action, mediated by semiotic activity; Stanley Salthe's hierarchical multi-level system is a model for emergent, complex processes; cognitive niche construction is a model for self-constructed evolutionary processes. We argue that habits can be modelled as a macro-level of Salthe's system, and also as cognitive niches. Both of these notions regard organization in time through accumulation of interactions. As the notion of a habit is central to our Peircean-based conception of meaning, a consequence of our argument in this chapter is that meaning processes are inherently development, evolutionary and temporally-distributed.

1.3.2 Icon and Abduction: Situatedness in Peircean Cognitive Semiotics

This chapter (chapter 3) relates iconicity and abductive inference to situatedness and distributedness of reasoning. It uses the frameworks of situated problem solving and of Peirce's semiotics and Semiotic Theory of Mind, and proceeds through meta-analysis of Zhang & Norman's (1994) experiments in situated problem solving with isomorphs of the Tower of Hanoi puzzle game. The puzzle game has a formal structure composed by a set of rules. The isomorphs used in the experiment analyzed differ in how many of these rules need to be provided as written instructions for the players and how many are already embedded in the material of play itself (as physical incapacity to move the pieces unless according to the rules). This physical embedment of a formal structure in the material of play is termed *externalization of constraints*. The chapter's conclusions is that iconicity can be conceptualized in situated problem solving as externalization of the constraints of the formal structure of a problem. In turn, abductive inferences are present in moving the pieces according to the rules in an attempt to win the game, so that the iconic externalization of constraints positively impacts abductive inference in the problem-solving task.

1.3.3 Iconic semiosis and representational efficiency in the London Underground Diagram

This chapter (chapter 4) proceeds from the previous conclusion that representational efficiency is related to iconicity as externalization of constraints. We analyze a well-known example of representational efficiency, Henry Beck's diagram of the London Underground System (London Underground Diagram -- LUD). We provide a comparison between a geographically more accurate, but less efficient representation of the London Underground System. If efficiency is a matter of iconicity, and if the LUD is more efficient than older, geographically more accurate maps of the Underground System, then how the transition from a geographically more accurate map to Beck's diagram has transformed the iconicity of the signs used? After introducing different notions of iconicity (in especial Stjernfelt's operational and optimal iconicity), and considering that geographically more accurate maps are more operationally iconic and less 'optimally' iconic than the

LUD, the chapter reaches its central argument, which is that the Object of the LUD as a Sign is a particular user experience, and not the Underground System itself.

1.3.4 Semiotic niche construction in musical meaning

This chapter (chapter 5) deals with the problem of location of meaning. If semiosis is necessarily situated and distributed, where does it happen? We depart from the common usage in examinations of musical meaning of notions such as "schemas, patterns, templates, and conceptual metaphors", that is, meaningful structures that frame musical cognition. All of these notions can be understood as 'semiotic forms' being mediated by musical signs. Does that mean that such forms are localized in the musical pieces themselves? We argue that the locus of such forms are not musical pieces, nor the environment, but can be better captured by the notion of a semiotic niche.[2]

1.3.5 Creativity as niche construction and some examples in theatrical dance

This chapter (chapter 6) formulates the perspective that creativity is a property of cognitive niche construction. This process involves the transformation of problem spaces, through the exploration and design of cognitive artifacts. More specifically, creativity is distributed in cognitive niches as opportunities for niche construction. We briefly analyze three examples in which the introduction of artifacts has lead to the emergence of a new dance paradigm: the development of classical ballet as related to the new design of stages, Merce Cunningham's innovations as related to the introduction of chance artifacts in choreography and postmodern dance as related to the introduction everyday objects and locations as dance artifacts. In all of these examples, the materially-embedded habits of semiotic resources have constrained semiotic activity, transforming problem spaces.

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[2] The notion of 'semiotic niche' corresponds in many respects to that of 'cognitive niche', differing mainly in terms of emphasis (whether in cognitive processes or in the meaning of artifacts). Note that according to Peirce's Cognitive Semiotics, cognition is defined as semiosis and there cannot be cognition without signs.

1.3.6 Intersemiotic translation and transformational creativity

This chapter (chapter 7) examines the phenomenon of intersemiotic translation (IT) in creativity. which we characterize as the communication of habits between conceptual spaces. We take advantage of Margaret Boden's typology of creativity and suggest IT is a paradigmatic case of transformational creativity (the most radical type of creativity, in which a conceptual space is transformed). Among many well-known cases of IT whose results are recognized as highly creative, we briefly analyze Gertrude Stein's intersemiotic translation of Cézanne and Picasso's compositional techniques from painting to literature. A consequence of this suggestion is that creativity can be understood as a mediation of interpretative constraints (see XX Niche Builder in the Conclusion). Another important consequence is the suggestion of intersemiotic translation as a major process in the evolution of artistic paradigms.

1.3.7 Poetry translation: An open-source platform for epistemic engineering

This chapter (chapter 8) looks more closely at what constitutes a habit in a cognitive artifact and how the mediation of a habit works. The cognitive artifact in question is the poem, which is characterized as a multi-level system of constraints capable of submitting language to unusual behavior (thus being termed a 'lab' for language experiments). An example of a multi-level constraint is the sound of a poem influencing on its syntactical construction. A good example of the mediation of the habit of a poem is poetry translation. We analyze Augusto de Campos' translation of a poem by John Donne, and model it as a situated problem solving task, in which what is being translated are not 'elements' of any level the source-poem per se, nor any kind of 'message' conveyed by the source-poem, but rather multi-level constraints: determinative relations between levels, internal habits of action of the poem.

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2 Habit in semiosis: Two different perspectives based on hierarchical multi-level system modeilng and Niche Construction Theory[3]

Abstract: Habit in semiosis can be modeled both as a macro-level in a hierarchical multi-level system where it functions as boundary conditions for emergence of semiosis, and as a cognitive niche produced by an ecologically-inherited environment of cognitive artifacts. According to the first perspective, semiosis is modeled in terms of a multilayered system, with micro-structural functional entities at the bottom and with higher-level processes being mereologically composed of these lower-level entities. According to the second perspective, habits are embedded in ecologically-inherited environments of signs that co-evolve with cognition. Both descriptions offer a novel approximation between Peirce's semiotics and theoretical findings in other areas (Hierarchy Theory and Evolutionary Biology), suggesting new frameworks to approach the concept of habit and its role in semiosis.

2.1 Introduction

We present here two different approaches of habit in semiosis: as a macro-level in a hierarchical multi-level system, where it functions as boundary conditions for emergence of semiosis; and as a cognitive niche produced by ecological and environmental inheritance of cognitive artifacts. According to the first approach, Peirce's semiosis can be modelled in terms of a hierarchical multi-level system of constraints. In our description, semiosis is modeled in terms of a multilayered

[3] To be published as: Atã, P., & Queiroz, J. (in press). Habit in semiosis: Two different perspectives based on hierarchical multi-level system modeilng and Niche Construction Theory. In D. E. West & M. Anderson (Eds.), *Consensus on Peirce's Concept of Habit: Before and Beyond Consciousness*. Springer.

system, with micro-structural functional entities at the bottom and with higher-level processes being mereologically composed of these lower-level entities (Queiroz and El-Hani 2006, 2012). According to the second approach, habits are embedded in ecologically-inherited environments of signs that co-evolve with cognition.

Peirce's semiotics is grounded on a list of logical-phenomenological categories – Firstness, Secondness, Thirdness – which corresponds to an exhaustive system of hierarchically organized classes of relations (Houser 1997). This system makes up the formal foundation of his model of semiosis as a process and of his classifications of signs (Murphey 1993: 303-306). Firstness as a mode of being is related to the modality of possibility. It is the category of vagueness and novelty — "the mode of being which consists in its subject's being positively such as it is regardless of anything else. That can only be a possibility" (CP 1.25). Secondness is the mode of being "which is as it is relatively to a Second but regardless of any Third." It is a kind of reaction (CP 6.200). Like Firstness, Secondness can be related to a modality, namely, the modality of actuality (CP 6.455; Parker 1998). The actuality of a thing is simply its occurrence. Rephrased, actuality is the realization of a possibility, without thereby making reference to something larger, be that a general law or an interpretation. Peirce considered "the idea of any dyadic relation not involving any third as an idea of secondness" (CP 8.330). Thirdness is the category of mediation, habit, generality, and conceptualization (CP 1.340). The example par excellence is Peirce's semiotic process (semiosis) in which a sign is related to an object by mediation through an interpretant.

According to Peirce, any description of semiosis should necessarily treat it as a relation constituted by three irreducibly connected terms (sign-object-interpretant, S-O-I), which are its minimal constitutive parts (CP 5.484; EP 2:171; Atkin 2016: 131). Peirce also defines a sign as a medium for the communication of a form or habit embodied in the object to the interpretant, so as to constrain (in general) the interpretant as a sign or (in cognitive systems) the interpreter's behavior (De Tienne 2003; Hulswit 2001; Bergman 2000; Queiroz and El-Hani 2006b). The notion of semiosis as form communicated from the object to the interpreter through the mediation of the sign allows us to conceive meaning in a telic, processual, non-

substantive way, as a constraining factor of possible patterns of interpretative behavior through habit and change of habit.

2.2 Stanley Salthe's model and semiosis

Queiroz & El-Hani (2012, 2006) have modelled semiosis through a hierarchical multi-level system model (Stanley Salthe's hierarchical structuralist model). Salthe's model separates complex processes in a hierarchical structure of levels. The author emphasizes that, in order to describe the fundamental interactions of a given process, we need (i) to consider it at the level where we actually observe it (focal level), (ii) to investigate it in terms of its relations to its parts, at a lower level (usually, but not necessarily always, the next lower level -- micro-level), and (iii) to take in due account entities or processes at a higher level, in which the focal entity or process is embedded (macro-level). Both the lower and the higher levels have constraining influences over the dynamics of the processes at the focal level. These constraints allow us to explain the emergence of processes (e.g., semiosis) at the focal level. At the micro-level, the constraining conditions amount to the *possibilities* or initiating conditions for the emergent process, while constraints at the higher level are related to the role of a (selective) environment played by the entities at this level, establishing the boundary conditions that regulate the dynamics at the focal level. In this model, an emergent process at the focal level is explained as the product of an interaction between processes taking place at lower and higher levels. The phenomena observed at the focal level should be "… among the possibilities engendered by permutations of possible initiating conditions established at the next lower level" (Salthe 1985: 101). Nevertheless, processes at the focal level are embedded in a higher-level environment that plays a role as important as that of the lower-level and its initiating conditions. Through the temporal evolution of systems at the focal level, this environment or context selects, among the states potentially engendered by the components, those that will be effectively actualized. Figure 2.1 shows a scheme of the determinative relationships in Salthe's basic triadic system.

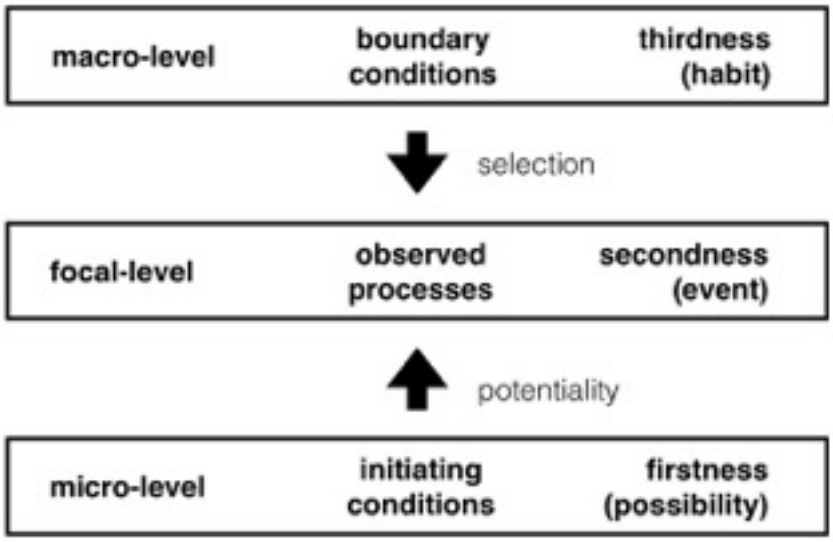

Figure 2.1: A scheme of the determinative relationships in Salthe's basic triadic system in relation to Peirce's categories. A habit (Thirdness) is associated with the macro-level of the observed phenomenon, performing a selection, through boundary conditions, of potentialities which exist in the micro-level (associated with Firstness). The interaction between micro- and macro-level lead to the emergence of processes as observed in a focal-level (associated with Secondness)

2.3 Habit and semiosis

A habit is a 'pattern of constraints', a "conditional proposition" stating that certain things would happen under specific circumstances (EP 2.388), a "rule of action" (CP 5.397, CP 2.643), a disposition to act in certain ways under certain circumstances, especially when the carrier of the habit is stimulated, animated, or guided by certain motives (CP 5.480), or, simply, a "permanence of some relation" (CP 1.415).

> … all things have a tendency to take habits. For atoms and their parts, molecules and groups of molecules, and in short every conceivable real object, there is a greater probability of acting as on a former like occasion than otherwise. This tendency itself constitutes a regularity, and is continually on the increase. In looking back into the past we are looking toward periods when it was a less and less decided tendency. But its own essential nature is to grow. It is a generalizing tendency; it causes actions in the future to follow some generalization of past actions; and this tendency is itself something capable of similar generalizations; and thus, it is self-generative. (CP1.409, circa 1890, from 'A guess at the riddle', reprinted in EP1: 277).

A habit involves a general 'would be' relation, which is not reducible to any number of its instances:

> …by a Habit I shall mean a character of anything, say of B, this character consisting in the fact that under circumstances of a certain kind, say A, B would tend to be such as is signified by a determinate predicate, say C. (MS [R] 681:22)
>
> …no agglomeration of actual happenings can ever completely fill up the meaning of a 'would-be'. (EP 2:402; CP 5.467)
>
> …no collection whatever of single acts, though it were ever so many grades greater than a simple endless series, can constitute a would-be, nor can the knowledge of single acts, whatever their multitude, tell us for sure of a would-be. (1910 | Note (Notes on Art. III) [R] | CP 2.667

Semiosis can be defined as the mediation of the self-generated regularity of habits, and a Sign can be defined as the vehicle of such mediation. That is, a Sign is something which communicates a "form", or habit which is embedded in another thing (an Object), generating a constraining factor in interpretative behavior (called an Interpretant) (see Queiroz and El-Hani 2004). Note that in Peirce's work, the notion of habit is very similar to that of "form". As Stjernfelt (2007: 37-38) notes, Peirce splits a same notion in two, with form being a "mere possibility", "anterior to anything actual", and habit referring to an already generalized possibility which governs actual occurrences. That is, "form as mere possibility in Firstness, anterior to anything actual, and form as realized possibility in Thirdness, where it governs Secondness in the shape of habits." (Stjernfelt 2007: 37-38)

> […] a Sign may be defined as a Medium for the communication of a Form. [...]. As a medium, the Sign is essentially in a triadic relation, to its Object which determines it, and to its Interpretant which it determines. [...]. That which is communicated from the Object through the Sign to the Interpretant is a Form; that is to say, it is nothing like an existent, but is a power, is the fact that something would happen under certain conditions (MS 793:1-3. See EP 2.544, n.22, for a slightly different version).

We will refer to this irreducibly triadic relation as S–O–I (see Figure 2.2). The irreducibility indicates a logical property of this complex: the sign process must be regarded as associated to the interpretant, as an ongoing process of interpretation

(Hausman 1993), and is not decomposable into any simpler relation (CP 5.484). For Peirce, “what a thing means is simply what habits it involves” (CP 5.400). It is a form embedded in the Object which allows a semiotic system to interpret the sign as indicative of a class of entities or phenomena (Queiroz and El-Hani 2006). Meaning is conceived, without any reference to psychological entities, as a constraining factor (S) in possible behavior (I) determined by a regularity of behavior previously embedded elsewhere (O). These are functional, interchangeable, roles: that which functions as a Sign in a given analytical description of the semiotic process could possibly be described as an Object, or an Interpretant, in another analysis. Note that the effect that characterizes the Interpretant does not necessarily act on an individual mind, but also, for example, on a social group or a culture (Bergman 2005: 218).

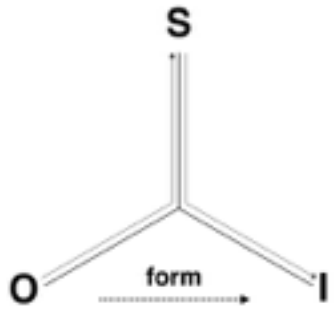

Figure 2.2. Semiosis as a relation between three irreducibly connected terms (sign-object-interpretant, S-O-I). This triadic relationship communicates/conveys a form from the object to the interpretant through the sign (symbolized by the horizontal arrow). The other two arrows indicate that the form is conveyed from the object to the interpretant through a determination of the sign by the object, and a determination of the interpretant by the sign.

2.4 Processualism and emergence in semiosis

This notion of semiosis as the mediation of a regularity of action allows us to conceive meaning in a processual, non-substantialist way: Substances in substance metaphysics are ontologically basic entities, internally undifferentiated, bearers of properties and subjects of change, which are independent and durable (Seibt 2016; Robinson 2014). In opposition to such notion, processes in process metaphysics are coordinated and systematically causally or functionally linked occurrences of

changes in the complexion of reality (Rescher 1996: 38). While a substance metaphysics take unchangingness as a default condition and emphasizes the need to explain changes, a process metaphysics understands change as the default condition and emphasizes the need to explain stability (Bickhard 2011: 5). While a substance metaphysics considers unchanging substances (e.g., atoms sensu Democritus) as the sole bearers of properties and causal powers (thus precluding emergence of new properties), a process metaphysics is inherently relational and considers that some properties are presented by processes by virtue of organization, so that the emergence of new organizations may generate new properties, including causal powers (see Bickhard 2011: 5-7).

Take the example of an entity with ill-defined boundaries:

> If a cloud vortex produces a tornado, which then retracts, and then a funnel descends from the same cloud vortex, how many instances of a tornado process are involved? In terms of criteria of ground level damage, there are two (or more), but, in terms of criteria of locus of self-organization, there may be only one (the wind shear and consequent roll that produces the cloud vortex). (Bickhard 2011: 8)

Consider “tornado” as a sign (S). It can either refer to the funnels produced by a cloud vortex (possibility A, so that the O of S is A), or to the cloud vortex itself (possibility B, so that the O of S is B). Take a dyadic description (S-A, or S-B) of the tornado sign. Such description has no explanatory consideration whatsoever of why S is connected to either A or B. It is not sufficient to say that the sign tornado is dyadically connected to some entity in the world: the connection itself depends on criteria which are irreducible to the explanation of the relation of meaning. A dyadic account of the meaning of the sign “tornado” is not explanatorily powerful. Now consider Peirce’s pragmaticist model as described above: in this case the meaning process is interpretant-dependent, that is, it produces effects. In this case A and B are described as follows (Figure 2.3):

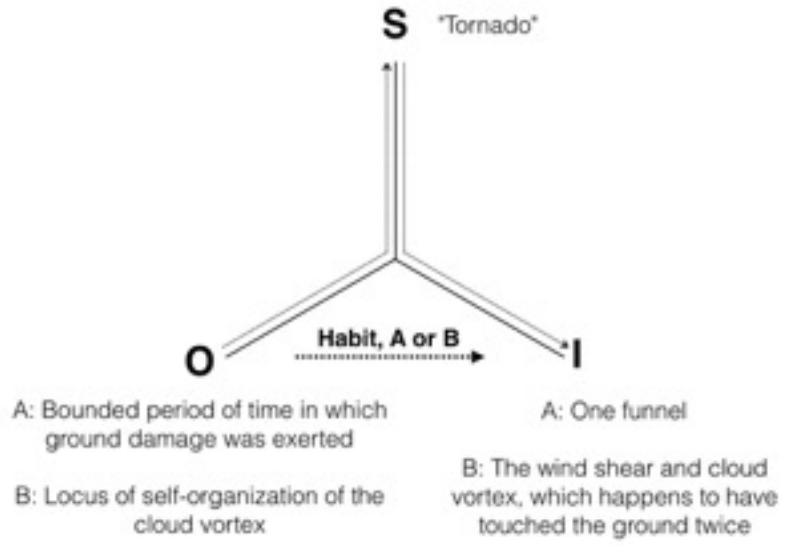

Figure 2.3: For the same sign ("Tornado") and the same observed phenomenon, there are two distinct possibilities for what constitutes the Object and the Interpretant of the semiotic process. However, these possibilities cannot be freely combined: the fixation of an Object determines an Interpretant and vice-versa, by virtue of a habit.

This example illustrates the emergence of a semiotic process: the selection of either A or B is dependent on a habit (A or B) embedded in the Object and which constrains the semiotic process. The emergence of semiosis can be modelled according to Salthe's model: consider the assumption that semiosis is a dynamical process that happens in time. Hence, each new triad is appended to the chain of triads. As Savan (1986: 134) argues, an Interpretant is both the third term of a given triadic relation and the first term (Sign) of a subsequent triadic relation. This is the reason why semiosis cannot be defined as an isolated triad; it necessarily involves chains of triads (see Merrell 1995) (see Figure 2.4).

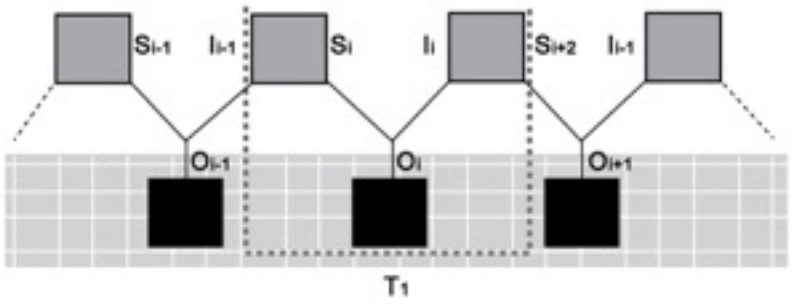

Figure 2.4: The triadic relation S-O-I forming a chain of triads.

Following Salthe's model, this dynamical semiotic process can be described at three levels (see Queiroz and El-Hani 2006). The focal-semiotic level is the level in which a given semiotic process is observed. Semiotic processes at the focal level are described as the chains of triads themselves. The micro-semiotic level concerns the relations of determination that may take place within each triad S-O-I. The relations of determination provide the way the elements in a triad are arranged in semiosis: the Interpretant is determined by the Object through the mediation of the Sign (I is determined by O through S) (MS 318:81). This is a result from two other determinative relations: the determination of the Sign by the Object relatively to the Interpretant (O determines S relatively to I), and the determination of the Interpretant by the Sign relatively to the Object (S determines I relatively to O) (De Tienne 1992). Finally, the macro-semiotic level concerns the historically-constructed environment of networks of chains of triads, in which each individual chain is embedded. Focal-level semiosis will emerge as a process through the interaction between micro- and macro-semiotic processes, i.e., between the relations of determination within each triad and the embedment of each individual chain in a whole network of Sign processes, which take the form of habits in individual semiosis.

Habits exert a downward effect on the spatiotemporal distribution of lower-level semiotic items. In the "Tornado" example above, the two possibilities of S-O-I triads regarding the sign "Tornado" are present in the micro-semiotic level. In the macro-semiotic level there is a historically established network of chains of triads which constitutes boundary conditions for the use of the "Tornado" sign according to certain situations. This corresponds to a habit, a regularity of action, embedded in the Object and to which the sign refers.

2.5 Evolution of habits as cognitive niche construction

The notion of habit emphasizes that the emergence of meaning is dependent on context and history: these are a necessary condition for and a constitutive part of semiosis. Emergence entails that habits historically unfold and evolve, so that meaning is a temporally-situated evolutionary process. As habits can be embedded on the material properties of signs, such process is also materially-distributed.

Recently, the distributed cognition and extended mind approach (see Clark and Chalmers 1998, Clark 1998) have questioned the legitimacy of skin and skull to serve as criteria for the demarcation of the boundaries between mind and the outside world. According to this thesis, various tools such as pen and paper, calculators, calendars, maps, notations, models, computers, shopping lists, traffic signals, measurement units, etc, are considered non-biological extensions of the cognitive system that allow cognitive operations external to the skull (Hutchins 1999, 1995). In this sense, they are called cognitive artifacts. On the one hand, cognitive artifacts impact cognitive performance: they may reduce the cognitive cost of an operation (such as when using a calculator to perform a division), increase its precision and efficiency (such as using a ruler to measure an object instead of just guessing its dimensions), or allow new capabilities that would be impossible to the brain alone (such as using a graphical diagram to represent the simultaneous relation between a large number of entities and infer specific visual patterns from it). On the other hand, cognitive artifacts also influence the environmental opportunities and demands for certain types of cognitive performance, i.e., they participate in the creation of new problems and problem-spaces. Language, for example, is a powerful cognitive artifact (Clark 1998, 2005, 2006) which sets new demands and opportunities related to memory, perception, navigation, forms of generalization and categorization, modes of inference, etc. We treat here all kinds of cognitive artifacts as signs: they all necessarily constrain interpretative behavior (for example, performance in a materially-extended cognitive task) according to a certain possessed regularity of action.

Cognitive artifacts are ecologically inherited: they become part of the environment where cognition takes place, and changes in such an environment of artifacts are legated to later generations. This cumulative process is evolutionary in an ecological (and not genetic) sense. Evolution in this case is matter of (semiotic) niche construction. In biology, the niche of an organism indicates its ecological role and way of life. A niche is an imaginary n-dimensional hypervolume whose axes correspond to several ecological factors for the welfare of the organism (Hoffmeyer 2008). Recently, Clark (2006: 370) suggested that we are immersed in cognitive niches structured by language -- “by materializing thought in words, we structure

our environments, creating ‘cognitive niches’ that enhance and empower us in a variety of non-obvious ways”.

A niche is dynamic, it develops and transforms over time. This transformation is often caused by ecosystem engineers (Jones et al. 1994) that alter their environment and ecosystem. Niche Construction Theory (Scott-Phillips et al. 2013; Odling-Smee et al. 2003) stresses the transformation of niches by organisms as performing a major role in evolution, establishing a non-genetic system of inheritance that shapes selective pressures creating a feedback loop between organisms and niches. For Laland and O’Brien (2011: 192-193) niche construction “should be thought of as the dynamical products of a two-way process involving organisms both responding to ‘problems’ posed by their environments and solving some of those problems, as well as setting themselves some new problems by changing their environments through niche construction”. The notion of *cognitive* niche construction emphasizes the ecological evolutionary nature of cognition. For Clark (2008: 62-63), cognitive niche construction is a process of transformation of problem spaces by building physical structures that, combined with appropriate culturally transmitted practices, enhances problem solving or even make possible new forms of thought. In our approach, the cognitive niche is the locus in which habits become available for semiosis.

To exemplify the relation between niche construction and habit, consider the widely known London Underground Diagram (LUD) (see Atã and Queiroz 2014) (see Figure 2.5). Today, adapted versions of this diagram are present in virtually every major city in the world. The LUD has established an international paradigm on how to perform simple decision-making tasks regarding networks of stations and lines. The original version of the LUD was created by the Henry C. (Harry) Beck in 1933. Beck’s design was based upon electrical circuit diagrams, which omit or falsify the relative physical position of wires in order to convey information about connectivity. Beck saw a similarity with the underground railway network in that it was possible to ignore the geographical information altogether and remove some of the sources of confusion in the previous, more literal maps. Some of the strategies, needs and preferences of users may not be supported by the design choices of the LUD: trying to figure out which station is closer to a particular street, for example. The set of potentialities for

action that a representation designed specifically for solving problems of navigation in the underground system embeds is only one between many other possible sets that might be derived from the system: that of a mechanic trying to locate a particular electrical fault in the system, for example. The set of potentialities that the LUD offers is a crucial part of any description or characterization of how thousands of commuters and tourists (but not mechanics, in this context), relate to the London Underground System everyday. This habit of action is a constitutive part of the cognitive niche of Londoners. The LUD is a mediator of this habit of action and an important artifact in Londoners' niche construction process.

Figure 2.5: The London Underground Diagram as we know it today, is an adaptation of Beck's original 1930's design which introduced the straight lines meeting at 45 and 90 degrees angles and a representation of subway lines and regularly spaced blobs and ticks as a representation of stations. This diagram communicates a habit of action for thousands of underground users everyday. It is part of the cognitive niche of Londoners.

2.6 Conclusion

We have presented two different perspectives of habit in semiosis: as macro-level in a hierarchical structure where it functions as boundary conditions for emergence of semiosis; and and as a cognitive niche produced by ecological and environmental inheritance of cognitive artifacts. The first perspective constitutes a model to study the process of the emergence of semiotic processes, which allows a better understanding how habits participate in semiosis. This conceptual tool is very appropriate to describe semiosis as a complex phenomenon. The second perspective relates habit with niche construction. In this case, habit functions as an explanatory component for the co-evolution of environment and cognition. We have elsewhere stressed Peirce as an early situated and distributed cognition proposer (Atã and Queiroz 2014). The ecological mechanism of inheritance conceptualized by the notion of cognitive niche is a necessary requisite for cognitive processes in a similar sense that the regularity of action conceptualized by the notion of habit as a requisite for semiosis. Both constitute processual strategies to approach meaning phenomena that emphasize their temporal situatedness and distributedness.

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3 Icon and Abduction Situatedness in Peircean Cognitive Semiotics[4]

Abstract: Differently from the anti-cartesianism defended by some embodied-situated cognitive scientists, which is predominantly anti-representationalist, for C. S. Peirce, mind is semiosis (sign-action) in a dialogical form, and cognition is the development of available semiotic material artifacts in which it is embodied as a power to produce interpretants (sign-effects). It takes the form of development of semiotic artifacts, such as writing tools, instruments of observation, notational systems, languages, and so forth. Our objective in this paper is to explore the connection between a semiotic theory of mind and the conception of situatedness and extended mind through the notions of iconicity and abductive inference, taking advantage of an empirical example of investigation in distributed problem solving (Tower of Hanoi).

3.1 Introduction

Charles S. Peirce can be considered an important precursor of situated mind and distributed cognition thesis. But differently from the anti-cartesianism defended by some embodied-situated cognitive scientists, which is predominantly anti-representationalist, as recently explored in a Merleau-Pontyan [1], Heidegerian [2], or a Gibsonian [3] trend, for Peirce, mind is semiosis (sign action) in a dialogical—hence communicational—materially embodied form, and cognition is the development of available semiotic material artifacts in which it is embodied as a power to produce interpretants. It takes the form of development of semiotic artifacts, such as writing tools, instruments of observation, notational systems,

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languages, and so forth, as stressed by Skagestad [4] with respect to the concept of intelligence augmentation.

Although only recently a more systematic discussion upon the distributed nature of the mental processes have been established in empirical fields (e.g. neurocognitive science, artificial intelligence), the philosophical basis of this thesis and its variations have well-known predecessors. Among them, the most quoted are William James, Wittgenstein, John Dewey, James Gibson, Vigotsky, Merleau-Ponty, Heidegger (see [2, 5]). However, Charles Sanders Peirce, the least mentioned among the pragmatists in this context, can be considered an avant-garde situated and embodied cognition proposer. In Peircean Semiotic Theory of Mind the fundamental unit of cognitive interest is reconceived—disembodied mind is replaced by environmentally embedded space of semiotic skills and artifacts.

Our objective in this work is to explore the connection between a semiotic theory of mind and the conception of situatedness through the notions of iconicity and abductive inference, taking advantage of an empirical example of investigation in distributed problem solving (Tower of Hanoi). In the following sections we introduce: (i) the basic semiotic relations that ground a semiotic theory of mind, (ii) the notions of iconicity and abductive inference as specially near to the conceptualization of situatedness and distributedness of reasoning, (iii) the experiment of the Tower of Hanoi, conducted by Zhang and Norman [6], analyzed through the framework provided.

3.2 Semiosis and Semiotic Theory of Mind

Peircean approach of semiotic processes (semiosis) is related to formal attempts to describe cognitive processes in general. This framework provides: (i) a pragmatic model of semiosis, (ii) a conception of mind as a sign-interpretation process (see [7]), and (iii) a list of fundamental varieties of representations based on a theory of logical-phenomenological categories.

According to the Peircean model, a meaning process involves a relational complex constituted by three terms irreducibly connected—Sign, Object and Interpretant (S–

O–I). The irreducibility indicates a logical property of this complex: the sign process must be regarded as associated to the interpretant, as an ongoing process of interpretation [8], and is not decomposable into any simpler relation (CP 5.484). Peirce also defines a sign as a medium for the communication of a form or habit embodied in the object [9, 10]. This form is communicated to the interpretant, so as to constrain (in general) the interpretant as a sign or (in biological systems) the interpreter's behavior. The object of sign transmission is a habit (a regularity, a rule of action, or a 'pattern of constraints') embodied as a constraining factor of interpretative behavior—a logically 'would be' fact of response. The habit embodied in the object allows a semiotic system to interpret the sign as indicative of a class of entities or phenomena [11]. Meaning and meaning change are conceived as a constraining factor of possible patterns of interpretative behavior through habit and change of habit. The mediation of a sign results in a consistent relationship between variations in the form of the object and the corresponding effects on the interpreter (Fig. 3.1).

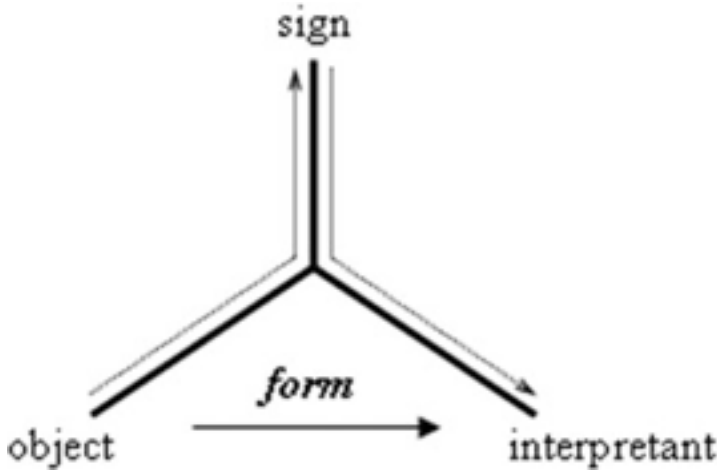

Fig. 3.1 Semiosis as a relation between three irreducibly connected terms (sign-object-interpretant, S–O–I). This triadic relationship communicates a form from the object to the interpretant through the sign (symbolized by the horizontal arrow). The other two arrows indicate that the form is conveyed from the object to the interpretant through a determination of the sign by the object, and a determination of the interpretant by the sign

Sign-mediated processes show a remarkable variety. The construction of appropriate typologies of these processes is a requisite for a deeper and more refined understanding of cognition. In an attempt to advance in the understanding of

semiotic processes, Peirce proposed several typologies, with different degrees of refinement and several relationships to one another. A basic typology in his framework differentiates between iconic, indexical, and symbolic processes.

3.3 Fundamental Kinds of Signs: Icons, Indices, and Symbols

Icons, indices, and symbols are differentiated by Peirce based on how the sign relates to its object, that might be defined as the item to which the interpretants are related by the mediation of sign (see [12]). This typology exhibits a property capable of functioning as an operational criterion to distinguish different kinds of signs: the relative dependence of sign-object-interpretant (S–O–I) components in triadic relation [13, 14].

A symbol is an S–O relationship logically dependent of I. This relation has been characterized as a law ascribing S–O. A symbol is “a Sign (q.v.) which is constituted a sign merely or mainly by the fact that it is used and understood as such, whether the habit is natural or conventional, and without regard to the motives which originally governed its selection” (CP 2.307). Differently, an index is dependent of O. The relation between S and O has been characterized as one of contiguity: constraints resulting from the space–time existence of the object— irrelevant in symbolic processes—are the reason for the representation of O through S. In that case, S is really determined by O, in such a way that both must exist as events. The notion of spatio-temporal co variation is the most characteristic property of indexical processes. When S is an icon, S signifies by means of qualities of S. Icons are dependent on the material, form and structure that are made–“An Icon is a sign which refers to the Object that it denotes merely by virtue of characters of its own, and which it possesses, just the same, whether any such Object actually exists or not” (CP 2.247). This relation between S and O based on the qualities of S has been characterized as one of similarity. The problem with the notion of similarity, however, is that it is too vague (see [15]). In order to detrivialize the notion of icon as a sign based on similarity it is possible to give an operational definition of the icon (Table 3.1).

Table 3.1: The fundamental types of signs underlying meaning processes -- icons, indexes, and symbols. They are characterized in terms of relative dependence of sign-object-interpretant (S-O-I) components in triadic relation. The icon is the sign whose relevant properties for signification are its own intrinsic qualities: S depends on S

Type of sign	**S-O relation**	**S-O-I dependence**
Icon	Similarity	Monadic (S): dependent of intrinsic properties of S
Index	Contiguity	Dyadic (S-O): dependent of S-O spatio-temporal correlation
Symbol	Law	Triadic (S-O-I): S-O dependent of I mediation

3.4 Iconicity: Operational Notion

The icons' dependence of its own materiality makes them suitable for modeling and experimentation. When an operational criterion is adopted, the icon is defined as anything whose manipulation can reveal more information about its object. Algebra, syntax, graphs, and formalizations of all types should be recognized as icons. This definition is considered a de-trivilization of the notion that the icon is fundamentally based on a relation of similarity (see [15]; also [16]).

The key of iconicity is not perceived resemblance between the sign and what it signifies but rather the possibility of making new discoveries about the object of a sign through observing features of the sign itself. Thus a mathematical model of a physical system is an iconic representation because its use provides new information about the physical system. This is the distinctive feature and value of iconic representation: a sign resembles its object if, and only if, study of the sign can yield new information about the object [16, p. 102].

The icon is notably related to situatedness and distributedness of reasoning. It is the sign whose signification is S-dependent (that means, dependent on the sign itself) and allows, through its manipulation, some discovery about the object. The notion of iconicity attests the capacity of material features to be the semiotic basis of cognitive operation, and not only play a secondary role.

3.5 Abduction: First Stage of Inquiry

Inferences are also understood as semiotic processes and have a place reserved under Peirce's typology. They are classified into three irreducible types –abduction, deduction and induction corresponding to three subsequent phases in the process of scientific inquiry (CP 6.469-473). Abduction rises from the observation of a mass of facts that doesn't fit into the habits and expectations of the observer and culminates with the formation and selection of a hypothesis. Deduction develops testable consequences of the previously generated hypothesis. Based on these consequences, induction performs tests to evaluate it.

The characterization of abduction as the transformation of mass of facts into hypotheses and the first stage of inquiry brings it close to perception (see [17, 18]). For Peirce, perception involves an interpretative process (CP 5.181). It is through an inferential-like perceptual judgment that percepts are subsumed under general classes. This perceptual judgment accounts for the transformation of sense data into knowledge applicable to theoretical or practical use. It is subconscious, but if it was subjected to logical analysis, it would present an inferential—abductive— form (CP 5.181). Therefore, "all that makes knowledge applicable comes to us via abduction" (MS 692).

As an "act of insight" that "comes to us like a flash" (CP 5.181) abduction is germane to creativity. For Peirce, abduction is also the logical inference by which new knowledge can be obtained: "Abduction consists in studying the facts and devising a theory to explain them. It is the only kind of argument which starts a new idea" (CP 2.96). According to Paavola [20], in abduction the iconic character of reasoning is more prominent. Icons, abductions and perceptual judgments all have important similarities between themselves.

In all of them, some characteristics or phenomena suggest a potential way of interpreting or explaining these characteristics or phenomena and bringing them into some kind of an order [20, p. 305]

Paavola has referred to these characteristics that only suggest a way in which they could be interpreted as clue-like characteristics. In abduction, these clue-like characteristics, together with background knowledge, lead to the conclusion of a hypothesis (i.e., a promising way of arranging a mass of facts). This is a distributed process whenever these clue-like characteristics are predominantly material qualities of external signs. Abduction is especially near to the conceptualization of distributedness because it is an inference which relies on a mass of percepted data for its conclusion.

To see how iconicity and abduction are related to situatedness, we analyze in the next section an example of distributed reasoning. More specifically, we identify the role of both icons and abductions in the distributed problem solving task of the Tower of Hanoi.

3.6 Externalization of Constraints as an Iconic-Embedded Abductive Process

The Tower of Hanoi is a puzzle game. It is (normally) constituted of three poles and several disks of variable diameters with a hole in the centre in order to be stacked in the poles (see Fig. 3.2). The diameter of the disks represents the hierarchy according to which they may be organized or moved across the poles. The goal of the game is to rearrange the disks from a specific initial state to a specific goal state, while observing some basic rules. The formal structure of the game is composed by the pieces (disks, for example), places (poles), hierarchy (disk diameters), rules, initial state, and goal state.

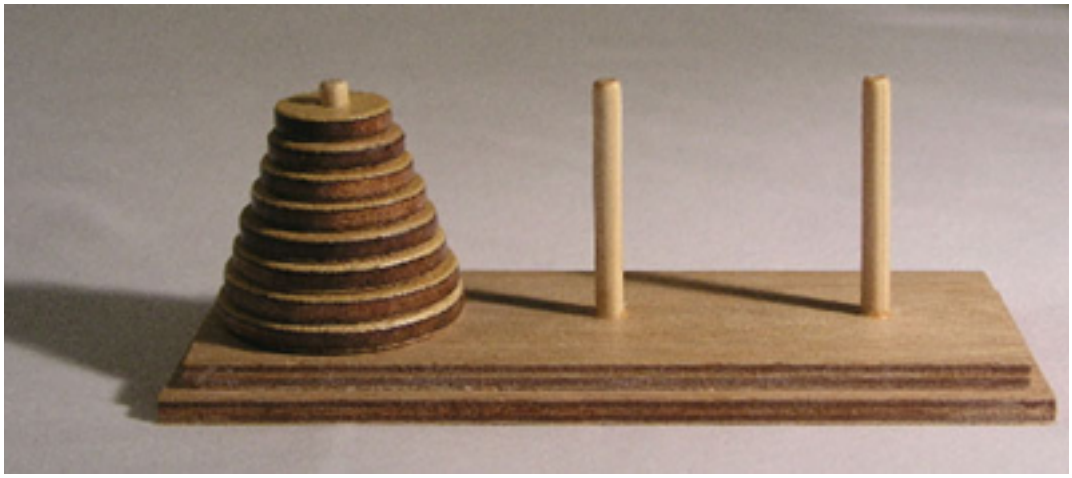

Fig. 3.2 The classical version of the Tower of Hanoi puzzle, with three poles and several disks stacked from the largest, in the base, to the smallest, in the top. In the experiments treated here, this order was altered: larger pieces should be put on top of smaller pieces. Image taken from Wikimedia Commons

Zhang and Norman [6] have used the tower of Hanoi game to study the influence of representations in cognition. More specifically, they were dealing with the Representational Effect: difference in cognitive behavior caused solely by representational features. The Representational Effect is investigated through the comparison of performance upon isomorphic representations in problem solving tasks, i.e., representations that carry the same amount of information, but that vary in the way that this information is presented. In the experiment treated here, the authors have used the isomorphic versions of the Tower of Hanoi puzzle showed in Fig. 3.3.

Zhang and Norman's tests covered several levels of isomorphism between representations (level of object representations, level of dimensional representations, level of rule representations and level of problem space structures). The particular experiment that interests us (experiment 2, Zhang and Norman [6], pp. 20–23) is the level of rule representations. In this level, the rules of the game itself can be represented in two ways: they are either (i) stated in instructions and memorized by the players or (ii) automatically embedded in the possibilities of move offered by the material of play. Rules introduced according to (i) and (ii) are termed, respectively,

internal and external rules, kept, in the act of play, either in the memory of the players or in the material of play itself.

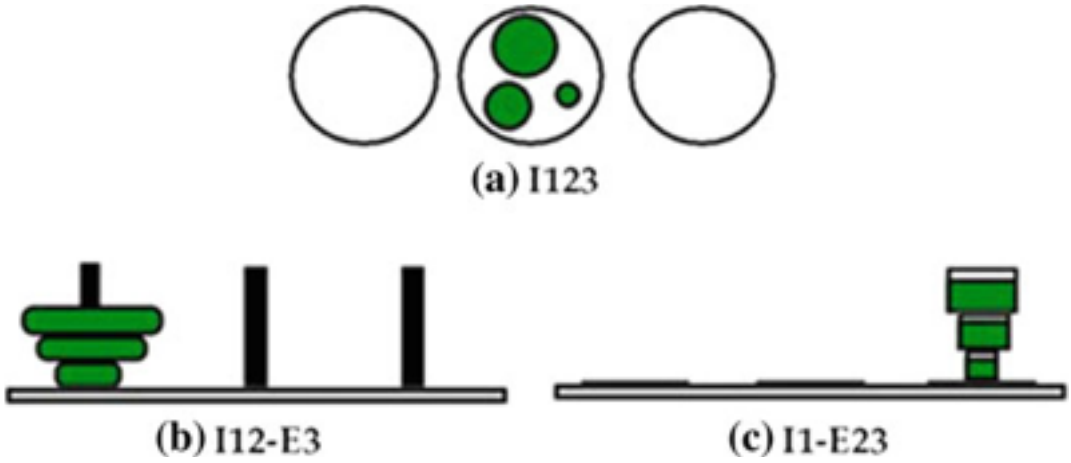

Fig. 3.3 Three isomorphs of the tower of Hanoi which vary in respect to the externalization of constraints. In a the three rules of the game are internal. In b two of the rules are internal and one is external. In c only one of the rules is internal, and the other two are external [6]

There were three rules in the game for this experiment (see Table 3.2) and two ways in which these rules could be introduced (internal or external rules). Three isomorphs were used (see Table 3.3) the, “waitresses and oranges”, “waitresses and donuts” and “waitresses and coffee”, that differently represent the elements that compose the formal structure of the game. The oranges version utilizes balls (“oranges”) as the pieces, plates as the places and the size of the balls as the hierarchy. The donuts version utilizes disks (“donuts”) as the pieces, poles as the places and the diameter of the disks as the hierarchy. The “coffee” version utilizes cups filled with coffee as the pieces, plates as the places and the size of the cups as the hierarchy. Each of the three rules were either internal (given as a list of instruction read before the experiment and memorized by the players) or external (automatically embedded in the material of play). In the “oranges” version, all the three rules were internal (I123). In the “donuts” version, rules 1 and 2 were internal and rule 3 was external (I12 E3). In the “coffee” version, only rule 1 was internal and rules 2 and 3 were external (I1 E23). The oranges version is internal in respect to all rules because the balls in plates can be physically moved without any constraining in relation to each other. The donuts version is external in respect to rule 3 because the stacking of disks in poles only allow that the disk in top be physically moved (unless you take more than one disk, but in this case you would be breaking the internal rule 1). The

coffee version is external in respect to rules 2, 3 because, beyond being stacked one on top of the other (rule 3), a smaller cup, filled with coffee, cannot be placed on top of a bigger cup, filled with coffee, because in this case the coffee will spill. In a context where it is understood that spilling coffee is bad, rule 2 has also been externalized.

Table 3.2: Rules of the Tower of Hanoi puzzle

Rules of the TOH, experiment 2
1. Only one piece can be transferred at a time
2. A piece can only be transferred to a place on which it will be the largest
3. Only the largest piece in a place can be transferred to another place

Table 3.3: Isomorphic representations of the game's formal structure

	"Oranges" (I123)	**"Donuts" (I12 E3)**	**"Coffee" (I1 E23)**
Pieces	Balls	Disks	Cups filled with coffee
Places	Plates	Poles	Plates
Hierarchy	Size of balls	Diameter of disks	Sizes of cups
Rules	1. Instruction 2. Instruction 3. Instruction	1. Instruction 2. Instruction 3. Material	1. Instruction 2. Material 3. Material

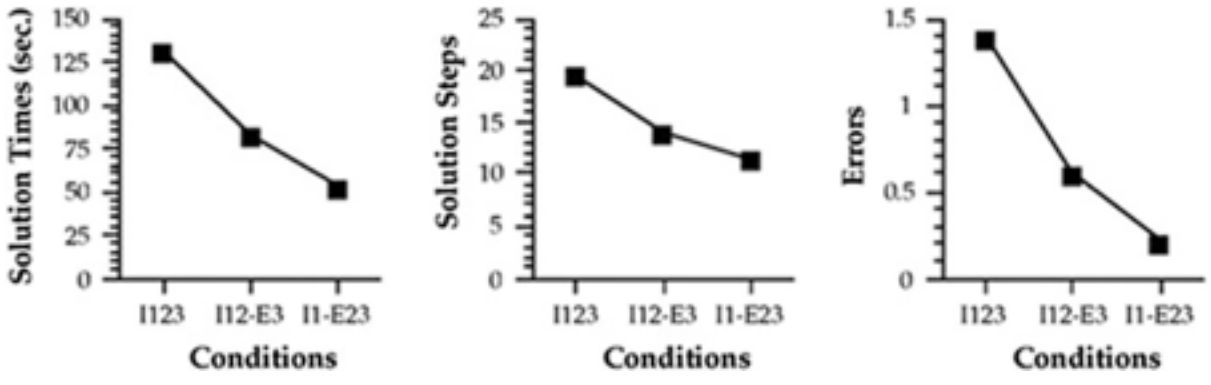

Fig. 3.4 Results of the experiment for each of the isomorphs [6]

The experiment measured the time required for solution, the number of steps required for solution and the number of wrong moves for each of the three isomorphs. In the three cases, the results for the most internalized version (oranges)

were the worst: more time to solve, more number of steps required to solve and more wrong moves. For the most externalized (coffee) the results were the best: less time to solve, less number of steps required and almost no wrong moves. The donuts version stayed in the middle (see Fig. 3.4). This experiment, together with others in the same article, have led the authors to propose that more extenalized representations are also more efficient representations for problem solving (see also [21, 22]).

The criterion the authors have used to classify between internal and external rules matches a criterion for iconicity, namely, dependence of material properties, i.e. S-dependence. The different isormophs of the experiment can be modeled as semiotic processes of communication of a form or habit from an object to an interpretant through the mediation of the sign. The object (O) of this triadic relation is the formal structure of the game that is common to all isomorphs. The sign (S) is the medium through which the game is played, i.e., the specific pieces and places and also the list of written instructions. The interpretant (I) is the constraining in behavior that characterizes the act of play itself. With this framework in mind, and taking into consideration the criterion of relative dependence of terms for the fundamental classification of signs, we conclude that, for the (i) internal and (ii) external cases:

(i) O (formal structure of the game) is independent of S (material of play). If you change the materials used to play, the game remains the same. The S–O relation cannot be established by these two terms alone, it requires the mediation of a third term (I). The constraining upon the specific material of play, that makes it correspond to the formal structure of the game, only happen as a cognitive constraining in the behavior of the player, in the act of play itself. As S–O relation is dependent of I, this is an example of symbolic semiosis.

(ii) The game is S-dependent. If you change the materials used to play, the formal structure of the game changes. The S–O relation is already established independently of the third term (I), because the constraints of S are a materialization of the formal structure of the game. The constraining upon the specific material of play, that makes it correspond to the formal structure of the game, is already given

in the material of play, before the game is played. As S–O is dependent of S, this is an example of iconic semiosis.

The results for this particular case can be generalized to any other case of externalization of constraints. First, because to be external implies to be physically materialized. Second, because the constraints of the physical material limit cognitive behavior, and not the other way around. Therefore, to say that a representation is external in respect to some constraints already implies that these constraints are S dependent, and that we are dealing with iconic semiosis.

To identify the role of abduction in this process, we stress the inferential activity involved in making each move in the game. To solve the game, the player must arrive at some conclusion as how to arrive at a goal state departing from an initial state. To do that, he/she passes through intermediate problem states. The player is making inferences whenever he makes decision as how to pass from one problem state to another. To go from one problem state to another, the player needs to move according to the rules. The rules give the player a certain number of possibilities that he can choose between. This inference is abductive because it is fallible (i.e., it doesn't necessarily conclude the best solution to play) and takes the form of the formation and selection of possible hypothesis of play by departing from a set of constraints.

Figure 3.5 shows three diagrams depicting constraints in the game. Each node of the diagrams is a problem state, i.e., a particular arrangement of pieces in their places. Each line of the diagrams is a possibility to move from one problem state to another, i.e., to move a piece in the game, according to the rules. One of the nodes is the initial state. Another node is the goal state. To play the game is to go from the initial state node to the goal state node through the possibilities offered by the lines. In the first diagram we have the possible moves as constrained only by the rule 1. In the second diagram we have the same, but now for rules 1, 2 and 3. Let's imagine that these diagrams corresponded to externalized isomorphic representations of the TOH. The first diagram would be a representation in which only rule 1 is externalized. The second diagram would be a representation in which all the three rules are externalized. In the game, to perform a move that is out of the rules is

considered an error. Therefore, the second diagram, which includes the constraints of all the rules, represents an error-proof scenario (regarding errors that are caused because of moves that are out of the rules). The third diagram shows a comparison between the two isomorphs. In black, is all that was wrong and have been ruled out by the second isomorph in relation to the first. In this sense, we can see the material as a selector of possibilities of play.

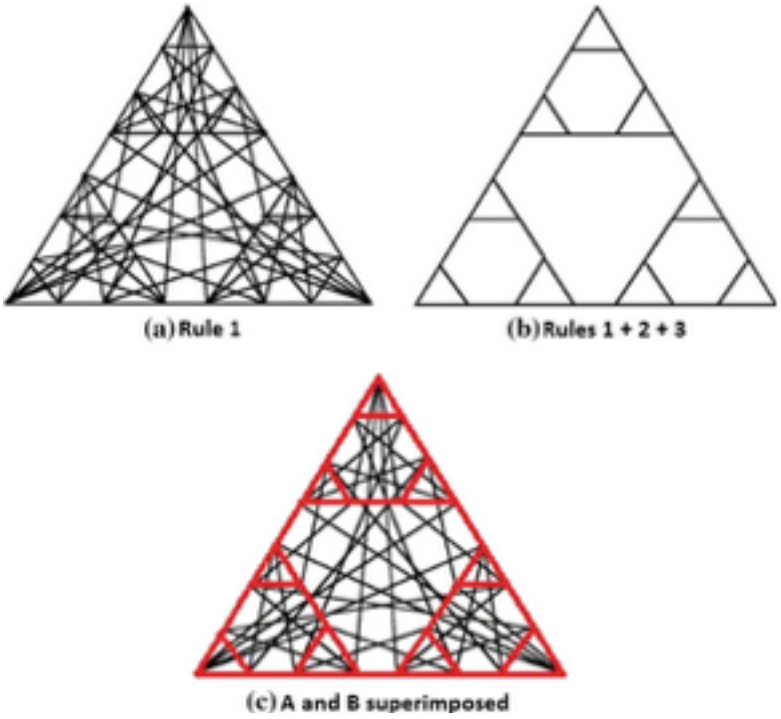

Fig. 3.5 Constraints of the game for Rule 1 (a) and Rules 1 + 2 + 3 (b). c A superimposition of b upon a. Adapted from Zhang and Norman [6]

A more externally constrained representation is also one where there are fewer possibilities to move the pieces. This doesn't mean that no inferences are present. There is an inferential and perceptual process in the act itself of dealing with the external constraints. For example, when a player chooses to move a cup of coffee to a certain place instead of another because in this better place the coffee will not spill. This inference is supported by external constraints that, as we have seen, are icons of the formal structure of the game. Externalization of constraints (and therefore iconicity) acts as a way to build better materials of play. Better, here, refers to an economy of possibilities, to the supporting of abductions by the materials of

play. In this sense, we have an example of abductive process which is distributed in iconic embedded features of an externalized semiosis.

3.7 Situated Semiotic Theory of Mind: Some Implications of Abduction and Iconicity

We have presented an externalist semiotic perspective of cognition, where mind is the result of manipulation of signs and (i) manipulation is described by irreducible forms of inferences; (ii) signs are classified by different morphologies. Abduction and iconicity correspond respectively to the categories of inference and sign processes in which the situated aspect of Peirce's conception of mind is especially conceptualized. Abduction is a weak form of inference (see [23]) related to perceptual features, while the icon is the S-dependent semiotic process. This treatment suggests that a reconsideration of the embodied-situated paradigm's own philosophical foundations can behave in semiotic terms. Peirce's semiotic theory of mind neither restricts representations to symbolic semiosis and inferential processes to deduction and induction as in ortodox representationalism, nor rejects representations and inferences as in anti-representationalism (see Table 3.4).

Table 3.4: Comparison between orthodox representationalism, anti-representationalism and the Semiotic Theory of Mind

	Representationalism	**Anti-representationalism**	**Semiotic theory of mind**
Signs	Symbolic	No	Not only symbolic but indexical and iconic
Inferences	Deductive, inductive	No	Deductive and inductive and abductive
Locus	Internal	External	Inference relies on internal and external resources

This position was exemplified in the case of externalization of constraints in the Tower of Hanoi puzzle. In the example, the task of deciding how to move the pieces of the puzzle was crucially dependent on the materiality of the play, so that isomorphic representations that varied their representational features had great influence on the cognitive behavior of the players (Representational Effect). The

game play was facilitated when constraints (the set of rules) were externalized. Externalization of constraints in this context corresponds to the embedment, in an external sign, of better chances to reach an adequate conclusion. We have argued that this process is abductive: it limits the universe of possible moves to a few optimal ones, performing a selection of hypotheses; it provides, through perception, an optimal hypothesis for further consideration; it gives the first step for the solution of the problem.

3.8 Conclusion

Recently, the distributed cognition and extended mind approach (see [24, 25]) have questioned the legitimacy of skin and skull to serve as criteria for the demarcation of the boundaries between mind and the outside world. The acceptance of external representation as parts of human cognition leads to different conceptions on the relation between cognition and environment. As we adapt the environment to facilitate our purposes, deploying our mind in external representations, we participate in the construction of cognitive niches, which fundamentally alter our cognitive capabilities (see [26]).

According to Peirce's semiotic theory of mind, thinking is semiosis, the process of sign action. While "representationalist", the semiotic theory of mind expands the understanding of signs and inferences beyond orthodox representationalist notions, making it possible to combine representations with an externalist view of the mind. Against any form of internalism, Peirce can be considered a precursor of situated mind and distributed cognition thesis. In the example treated, some of the best solutions, or "ideas" about how to win the game, were embedded in the outside world. Inferences were drawn based on perceptual qualities of material objects rather than an abstract understanding or the 'mind's-eye'. Peirce's broad ideas concerning signs and inferences are an important tool for advancing in the development of an externalist theory of mind.

3.9 References

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4 Iconic semiosis and representational efficiency in the London Underground Diagram[5]

Abstract: The icon is the type of sign connected to efficient representational features, and its manipulation reveals more information about its object. The London Underground Diagram (LUD) is an iconic artifact and a well-known example of representational efficiency, having been copied by urban transportation systems worldwide. This paper investigates the efficiency of the LUD in the light of different conceptions of iconicity. We stress that a specialized representation is an icon of the formal structure of the problem for which it has been specialized. By embedding such rules of action and behavior, the icon acts as a semiotic artifact distributing cognitive effort and participating in niche construction.

4.1 Introduction

The design of the London Underground Diagram (LUD) is a well-known example of representational efficiency, facilitating urban transportation for thousands of everyday users, copied by urban transportation systems worldwide. Present in virtually every major city in the world, it has established an international paradigm on how to perform simple decision-making tasks regarding networks of stations and lines. Its origins date back to 1933, when the engineer draughtsman Henry C. (Harry) Beck proposed several innovative features to the old Underground Map, sacrificing geographic accuracy in favor of specialization in particular tasks (see Walker 1979).

This paper explores the design of the London Underground Diagram identifying the semiotic basis of its representational efficiency. Efficiency in a representation is a

[5] Atã, P., Bitarello, B. & Queiroz, J. (2014). Iconic semiosis and representational efficiency in the London Underground Diagram. *Cognitive Semiotics*, 7(2), 177–190.

matter of iconic semiosis.[6] Several conceptions of iconicity have been acknowledged: the icon is operationally defined as a sign whose manipulation reveals, by direct observation of its intrinsic property, some information on its object (operational iconicity) (CP 2.279[7] ; Stjernfelt 2011: 397); but it has also been connected to representational features involved in the specialization of signs for certain purposes (optimal iconicity) (Stjernfelt 2011: 415). It is the type of sign whose signification is S-dependent (that means, dependent on the sign itself) and, more traditionally, it has been defined as similarity between the sign and its object. These different conceptions of iconicity sometimes appear to generate contradictory claims regarding representational efficiency. To solve such contradictions, we stress that a specialized representation is an icon of the formal structure of the problem for which it has been specialized.

Icons are cognitive artifacts, material tools that embed cognition and shape our minds. The London Underground Map is a remarkable example of a cognitive artifact, providing a niche[8] built for extraction and manipulation of relations, capable

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[6] We employ the term "representational efficiency" in the sense used by Zhang (1997), meaning the easiness of use of representations in problem-solving tasks, which can be empirically measured through the comparison of cognitive performances on isomorphic representations (see Zhang and Norman 1994; Zhang 1997; Chuah et al. 2000). In this sense, representational efficiency is an influence that is directed from the material features of the representation to the cognitive performance. This process is identified as iconic: signification is determined by the sign materiality (criterion of relative dependence of the sign process) and problem-solving involves the discovery of information about an object (operational definition of the sign) (see Atã and Queiroz 2014). This is not to say that indexical and symbolic signification is absent, but rather that the decisive element for efficiency is iconicity.

[7] Following a scholarship tradition, Peirce's work will be referred to as CP (followed by volume and paragraph number for quotes from The Collected Papers of Charles S. Peirce).

[8] In Ecology, the concept of niche means the environmental conditions required for a certain species to live. Cognitive niche construction is related to the transformation of problem spaces in order to aid thinking (see Clark 2006a).

of generating overall changes in the behavior of the users and influencing in the understanding of the city itself.
In the following sections, we (i) introduce Peirce's concept of iconic sign, (ii) describe the London Underground Diagram and its representational features, (iii) investigate the LUD's efficiency by examining its relevant innovations in the light of different conceptions of iconicity, (iv) describe its role in cognitive niche construction. Our conclusions relate cognitive distribution and niche construction with representational efficiency as a matter of iconicity.

4.2 Peirce's iconic semiosis

Peirce defined semiosis (sign-mediated processes) as an irreducible triadic relation between a sign (S), its object (O) and its interpretant (I). We will hereafter refer to this triad as S-O-I. That is, according to Peirce, any description of semiosis involves a relation constituted by three irreducibly connected terms (CP 2.242), S-O-I.

As it is well known, sign-mediated processes show a notable variety. There are three fundamental kinds of signs underlying meaning processes – icons, indexes, and symbols. Respectively, a sign may be analogous to its object, spatio-temporally connected to it, or might represent it by means of a law, rule, or norm. These classes correspond to relations of similarity, contiguity, and law between sign and object (see Table 4.1). Icons are signs that stand for their objects through similarity or resemblance, irrespective of any spatio-temporal physical correlation that sign S may have with an existent O. If a determinative relation of the S by the O is a relation of analogy, that is, if S is a sign of O in virtue of a certain quality that S and O share, then S is an icon of O. S and O are related due to the identity of some aspect they share. Icons are very dependent on the material, form, and structure of which they are made – "An Icon is a sign which refers to the Object that it denotes merely by virtue of characters of its own, and which it possesses, just the same, whether any such Object actually exists or not" (CP 2.247). In contrast, if S is a sign of O by reason of "a direct physical connection" (CP 1.372) between them, S is said to be an index of O. In that case, S is really determined by O, in such a way that both must exist as events – "An Index is a sign which refers to the Object that it denotes by virtue of being really affected by that Object" (CP 2.248). The notion of spatio-

temporal co-variation is the most characteristic property of indexical processes. The examples range from a pronoun demonstrative or relative, which "forces the attention to the particular object intended without describing it" (CP 1.369), to physical symptoms of diseases, photographs, weathercocks, thermometers. Finally, in a symbol, the relation between S and O is logically dependent on the third term, I. In a symbolic relation, the interpretant stands for "the object through the sign" by a determinative relation of law, rule or convention (CP 2.276).

Table 4.1: The fundamental types of signs underlying meaning processes -- icons, indexes, and symbols. They are characterized in terms of relative dependence of sign-object-intepretant (S-O-I) components in triadic relation.

Sign	**S-O relation**	**S-O-I dependence**
Icon	Similarity	Monadic (S): Dependent of intrinsic properties of S
Index	Contiguity	Dyadic (S-O): Dependent of S-O spatio-temporal correlation
Symbol	Law	Triadic (S-O-I): S-O dependent of I mediation

The icon is the only type of sign that involves a direct presentation of qualities that pertain to its object. Analogies depend on icons. When manipulated, the icon "reveals" aspects or qualities of its object.

The key of iconicity is not perceived resemblance between the sign and what it signifies but rather the possibility of making new discoveries about the object of a sign through observing features of the sign itself. Thus a mathematical model of a physical system is an iconic representation because its use provides new information about the physical system. This is the distinctive feature and value of iconic representation: a sign resembles its object if, and only if, study of the sign can yield new information about the object (Hookway 2002: 102).

The icon is not just the only type of sign involving a direct presentation of qualities that pertain to its object; it is also the only sign through which, by its direct observation, it is possible to discover something about its object.

Maps, graphs and diagrams are special types of icons. As soon as an icon can be considered as consisting of interrelated parts, and since these relations are subject to experimental manipulation governed by laws, we are working with diagrams (see Stjernfelt 2007: 92). Diagrams are the principal way of acquiring new knowledge about relations. They represent, through the relations between its parts, the relations that constitute the related parts of the object it represents. The object of the diagram is always a relationship, and the related parts of the diagram represent the relationships that constitute the object represented. The prototypical diagram is described as the manipulation of a geometric figure for the observation of a theorem. But the idea is quite general. An example taken from algebra is enlightening: “In fact, every algebraic equation is an icon, since that shows, through their algebraic signs (which are not themselves icons) relations of the quantities involved” (CP 2.282, emphasis added). Indeed, if a sign is observed as a whole consisting of interrelated parts, and these related parts are subject to experimental modification governed by rules, we are operating with a diagram. The London Underground Diagram is an example of a diagrammatic cognitive artifact, providing a niche built for extraction of relational properties.

4.3 London Underground Diagram (LUD): A cognitive tool for its users

The London Underground Diagram (LUD) is a hallmark of information design that influenced many other public transportation diagrams, a “form of representation judged to be so effective that it is now employed by virtually every transportation authority in the world” (Spence 2007: 77). The original version of the LUD was created by the Henry C. (Harry) Beck in 1933. Previously to the LUD, maps of the London Underground System adhered to geographically more accurate representations of the lines and station locations (see Figure 4.1).

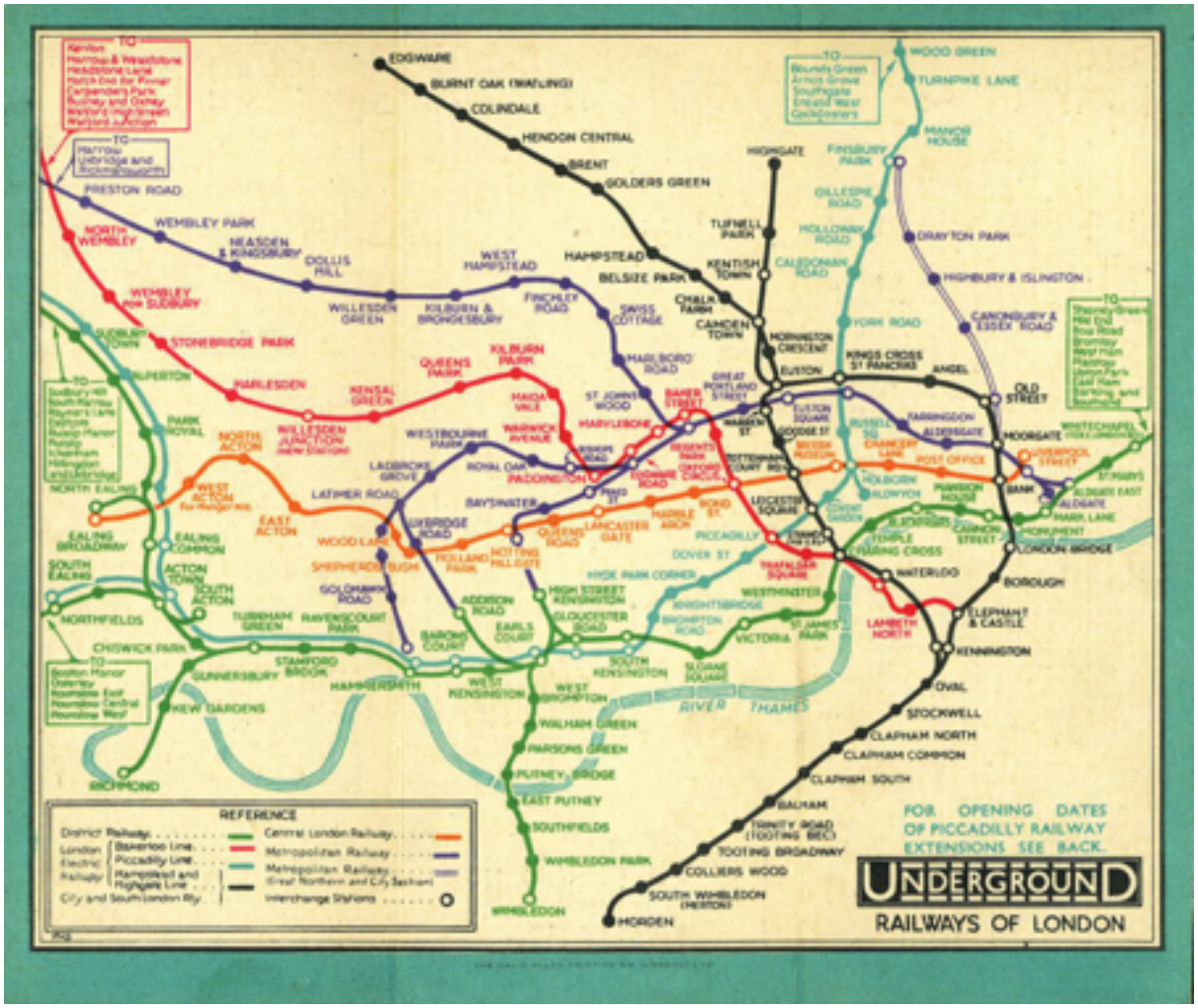

Figure 4.1: A route guide of the Underground System made by F.H. Stingmore, published circa 1932 (this is an overall equivalent version of Stingmore's 1919 guide shown in Garland [1994], the only difference being the addition of a few stations and lines). The background is blank and the different lines are color-coded. Although the concern for geographic accuracy diminished in comparison with the previous maps, it is a central component of the design. © TfL from the London Transport Museum collection.

Beck produced his first sketch for the London Underground Map in 1931. The design was based upon and adapted from an electrical circuit diagram (with which Beck was familiar as he was an engineer draughtsman). Such diagrams omit or falsify the relative physical position of wires in order to convey the information about connectivity. Beck saw a similarity with the underground railway network in that it was possible to ignore the geographical information altogether and remove some of the sources of confusion in the previous, more literal maps (Whitby 1996: 70).

Beck's initial sketch was transformed into a properly labeled and color-coded diagram (Figure 4.2) where he compressed the outlying portions of lines. The central area of the network appears to be viewed through a convex lens so as to enlarge its scale, and route lines are simplified in verticals, horizontals and diagonals (45°) (Garland 1994: 16).

Figure 4.2: Beck's original Underground Diagram, from 1933. © TfL from the London Transport Museum collection.

In later versions of the London Underground Diagram based on the last of Beck's diagrams (published in 1959), his successors retained the essential structure from the original: octagonal grid and colored lines meeting at angles of 90° or 45°; stations arranged to show the position of each one to the next instead of the real geographic distance between them; the presence of the simplified River Thames along the bottom of the diagram helping the notion of position and scale; non-interchange stations represented by ticks and interchange stations represented

sometimes by rings sometimes by diamonds (Garland 1994). Graphical changes such as changing the color of the lines and the fonts used in the names of the stations in order to improve the grasping of information by the users and reduce their possibility of confusion were made, also to accommodate the expansion of the transport system. As a result of the adaptations and modifications made by Beck and his successors, we have the diagram as we know it today.

4.4 Representational efficiency and iconic semiosis in the London Underground Diagram

The LUD (Figure 4.2) has been recognized as more efficient than a geographically more accurate map (such as Figure 4.1). We assume that the type of semiosis involved in the signification of the efficient properties of a representation is the iconic semiosis (see Atã and Queiroz 2014; Zhang and Norman 1994; Zhang 1997). Efficiency corresponds to advantage in the material manipulation of the sign for a certain goal. Iconicity is involved whenever signification is dependent on the materiality and structure of the sign. However, to say that difference in efficiency is due to iconicity is not enough to clarify what happened in the transition from the old map to the LUD that has shaped the cognitive niche of the users. In the following paragraphs, we further analyze the notion of iconicity and the representational differences between the two representations of London Underground System.

The notion of iconicity can be understood in different ways. Traditionally, it has been defined as “similarity” between sign and object. It has also been defined as relative dependence on S in the S-O relation (see Queiroz 2012). Stjernfelt (2011) identifies two different contrasting conceptions of icon and iconicity in Peirce’s work: first, the icon can be operationally defined as any sign whose manipulation is able to reveal more information about its object. This operational definition of the icon focuses solely on the capability of a sign to enclose information about its object. Following the author, we use the term “operational iconicity” to refer to the conception of iconicity arising solely from this operational definition. Operational iconicity contrasts with a stricter notion that considers factors such as immediacy of the information presented and economy of elements. We refer to the conception arising from these stricter criteria as “optimal iconicity” (Stjernfelt 2011: 400).

Stjernfelt (2011: 414) exemplifies the distinction between operational and optimal iconicity through the example of a digital picture. A picture can be digitally represented as pixels on a screen or as a linear sequence of digital information. If we only take into account the operational definition of the icon, the two representations are equally iconic: they are informationally equivalent (i.e. enclose the same amount of information), and one can be algorithmically transformed into the other. However, this operational definition alone ignores some representational features that are decisive for the S-O relationship in each sign: in the pictorial image, for example, object contours are represented as continuous lines while in the linear digital representation this information is scattered throughout the code. A single object contour is materially closer to a single continuous line than several scattered pieces of information, regardless of the interpreter (see Stjernfelt 2011: 414). Therefore, it is more iconic. Put in another words, a one-to-one correspondence holds some kind of logical and phenomenological intrinsic iconic value that is shattered by a one-to-several correspondence.[9] This is an example of the optimal notion of iconicity.

In the LUD, the operational iconicity criterion is able to unambiguously identify the diagram as an icon. It must be iconic semiosis, since a user manipulating the LUD is able to discover implicit information about the Underground System, e.g. on which line to embark to get to a specific station. It does not differentiate, however, between the LUD and older maps. On the other hand, the optimal iconicity criterion is able to stress the LUD's specialization as a problem-solving tool, thus differentiating it from other representations equally capable of revealing information about lines and stations.

The LUD has proved to be more efficient for navigation in the Underground System than a geographically more accurate map (such as Figure 4.1), even though the latter contains more information about the Underground System than the former (see Table 4.2).

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[9] Stjernfelt (2011) has related the development from a more operational to an optimal conception of iconicity to the transition to a more realist stance in Peirce's philosophy.

Table 4.2: A comparison between information of O (the Underground System) contained in S (maps and diagrams) for the LUD and a geographically accurate map of the Underground System. The LUD contains less information about the Underground System than the map. Therefore, it is less iconic for operational iconicity, suggesting it to be less similar to the Object. However, it is more efficient, therefore more iconic for optimal iconicity, suggesting it to be more similar to the Object.

Information of O accurately contained in S	**Geographically accurate Map**	**London Underground Diagram**
Stations	Yes	Yes
Connections between stations (tube lines)	Yes	Yes
Connections between lines (interchange stations)	Yes	Yes
Distance between stations	Yes	No
Geographic locations of stations	Yes	No
Length of lines	Yes	No
Specific directions and changes of directions of lines	Yes	No

There is more information to be discovered about the Underground System in a geographically accurate map than in the LUD. In this sense, we should conclude that the map is more iconic than the LUD with regard to operational iconicity. Since operational iconicity is a detrivialization of the psychological notion of similarity (see Stjernfelt 2011: 397), we can also conclude that a geographically accurate map is more similar to the Underground System than the LUD. The same conclusion might be reached intuitively: an observer, looking at the map which shows the real trajectories of the lines through the city might say that “it looks more like” the real Underground System than a simplified diagram.

The above conclusion appears to inflict a contradiction between similarity and representational efficiency. A geographically accurate map is more iconic (operational iconicity) and “looks more like” the Underground System itself, and yet it is less efficient for navigation in the same Underground System than a simplified diagram. The contradiction can also be understood in terms of opposing operational and optimal iconicity. Compared to a geographically accurate map, the LUD is

simultaneously less iconic for operational iconicity, thus, less similar, and more iconic for optimal iconicity, thus, more similar.

This, we argue, is a false contradiction, that points to what is relevant in the transition from the old maps to the LUD: while the geographically accurate map might actually be more similar to the London Underground System understood as a whole, the LUD, with the rules of manipulation and behavior it entails, is more similar to the particular experience of the Underground users and the most relevant variables involved in the choices they need to make. This experience of orientation and navigation in the Underground System can be modeled as a game (see Walker 1979) with a formal structure that comprises an initial state (the user's current station), a final state (destination), intermediate states and a set of rules (see Table 4.3). The LUD is a more efficient representation because it embeds this formal structure more directly than a geographically accurate map.[10] It is easier to locate the user current location (initial state) and destination (final state). It is also easier to grasp the overall structure of possible lines and connections among which to choose (intermediate states), with no superfluous information such as changes of directions or specific distances between stations.

[10] A similar argument is presented by Zhang and Norman (1994): in one of their experiments, the authors argue that the more efficient isomorph of the Tower of Hanoi puzzle game is the one that externalizes most rules of the game, so that the performance of the players is efficiently constrained. This process of externalization of constraints has been characterized as iconic (Atã and Queiroz 2014).

Table 4.3: The formal structure of the game-like experience a user has when trying to solve problems related to navigation in the Underground System.

The Underground User Game: Formal Structure	
Initial state	the user's current station
Final state	the user's goal station
Intermediate states	every station the user is going to access in order to go from the initial to the final state
Rules for moving between states	In order to move, the user embarks on a train, following its path on the line until the station (final or intermediate) she wants to disembark The train will follow its path on one particular orientation until the end of the line. It will not change its trajectory, orientation or line while traveling There are two types of stations: normal stations only allow for embarking or disembarking on one line. Interchange stations allow for changing lines

There are others notable factors why the LUD, with regard to its rules of action and behavior, can be seen as more similar to the experience of a user in the Underground System than a geographically accurate map. The concrete experience a user has on an Underground trip is one of no visible landscape or landmarks with which to mark and be conscious of the specific changes of direction of the lines or the specific distances traveled. Since there is also no traffic and the trains move in high speed, the differences in distance can be less significant for the amount of time a train will spend to get to the destination than the number of stops it will need to make. The experience the user has is, arguably, of a continuous homogeneous movement interrupted only by the stops in the stations, just like a straight line undisturbed by topographic issues and interrupted only by the chain of blobs or ticks that represent the stations. In this sense, a hypothetical user that is completely unaware of the geography of the city of London above the ground and is familiar only with the experience of the Underground might agree that, even intuitively, the LUD looks more like the Underground System than a geographically accurate map.

In comparison to its predecessor, Beck's diagram has diminished the amount of implicit reachable information in the map, reducing the number of possible operations to be performed (to know about real distances, for example). Beck has

added features that do not increase the amount of information, but rather decrease the difficulty of the search for the proper information, which influences in the whole process of problem solving. That means to say that the behavior of the user as well as the task itself are constrained and, to a certain extent, defined by the material iconic features of the representation. A problem solver behaves according to a problem space that corresponds to a formal structure of states and rules; this problem space is made available through iconic features of the representations involved in the cognitive process of solving the problem, so that this material representational features shape the behavior of the solvers. Change in efficiency in the transition from the geographically more accurate maps to the LUD corresponds to iconicity in the LUD putting the users in direct touch with rules that are really part of the experience of using the Underground System.

4.5 The London Underground Diagram as a cognitive artifact

Peirce can be considered an important precursor of the situated mind and distributed cognition thesis (Atã and Queiroz 2014). Recently, the distributed cognition and extended mind approach have questioned the legitimacy of skin and skull to serve as criteria for the demarcation of the boundaries between mind and the outside world (see Clark and Chalmers 1998; Clark 1998, Clark 2006b). For Peirce, mind is semiosis (i.e., sign action) in a materially embedded form and cognition is the development of available semiotic artifacts, in which is embodied a power to produce interpretants (see Skagestad 2004). From this perspective, the fundamental unit of cognitive interest is reconceived and replaced by an environmentally embedded space of semiotic skills and artifacts. As we adapt the environment to facilitate our purposes, deploying our mind in external representations, we participate in the construction of cognitive (or semiotic) niches, which fundamentally alter our cognitive capabilities (see Clark 2006a). Cognitive niche construction transforms the environment in which cognition takes place, through the selection of environmental features capable of mediating and controlling behavior (see Magnani 2009; Clark 2008: 61–63).

Beck's design has reduced the similarity of the LUD to the geographical identity of the Underground System and instead increased its similarity to a specific structure

of rules and goals that characterizes a particular experience of urban transportation and urban space. It has selected a habit – a set of relations and rules of action – and materialized it through iconicity so that it manifests itself again as iconic semiosis in the behavior of the users. This formal structure thus becomes a coupled part of the mind of Londoners, now hybrid beings embedded with a particular set of rules of action. For them, the LUD stands as a common familiar model, a specialized environment built for extraction and manipulation of relations. In this sense, the impact of the efficiency of the LUD goes beyond the scope of discrete particular problem-solving tasks. It becomes part of the semiotic niche of urban dwellers, making them more suited to the urban environment and influencing in their overall behavior and perception towards the city. It is “more than a simplification of Underground railway routes [...] it is an essential simplification of the city itself” (Garland 1994: 5).

4.6 Some conclusions

In our approach, while it may be of little relevance whether cognition is happening inside or outside the head, it is decisive that it must happen in representations: writing tools, modeling artifacts, notational systems, languages, and so forth. This conception neither restricts representations to symbolic semiosis as would orthodox representationalism nor rejects representations as would anti-representationalism. The study of distributed cognition benefits from the system proposed by Peirce in the sense that it offers a model of how and by virtue of what the mind semiotically unfolds itself. As the study of the representations and its functioning becomes a necessary part of the study of cognition, Peirce’s conception of icon arises as an important tool for the investigation of thought processes.

Iconicity is a central idea that connects cognitive distribution, niche construction and representational efficiency. An efficient representation is an icon of a structure of habits (rules of action) that foster certain kinds of cognitive behavior that are appropriate for an objective (here conceived as a game-like activity with an initial state and a goal state). Iconicity helps to clarify how it is possible for a habit to be embedded on a representation and be forced upon the user. Representational features act themselves as rules of action because of the interrelatedness of its

parts being analogous to certain effects of the environment that allow: (i) the embedding of extractable information in the sign about the object (related to operational iconicity) and (ii) the direct manipulation of this information (related to optimal iconicity). Through iconicity, cognition is distributed. As representations mold cognitive behavior, they become part of an ongoing process of niche construction, where the cognitive potentialities of groups of individuals are expanded or directed towards certain purposes. In our example, a particular experience of urban transportation, partly determined by the technology itself of Underground transportation, materializes itself on a sign that causes urban dwellers to adapt to it, thus participating in niche construction. The most decisive step of the process happens through iconic semiosis. The reduction of the amount of information in a representation by virtue of its specialization for specific tasks does not oppose different conceptions about iconicity, but rather redefines the object of the sign, clarifying itsrole as the materialization of a problem space optimized to function as an environment where cognition develops through manipulation of diagrams.

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5 Semiotic niche construction in musical meaning[11]

Abstract: According to Peirce's pragmatic semiotics, meaning (semiosis) is not an infused concept, but a power to engender interpretants. Semiosis is a triadic, context-sensitive (situated), interpreter-dependent (dialogic), materially extended (embodied and distributed) dynamic process. Although meaning is context-sensitive and materially extended, its locus is not well-captured by the notion of an environment. Inspired by biological concepts, we suggest the locus of meaning to be a niche. Here, we develop a semiotic account of musical meaning that emphasizes the location of musical signs in semiotic niches.

5.1 Introduction

Meaning is the object of investigation of semiotics, the "formal science of signs" as defined by Charles S. Peirce (CP 2.227). His definition of Semiotics and his pragmatic notion of meaning as the "action of signs" (semiosis) have had deep impact in several fields (see Freeman 1983; Fetzer 2004; Freadman 2004; Hookway 2002; Queiroz & Merrell 2009; Queiroz et al. 2011). Speculative Grammar, a branch of Peirce's theory of sign, is dedicated to the empirical studies of the nature of signs as they emerge and develop, and the conditions that determine the sign's further development, its intrinsic properties, and its interpretation (CP 2.83). It is concerned with sign relations, the necessary and sufficient conditions for representing, and classification of different possible kinds of representation and how they merge with one another (Houser 1997: 9).

Differently from internalist views that conceive meaning as communicative intent (Bach 1999), Peirce's pragmatic semiotics tells us that meaning (semiosis) is not an infused concept, but a power to engender interpretants (effects on interpreters). In concert with this idea, semiosis is a triadic, context-sensitive (situated), interpreter-dependent (dialogic), materially extended (embodied and distributed) dynamic process. It emphasizes process and development (Queiroz & El-Hani 2006). It

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cannot be dissociated from the notion of a situated agent (potential or effective). It is context-sensitive in the sense that it is determined by the network of communicative events within which the interpreting agents are immersed with the signs (Queiroz & Merrell 2009). It is both interpreter-dependent and objective, but is not a thing or an entity. Meaning is not in the sign, in some talking head (intracranial or neuronally-based system of signs or symbols), in the referent of the sign, or in the medium by which the sign is transmitted to its potential receiver and interpreter.

Although meaning is context-sensitive and materially extended (situated, embodied and distributed), its locus is not well-captured by the notion alone of a physical environment. Inspired by biological concepts, we suggest the locus of meaning to be a niche, instead of an environment. In ecology, while environment indicates the physical habitat of an organism, niche indicates not only the organism's "address" but its "profession" (Odum 1959), i.e. its ecological role and way of life, or, in a more modern definition, a niche is an imaginary n-dimensional hypervolume whose axes correspond to several ecological factors for the welfare of the organism (Hoffmeyer 2008). Extending the concept of ecological niche to cognition, the notion of "cognitive niche" stresses the environmental offer of opportunities (and boundaries) for thought as a major process in cognitive development. A cognitive niche can be understood as materially extended sets of problem spaces that demand or select a set of cognitive abilities. The construction of niches has been related to enhancement of problem solving activities (Clark 2008), cultural evolution (Laland & O'Brien 2011) and the birth of language (Clark 2006; Sterelny 2008; Bickerton 2009).

In this work, we develop a semiotic account of musical meaning that emphasizes the location of musical signs in semiotic niches. In section 1, we define semiosis as medium for the communication of a semiotic form. In section 2, we see examples of semiotic forms in the investigation of musical meaning. In section 3, we argue that semiotic forms are made available in semiotic niches through the process of niche construction. In the final section, we identify some consequences of this model for the investigation of musical meaning.

5.2 Meaning (or the action of signs) according to Peirce

First and foremost, Peirce's semiotics is grounded on a list of categories — Firstness, Secondness, Thirdness — which corresponds to an exhaustive system of hierarchically organized classes of relations. This system makes up the formal foundation of his philosophy (Parker 1998) and of his model of semiotic action (Murphey 1993: 303–306). In brief, the categories can be defined as: (1) Firstness: what is such as it is, without reference to anything else; (2) Secondness: what is such as it is, in relation with something else, but without relation with any third entity; (3) Thirdness: what is such as it is, insofar as it is capable of bringing a second entity into relation with a first one in the same way that it brings itself into relation with the first and the second entities.

As it is well-known, Peirce defined semiosis as an irreducible triadic relation between a Sign, its Object and its Interpretant. We will hereafter refer to this triad as S-O-I. That is, according to Peirce, any description of semiosis involves a relation constituted by three irreducibly connected terms, which are its minimal constitutive elements (MS 318:81; CP 2.242). In Peirce's words:

> My definition of a sign is: A Sign is a Cognizable that, on the one hand, is so determined (i.e., specialized, bestimmt) by something other than itself, called its Object, while, on the other hand, it so determines some actual or potential Mind, the determination whereof I term the Interpretant created by the Sign, that that Interpreting Mind is therein determined mediately by the Object (CP 8.177).

Peirce (see De Tienne 2003, Bergman 2000) also defines Sign as a medium for the communication of a form or a habit embedded in the Object to the Interpretant, so as to determine (in semiotic systems) the interpreter's behavior:

> […] a Sign may be defined as a Medium for the communication of a Form. […]. As a medium, the Sign is essentially in a triadic relation, to its Object which determines it, and to its Interpretant which it determines. […]. That which is communicated from the Object through the Sign to the Interpretant is a Form; that is to say, it is nothing like an existent, but is a power, is the fact that something would happen under certain conditions (MS 793:1–3. See EP 2.544, n.22, for a slightly different version).

In short, a Sign is both “a Medium for the communication of a Form” and “a triadic relation, to its Object which determines it, and to its Interpretant which it determines”. If we consider both definitions, we can say, then, that semiosis is a triadic process of communication of a form from the Object to the Interpretant through Sign mediation (see figure 5.1).

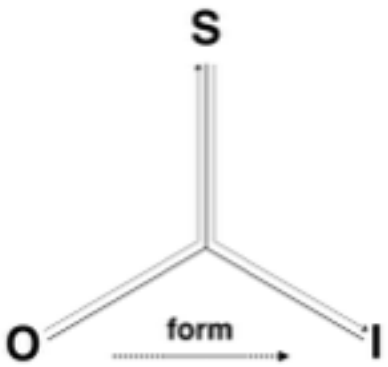

Figure 5.1: Sign (S) as medium for the communication of a form embedded on the object (O) to the interpretant (I). A sign can be an external artifact, as well as a mental representation. The object is that for which the sign stands. The interpretant are the effects caused by the relation between sign and object to an interpreting mind.

In Peirce’s works, form is defined as having the “being of predicate” (EP 2.544) and it is also pragmatically formulated as a “conditional proposition” stating that certain things would happen under specific circumstances (EP 2.388). It is something that is embodied in the Object (EP 2.544, n. 22) as a habit, a “rule of action” (CP 5.397, CP 2.643), a “disposition” (CP 5.495, CP 2.170), a “real potential” (EP 2.388) or, simply, a “permanence of some relation” (CP 1.415).

5.3 Examples of semiotic forms in musical meaning

Investigations of musical meaning have used notions such as schemas, patterns, templates and conceptual metaphors to account for how heard sounds are framed as meaningful structures. In our Peircean-inspired terminology, such notions correspond to semiotic forms. We are aware that the notion of semiotic forms is being applied to a broad scope of phenomena, but we are concerned here more

with a logical-phenomenological level of analysis that examines conditions for the emergence of meaning than with specific instantiated mechanisms of this logic: the focus of the present work is on the semiotic locus of these structures – which we will explore in the next section – and not their functioning. In this section we briefly introduce examples of concepts in the research of musical meaning that we characterize as semiotic forms.

Kendall (2010) stresses the fact that listeners make associations among things, and that these can be related to typical patterns or schemas. These schemas are central to the effort of listeners to discern meaning (Kendall, 2010: 63–64). An example is how listeners are able to discern musical events. According to the author, listeners make use of an “event schema” that help them not only to listen in terms of events, but also to access past experiences in terms of a history of events. For example, continuous felt experience of energy flow dynamics in a musical passage can be discerned and remembered as musical events and be ascribed general labels such as “rough, bumpy, grainy, smooth or flowing” (Kendall, 2010: 66). Note that such labeling rests on the assumption that adjectives commonly used to describe qualities of texture can be used to describe qualities of sound. We refer to this assumption here as the “texture metaphor”.

This event schema can be regarded as a semiotic form that is communicated from O to I through S as depicted in Figure 5.2:

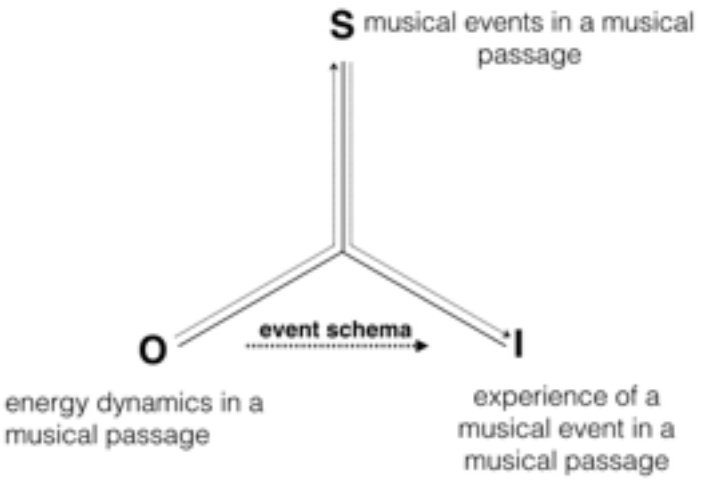

Figure 5.2: The “event schema” (semiotic form) is communicated, through a musical event (sign), from the energy dynamics of a musical passage (object) to the listener’s experience of musical events (interpretant). In an alternative description, an event schema, embedded in the energy dynamics of a musical passage, allow these dynamics to be regarded as musical events and experienced as such. More details about the nature of this kind of embedment will be given in the next section.

The “texture metaphor” that allows a retrieving a musical event in memory due to labeling it as “rough” is also a semiotic form as depicted in Figure 5.3:

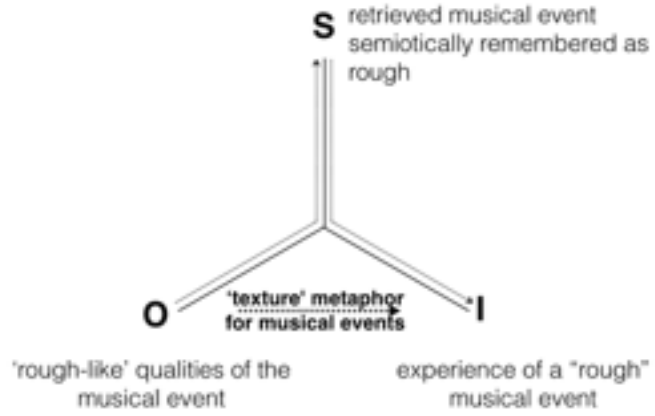

Figure 5.3: The "texture metaphor" (semiotic form) is communicated, through a retrieved musical event (sign), from the "rough-like" qualities of the musical event (object) to the listener's retrieved experience of a "rough" musical event (interpretant). In an alternative description, the texture metaphor embedded in the rough-like qualities of the musical event allow such these qualities to be retrieved as a musical event remembered as rough so as to produce the experience of a "rough" musical event.

Lakoff & Johnson (1980 / 2003: 3), stressed the importance of "conceptual metaphors" for human cognition: "our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature". Conceptual metaphors operationalize a target domain in terms of a source domain. Jonhson & Larson (2003) apply the Theory of Conceptual Metaphors to the cognition of musical motion, arguing that musical motion is metaphorically conceptualized as physical motion:

> Our claim is that people have no robust way of conceptualizing musical motion without metaphor and that all reasoning about musical motion and musical space inherits the internal logic of such metaphors. If this claim is correct, and if the source domain for musical motion is motion in space, then the ways we learn about space and physical motion should be crucial to how we experience and think about musical motion. (Johnson & Larson, 2003: 68)

The authors consider three ways through which we experience and learn about motion: (a) we see objects move; (b) we move our bodies; (c) we feel our bodies being moved by forces (Johnson & Larson, 2003: 68). These three ways give rise to three main metaphors to conceptualize musical motion: the “moving music” metaphor, the “musical landscape” metaphor and the “music as a moving force” metaphor.

The moving music metaphor describes musical events as objects that move past a stationary hearer from front (future events) to back (past events). Examples given by the authors include expressions such as “Here comes the recapitulation”, “The strings slow down now”, and “The music goes faster here” (p. 69). The musical landscape metaphor conceptualizes music as a three-dimensional environment through which the hearer moves. Future events are the landscape ahead and past events are the landscape already crossed. This metaphor accounts for expressions such as “We are coming to the coda”, “Let’s see, where are we in the second movement?”, “The melody rises up ahead” (p. 71). The metaphor of music as a moving force is based on the experience of being physically displaced by substances and processes such as water and wind currents or large objects. In the metaphor, music becomes the substance that acts upon the hearer. This metaphor accounts for conceptualizations of music as something that “blow you away”, “carry you along”, “take you on a roller coaster ride”, or make you “swing” (p. 75)

The conceptual metaphors can be modelled as semiotic forms as depicted in Figure 5.4:

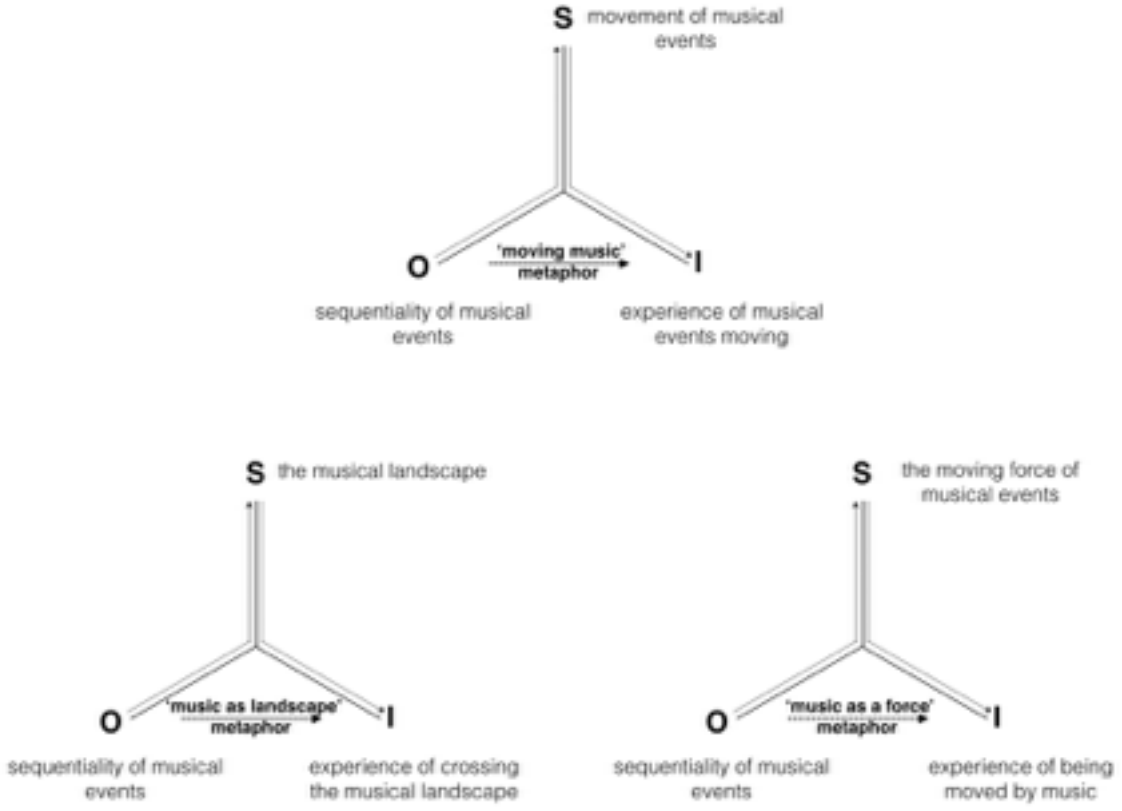

Figure 5.4: Semiosis of conceptual metaphors of musical motions. 4A: The “music as motion” metaphor (semiotic form) is communicated, through the “movement of musical events” (sign), from the sequentiality of these events (object) to the experience of events moving past the hearer (interpretant). In an alternative description, the music as motion metaphor embedded in the sequentiality of musical events allow these events to be regarded as movement so as to produce the experience of observing the music move. 4B: The “music as landscape” metaphor (semiotic form) is communicated, through the “landscape of musical events” (sign), from the sequentiality of these events (object) to the experience of crossing the musical landscape (interpretant). In an alternative description, the musical landscape metaphor embedded in the sequentiality of musical events allow these events to be regarded as a landscape so as to produce the experience of crossing such landscape. 4C: The “music as a moving force” metaphor (semiotic form) is communicated, through the “moving forces of musical events” (sign), from the sequentiality of these events (object) to the experience of being moved by music (interpretant). In an alternative description, the music as a moving force metaphor embedded in the sequentiality of musical events allow these events to be regarded as moving forces that produce experience of being moved by music.

The premises of our approach (that meaning rests on the action of contextually dependent, materially extended signs, as presented in section II) entail that semiotic forms – whether conceptual metaphors, event schemas or other theoretical concepts – are situated in some locus, where they are available as semiotic resources that can be recruited by interpreting minds. Meaning is shaped by the availability of these semiotic resources. Under this conception, the examination of the locus where these semiotic resources are available as well as the process that make them available becomes a fundamental part of the investigation of the meaning of something. In the following section we delve into this examination through the notions of semiotic niche and semiotic niche construction.

5.4 Musical niche construction

In biology, the niche of an organism indicates its ecological role and way of life. A niche is an imaginary n-dimensional hypervolume whose axes correspond to several ecological factors for the welfare of the organism (Hoffmeyer 2008). Recently, Clark (2006: 370) suggested that we are immersed in cognitive niches structured by language – "by materializing thought in words, we structure our environments, creating 'cognitive niches' that enhance and empower us in a variety of non-obvious ways". Biologists and philosophers of biology have suggested other categories: Hoffmeyer (2006), mentions "semiotic niche", which can be defined as an environment built by "semiotic artifacts"; Hoffmeyer (2008: 13) stresses that the term "semiotic niches" embraces "the totality of signs or cues in the surroundings of an organism - signs that it must be able to meaningfully interpret to ensure its survival and welfare". Farina (2008) suggests "semiotic landscape", which differs from the Uexkullian concept of Umwelt, or "phenomenal world", and focus on that which is made available physically in the environment in the form of signals, information and affordances (opportunities for action); Hutchins (1999) proposes "mediating structures" to refer to representational entitites and processes whose manipulation confers new cognitive abilities and provides new problem spaces.

A niche develops and transforms over time. This transformation is often caused by ecosystem engineers (Jones et al. 1994) that alter their environment and ecosystem. Niche Construction Theory (Scott-Phillips et al. 2013; Odling-Smee et al. 2003)

stresses the transformation of niches by organisms as having a major role in evolution, establishing a non-genetic system of inheritance that shapes selective pressures creating a feedback loop between organisms and niches. Examples include the construction of dams by beavers which reinforces an aquatic niche that selects for further adaptations fit for the aquatic niche (Pinker 2010: 8995). In humans, examples include animal husbandry as basis for selection of lactose tolerance (Clark 2006: 62).

We suggest that this biological evolutionary process can serve as a model for cultural evolution and meaning development, avoiding the main problems usually found in attempts to use darwinian evolution as a metaphor for cultural evolution (see Gabora, 2015). In this case, we are dealing with semiotic niche construction: interpreting minds (analogous to the organisms in ecological niche construction) act locally according to sets of opportunities and boundaries for the generation of meaning, their action frequently alters these sets, which in turn feedbacks into the interpretation activity and the mind. In other words, semioses depend on the availability of semiotic forms to generate interpretants through signs, and as semiotic activity transforms signs and semiotic forms, it evolves new interpretants.

The semiotic niche serve as the locus where semiotic forms are available as resources for semiosis. As we have seen, semiotic forms are embedded in the object of the sign (O in S-O-I). In our examples (above), the “event schema” is embedded in the energy dynamics of a musical passage, the “texture metaphor” is embedded in the rough-like qualities of a musical event and the “musical motion as motion in space” metaphor (in each of its three different possible instantiations) is embedded in the sequentiality of musical events. However, this may sound odd. How can an event schema be embedded in the energy dynamics of a musical passage? How can a texture metaphor be embedded in the qualities of a musical event? How can the musical motion as motion in space metaphor be embedded in the sequentiality of musical events? They are there not in the physical properties of musical passages and events per se, but in the role played by physical properties of musical passages and events to individual minds or communities of minds. A role which, because of niche construction with its feedback loop between minds and artifacts, constitutes the reasons and conditions for the musical passages and

events to have semiotically evolved the way they did. That is, the “event schema”, the “texture metaphor” and the “musical motion is motion space” metaphor situatedness (“being there”) in musical passages and events is not only situatedness in an environment, but situatedness in a constructed niche.

5.5 Final comments

Our approach suggests that examinations of musical meaning involve the following questions:

- How the musical niche which the piece occupies is structured and shaped by musical artifacts?
- What are the specific semiotic forms and features involved in the semiosis of the piece?
- How these forms and features act in the identified niche and how they participate in niche construction?

This framework re-conceives dichotomies such as aural versus mimetic, sinesthetic versus pure, programatic versus absolute, concrete versus abstract as different strategies for establishing meaning relations (S-O-I) in music. These different strategies are situated in musical semiotic niches as semiotic forms that are developed in the process of niche construction. Following Peircean semiotics, we conceive musical meaning as a social-cognitive dynamic process. This process is context-dependent (situated), interpreter-dependent (dialogic), materially extended (embodied), and emphasizes process rather than product, development rather than finality.

With this framework in mind, musical meaning can be treated as system of relations between the signs (musical pieces themselves) and the semiotic forms which are part of semiotic (musical) niches but nevertheless are situated in the signs themselves because of niche construction. As a semiotic form has the nature of a materially extended conditional proposition, the question of whether a certain quality of a musical piece is objectively present in the piece or is culturally constructed

makes no sense anymore: it is objectively present in the piece because it is culturally constructed and vice-versa.

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6 Creativity as niche construction and some examples in theatrical dance[12]

Abstract: Creativity can be regarded as a property of semiotic resource exploration and niche construction. More specifically, and according to this perspective, creativity is distributed, in cognitive niches, as opportunities for niche-construction. Artistic cognitive niches represent established ways to exploit available artistic semiotic resources. When such opportunities are explored so that new relations between cognition and artistic semiotic resources are established (i.e., the artistic cognitive niche is constructed), then creativity is observed. This process of niche construction involves the transformation of problem spaces ("a branching-tree of achievable situations") through the design and/or exploration of cognitive artifacts (in dance, for example, softwares, techniques, equipments such as dance shoes, stage, dance and music notations). Our approach is supported by specific examples in history. In each of these examples, the introduction of artifacts changed not only how to make dance, but also the very concept of dance, opening opportunities for the exploration of new niches.

6.1 Introduction

Artistic creativity has often been associated with mysterious, inexplicable, or vaguely formulated concepts such as appeals to “talent or gift”, “subjective expression”, “intuition”, “inspiration” or “geniality”. A common view is that creativity possess an unaccountable element of subjectivity and cannot be understood [1, 2]. Differently, psychological approaches to creativity have investigated personality and psychological traits, cognitive abilities, emotional dispositions and the relation between "creative individuals" and cultural and social institutions [3]. As Mayer [4] demonstrates, it has been almost a consensus in Creativity Research to ground definitions of creativity in the features of the products of the creative process,

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typically originality (novelty) and usefulness (value). Boden, for instance, defines creativity as

> “the ability to come up with ideas or artefacts that are new, surprising, and valuable. ‘Ideas’, here, includes concepts, poems, musical compositions, scientific theories, cooking recipes, choreography, jokes…and so on, and on. ‘Artefacts’ include paintings, sculpture, steam engines, vacuum cleaners, pottery, origami, penny whistles…and you can name many more” [5].

Despite the centrality of “ideas and artifacts” in this definition, they are regarded as mere products of a mental ability. This type of approach is consistent with internalist paradigms in cognitive science that regard cognition as the processing of internal, discrete and intentional units of information and in which the role of context, situation and external tools is secondary. In opposition to such paradigms, situated cognitive science [6, 7, 8] has questioned the legitimacy of skin and skull to serve as criteria for the demarcation of the boundaries between mind and the world. This approach stresses that the capacities of mind are shaped by non-biological tools for thinking (the most radical example of which is constituted by language) and that decisive stages of cognitive processing can happen externally to the brain [9].

In our approach, “ideas and artifacts” whether internal or external to the brain, are all captured by the notion of semiosis (action of sign), as defined by C.S. Peirce. Peirce's definition of semiosis [see 10] treats it as relational and processual, so that it is distributed in space (it cannot be located neither in the brain nor in the environment alone), and in time (it evolves and develops) [11]. For Peirce, cognition is semiosis, embedded in a dialogical material form, and includes the development and manipulation of artifacts, such as softwares and digital technologies, writing tools, instruments of observation, notational systems, artificial and natural languages, and so forth [12].

Differently from Boden, we approach creativity not as an "ability" of individual minds to produce creative signs ("ideas and artifacts"), but as patterns of semiotic resource activity. As semiosis evolves and develops in time, distributed patterns of semiotic resources give rise to new cognitive capabilities. Resources, in this case, is an epistemic metaphor related to the notion of niche. Semiotic resource is near to

the notion of cognitive artifact: Cognitive artifacts are objects made by humans for the purpose of aiding, enhancing, or improving cognition [see 13, 14].

The search for creativity in individual psychological traits has long served as an alternative to the conception that creativity cannot be studied. It gives it a recognizable locus for examination. In this sense, any distributed approach to creativity has the challenge to also offer a locus for the study of creativity. In this work we suggest that creativity is to be found in cognitive niches [15] in the form of opportunities for niche construction through the exploitation of available semiotic resources, which can often be external artifacts. Similar approaches include Magnani [16], Bardone [17]. We give some examples of how the availability of external artifacts have participated in dance cognitive niche construction.

6.2 Creativity and niche construction

The notion of niche involves an environment and its resources but is not reducible to them. In ecology, while environment indicates the physical habitat of an organism, niche indicates not only the organism's "address" but its "profession" [18], i.e. its ecological role and way of life, or, in a more modern definition, a niche is an imaginary n-dimensional hypervolume whose axes correspond to several ecological factors decisive for the welfare of the organism [19]. Extending the concept of ecological niche to cognition, the notion of "cognitive niche" stresses the environmental offer of opportunities (and boundaries) for thought as a major process in cognitive evolution. A cognitive niche can be understood as materially extended sets of problem spaces that demand or select a set of cognitive abilities.

A fundamental property of niches is that they are self-constructed: they are not previously existing environmental factors to which organisms adapt, but instead co-evolve with organisms. Niche Construction Theory (NCT) reframes the understanding on evolutionary processes [20]. In classic darwinian evolution the environment unilaterally exert selective pressure on genetically generated and genetically inherited traits. Under the perspective of NCT, environments and organisms mutually influence each other and niches are systems for generating and inheriting traits (especially behavioral) parallel to genetic variation and inheritance.

Examples include the construction of dams by beavers which generate an aquatic niche that selects for adaptations fit for this aquatic niche [21] and animal husbandry as basis for selection of lactose tolerance in humans [22]. In cognitive niches, niche construction is related to the co-evolution of cognition and semiotic resources, such as external artifacts and language [23].

Creativity can be regarded as a property of semiotic resource exploration and niche construction. More specifically, and according to this perspective, creativity is distributed, in cognitive niches, as opportunities for niche-construction. In other words, artistic cognitive niches represent established ways to exploit available artistic semiotic resources, but they also embed opportunities for evolution. When such opportunities are explored so that new relations between cognition and artistic semiotic resources are established (i.e., the artistic cognitive niche is constructed), then creativity is observed. This process of niche construction involves the transformation of problem spaces ("a branching-tree of achievable situations", [24]) through the exploration and design of cognitive artifacts (in dance, for example, softwares, techniques, equipments such as dance shoes, stage, dance and music notations). Our approach is supported by specific examples in history. In each of these examples, the introduction of artifacts changed not only how to make dance, but also the very concept of dance, opening opportunities for the exploration of new niches.

6.3 Dance and niche construction

External semiotic resources in dance constrain the dancers' and choreographers' action in different levels [26, 27, 28]. Therefore, it must be possible to analyse the coercions of the niches over an aesthetic program development and over the creation/composition of specific dance works. In this section we approach how this constraining is related to the cognitive niches in theatrical dance. Codified dance techniques, presentation spaces, conceptual ideas about composition, and many other resources, function as boundaries for creating choreographic pieces. When new resources are introduced new niches can be constructed, inaugurating new artistic paradigms. Below we briefly introduce some examples that constitute dance niches, and indicate some semiotic resources that contribute to their construction.

6.3.1 Classical ballet

What is today known as classical ballet is related to the construction of a dance niche which involved the production and introduction of novel artifacts, such as the changes in the relative position of the observer originated by Renaissance exploration of one-point perspective. Before the use of theaters based on Jean Battista Alberti's perspective (Fig. 6.1), dance pieces were watched in great halls either from the same level as the dancers or from higher positions, what contributed to the exploration of geometric patterns of dancers displacement in the space floor. The alteration of the place of presentation has lead to preference for more vertical morphologies of movements, strategies that emphasize the frontality of choreography such as en dehors and pirouette, one-point perspective scenery paintings, hierarchical occupation of stage which values the center, among others. As a cumulative process, the preference for verticality has lead to the introduction of point dance shoes, which participated in the evolution of a new aesthetic landscape in which the dancer became an "ethereal figure". For Smith, one-point perspective lead to a "heavy visualism" in different art forms:

> Beyond its political implications, ballet was lodged firmly in the eye: mirrors were critical to bodily training, performers went to lengths to minimize the sound of their steps and breathing, bestowing at once a silent and hyper-visual quality on the performance, and performers aimed to look similar [29].

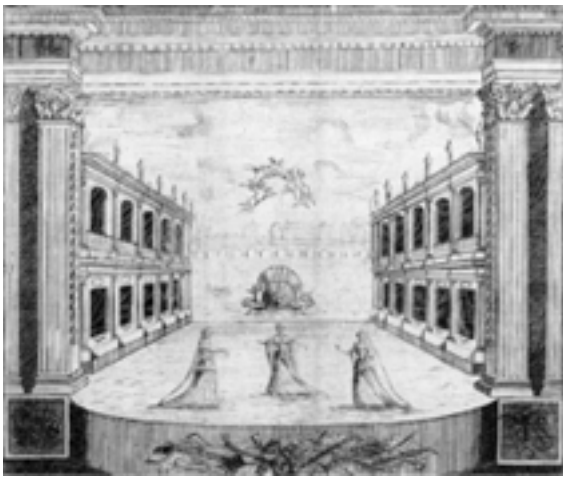

Fig. 6.1: Renaissance theater.

6.3.2 Merce Cunningham

The innovations of Merce Cunningham are related, among other things, to the exploration of chance procedures (such as coin-tossing, or the I-Ching, the Chinese book of changes) as a methodology for choreography creation. The operation of coin-tossing, in special, can be regarded as a form of proto-computing binary artifact to create and explore new syntactical problems in dance [see 30]. The use of chance operations impact dance in several ways: the sequences of performer's actions are changed, creating unusual dance syntax and forcing dancers to acquire new skills and reorganize motor coordination; the hierarchical structure of space is reframed, as well as the nature of observer positions; the relations between music and dance are reconceived so that a “non-representational” character of dance is stressed, i.e. dance as body movement dissociated from anything else.

6.3.3 Postmodern dance

Postmodern dance, a movement of the beginning of the 1960’s in New York, is another example of a paradigm change in dance. In response to modern dance and also to Merce Cunningham, a new niche arose based on the exploration of everyday objects and locations, ordinary rules of action and patterns of motor behavior as dance artifacts. Simone Forti, for example, presented “Five dance constructions and some other things” (1961) (Fig. 6.2) at Yoko Ono’s loft, where several artifacts, as a ramp, boxes, see-saw and verbal instructions were introduced to drive the performance [31]. In this example, there is the introduction of available semiotic resources. A see-saw, for example, is a very well known child playground artifact. When it is used in dance to create movement new possibilities to the performance are opened. In this new dance niche, pedestrian movements can be part of a dance performance, thus conventional dance techniques are not what constitute a choreography anymore.

Fig. 6.2: “Five dance constructions and some other things” by Simoni Forti, an example of how the change of presentation space and the introduction of several props leads to a radical reconceptualization of what counts as dance

In the table below (Table 6.1), we summarize the dance paradigms, their new semiotic resources and the innovations related to them:

Table 6.1: A Summary of the niche construction examples discussed above.

Dance paradigm	**Semiotic resource**	**innovations**
Classical ballet	One point perspective in theaters; Point dance shoes	alteration of the observer position; hierarchical occupation of the stage which values the center; strategies to deal with the frontality of the choreography; vertical morphology of movement
Merce Cunningham	proto-computing binary artifact inspired by the I-Ching	chance operations as a methodology for choreographic creation

Post modern dance	everyday objects and locations; ordinary rules of action and patterns of motor behavior	dance codified techniques are not essential to dance creation; vocabulary of body movements can be created for each artistic project; dance can be performed in any space (art galleries, roofs, walls, streets)

6.4 Discussion

Cognitive science has difficulty dealing with creative dimensions of cognition, particularly under the information processing paradigm and its computational strategy of approaching a complex phenomenon by breaking it into gradually simpler sub-tasks. Differently, creativity has been treated as an irreducible experience by aestheticians, anthropologists, art scholars and artists themselves, often however suffering from lack of systematicity and referring to non-operational mysterious notions. Artistic creativity, in particular, has often been regarded as a deeply subjective and personal phenomenon that cannot be properly explained. In our approach, creativity is causally distributed in space in time. It is not to be found neither in a given entity (such as a “creative person”) nor in a given point in time (such as a “moment of insight”). The term “creative artist” takes the meaning of someone who participates in a semiotic process of niche construction, and not the other way around (i.e., the creative artistic process as something inherent to a creative artist). Individual features such mental abilities or psychological traits, as well as expertise and training, influence the creative artistic process in the sense that they contribute or not to the exploration of opportunities for cognitive artistic niche construction. However, they are not viewed as the locus of creativity.

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7 Intersemiotic translation and transformational creativity[13]

Abstract: Here we approach a case of intersemiotic translation as paradigmatic example of Boden's 'transformational creativity' category. To develop our argument, we consider Boden's fundamental notion of 'conceptual space' as a regular pattern of semiotic action, or 'habit' (sensu Peirce). We exemplify with Gertrude Stein's intersemiotic translation of Cézanne and Picasso's proto-cubist and cubist paintings. The results of Stein's IT transform the conceptual space of modern literature, constraining it towards new patterns of semiosis. Our association of Boden's framework to describe a cognitive creative phenomenon with a philosophically robust theory of meaning results in a cognitive semiotic account of IT.

7.1 Introduction

Intersemiotic translation (IT) is a phenomenon of interest in many fields of research such as Comparative Literature, Translation Studies, General Semiotics, and Intermediality Studies. It has been called adaptation (Clüver 2011), intersemiotic transposition (Clüver 2006), medial transposition (Rajewsky 2005) and so on. Each term emphasize a slightly different aspect of the phenomenon. IT was first defined by Roman Jakobson (2000 [1959]: 114) as 'an interpretation of verbal signs by means of signs of nonverbal sign systems'. Currently, the term designates relations between systems of different natures, and it is not restricted to the interpretation of verbal signs. Consequently, this process is observed between several semiotic phenomena, including literature, cinema, comics, poetry, dance, music, theater, sculpture, painting, video, and so on.

It is well known that several experimental artists who have creatively transformed their fields dedicated themselves to the intersemiotic translation of methods and aesthetic procedures from one sign system into another -- Gertrude Stein translated

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[13] To be published as: Aguiar, D., Atã, P. & Queiroz, J. (in press). *Punctum.*

Cézanne and Picasso's proto-cubist and cubist approaches into literature; Kandinsky translated Arnold Schoenberg's methods into painting (Weiss 1997); Morton Feldman translated abstract expressionism's formal procedures into music (Kissane 2010); Paul Klee translated polyphony's music structures into painting (Verdi 1968); Augusto de Campos translated Anton Webern and Klangfarbenmelodie models into concrete poetry (Clüver 1981). Nevertheless, to consider an IT creative is often a matter of personal taste. In fact, creativity has often been associated with mysterious, inexplicable, or vaguely formulated concepts such as appeals to 'talent or gift', 'subjective expression', 'intuition', 'inspiration' or 'geniality'. A common view is that creativity possesses an unaccountable element of subjectivity and cannot be scientifically explained (Sternberg and Lubart 1999, Magnani 2005).

Here we approach a case of IT as paradigmatic example of Boden's 'transformational creativity' category: 'some transformation of one or more of the (relatively fundamental) dimensions defining the conceptual space concerned' (Boden, 2010: 29)14. To develop our argument, we consider Boden's fundamental notion of 'conceptual space' as a regular pattern of semiotic action, or 'habit' (sensu Peirce). For Boden:

> A conceptual space is defined by a set of enabling constraints, which make possible the generation of structures lying within that space […]. If one or more of these constraints is altered (or dropped), the space is transformed. Ideas that previously were impossible (relative to the original conceptual space) become conceivable (Boden 1999: 352).

These set of enabling constraints define 'structured styles of thought' such as 'ways of writing prose or poetry; styles of sculpture, painting, or music; theories in chemistry or biology; fashions of couture or choreography, nouvelle cuisine and good old meat-and-two-veg' (Boden 2012: 32) To give a more precise philosophical framework to the definition of conceptual space we suggest the notion of 'habit'. Peirce's notion of habit can be defined as a constraining factor of semiotic behavior

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[14] We shall follow the practice of citing from the Collected Papers of Charles Sanders Peirce (1931–1935, 1958) by volume number and paragraph number, preceded by "CP"; the Essential Peirce by volume number and page number, preceded by "EP." References to the microfilm edition of Peirce's papers (Harvard University) will be indicated by "MS," followed by the manuscript number.

(see below). In our description, Boden's 'set of enabling constraints' constitutes habits, so that conceptual spaces are defined by habits. We characterize IT as a semiotic process (Aguiar and Queiroz, 2010, 2013) of communication of habits from one conceptual space to another. In transformational IT (ITs involved in transformational creativity) the effect of the communication is the alteration of the target conceptual space's habits.

In the next section we introduce intersemiotic translation and the Peircean notion of habit. In section 3 we relate intersemiotic translation and the transformation of conceptual spaces, following Boden's typology of creativity. We explore, in section 4, the case of Gertrude Stein's intersemiotic translation of Cézanne and Picasso's proto-cubist and cubist painting as a case of transformational creativity. At the end of the paper, we try to summarize the main consequences of our approach.

7.2 Intersemiotic translation as communication of habits

As we have argued in other works (Queiroz and Aguiar 2015; Aguiar and Queiroz 2013, 2010), intersemiotic translation is a semiotic process (semiosis or 'sign action'). According to Peirce's model, any description of semiosis involves a relational complex constituted by three terms irreducibly connected -- Sign, Object and Interpretant (S-O-I) (see Bergman & Queiroz 2014). The irreducibility indicates a logical property of this complex: the sign process must be regarded as associated to the interpretant, as an ongoing process of interpretation (see Hausman 1993: 9), and it is not decomposable into any simpler relation. A sign is pragmatically defined as a medium for the communication to the interpretant of a form embodied in the object, so as to constrain, in general, the interpreter's behavior. For Peirce,

> […] a Sign may be defined as a Medium for the communication of a Form. [...]. As a medium, the Sign is essentially in a triadic relation, to its Object which determines it, and to its Interpretant which it determines. [...]. That which is communicated from the Object through the Sign to the Interpretant is a Form; that is to say, it is nothing like an existent, but is a power, is the fact that something would happen under certain conditions (MS 793:1-3. See EP 2.544, n.22, for a slightly different version)[15].

[15] For further discussion on how sign, object and interpretant are causally related in semiosis, see Atkin (2015).

The object of sign communication is a form, or habit (or a 'pattern of constraints') embodied as a constraining factor of interpretative behavior – a logical 'would be' fact of response (see Queiroz and El-Hani 2004). The habit is something that is embodied in the object as a regularity, a 'disposition' (CP 2.170) (De Tienne 2003; Hulswit 2001). The notion of semiosis as habit communicated from the object to the interpreter through the mediation of the sign allows us to conceive meaning in a processual, non-substantive way, as a constraining factor of possible patterns of interpretative behavior (Queiroz and El-Hani 2006) (Figure 7.1).

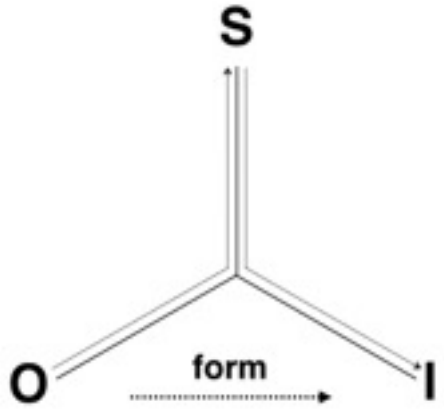

Figure 7.1: Semiosis as a relation between three irreducibly connected terms (sign-object-interpretant, S-O-I). This triadic relationship communicates/conveys a form from the object to the interpretant through the sign (symbolized by the horizontal arrow). The other two arrows indicate that the form is conveyed from the object to the interpretant through a determination of the sign by the object, and a determination of the interpretant by the sign.

Peirce's habit entails a disposition to act in certain ways under certain circumstances, especially when the carrier of the habit is stimulated, animated, or guided by certain motives (CP 5.480).

> … all things have a tendency to take habits. For atoms and their parts, molecules and groups of molecules, and in short every conceivable real object, there is a greater probability of acting as on a former like occasion than otherwise. This tendency itself constitutes a regularity, and is continually on the increase. In looking back into the past we are looking toward periods when it was a less and less

> decided tendency. But its own essential nature is to grow. It is a generalizing tendency; it causes actions in the future to follow some generalization of past actions; and this tendency is itself something capable of similar generalizations; and thus, it is self-generative. (CP1.409, circa 1890, from 'A guess at the riddle', reprinted in EP1: 277).

A Habit involves a general 'would be' relation, which is not reducible to any number of its instances:

> …by a Habit I shall mean a character of anything, say of B, this character consisting in the fact that under circumstances of a certain kind, say A, B would tend to be such as is signified by a determinate predicate, say C. (MS [R] 681:22)

> …no agglomeration of actual happenings can ever completely fill up the meaning of a 'would-be'. (EP 2:402; CP 5.467)

> …no collection whatever of single acts, though it were ever so many grades greater than a simple endless series, can constitute a would-be, nor can the knowledge of single acts, whatever their multitude, tell us for sure of a would-be. (1910 | Note (Notes on Art. III) [R] | CP 2.667

Intersemiotic translation can be described as a fundamentally triadic phenomenon of communication of habits. As the intersemiotic translation is a semiotic process by definition, and semiosis is understood as a relation in which Sign, its Object and its Interpretant are its main constitutive elements that cannot be reduced any further, we can determine specific situations in which this relation can take place in different configurations. Aguiar and Queiroz (2010) propose two different models of intersemiotic translation based on the triadic relation between S-O-I. The reader should be aware that these models are a simplification of a complex multi-hierarchical process involving several layers of description. Thus, their aim here is to highlight some relevant properties to explain a complex phenomenon. In the first model: 'the sign is the semiotic source (translated work). The object of the translated sign is the object of the semiotic-source, and the interpretant (produced effect) is the translator sign (semiotic target)'. (Figure 7.2):

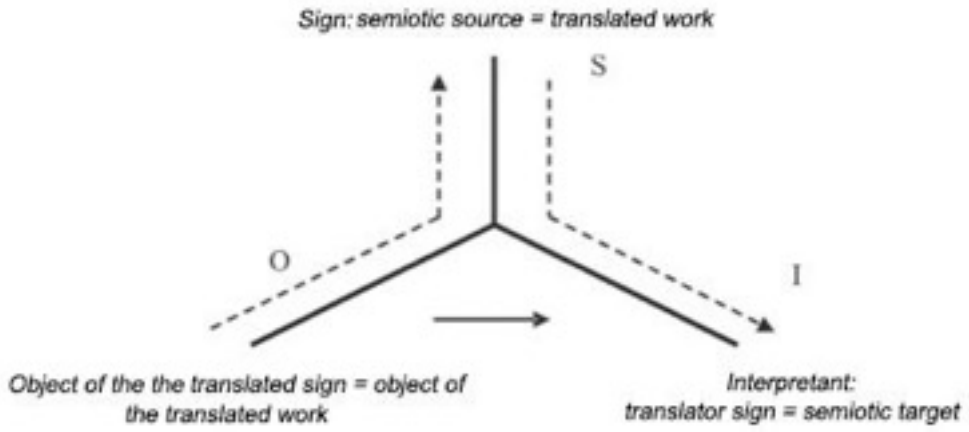

Figure 7.2. Triadic relation in which the sign is the translated work, the object of the sign is the object of the work, and the interpretant is the translator sign.

In the second model, 'the sign is the semiotic target. The object of the sign is the translated work, and the interpretant is the effect produced on the interpreter (interpretant)'. (Aguiar and Queiroz 2010) (Figure 7.3):

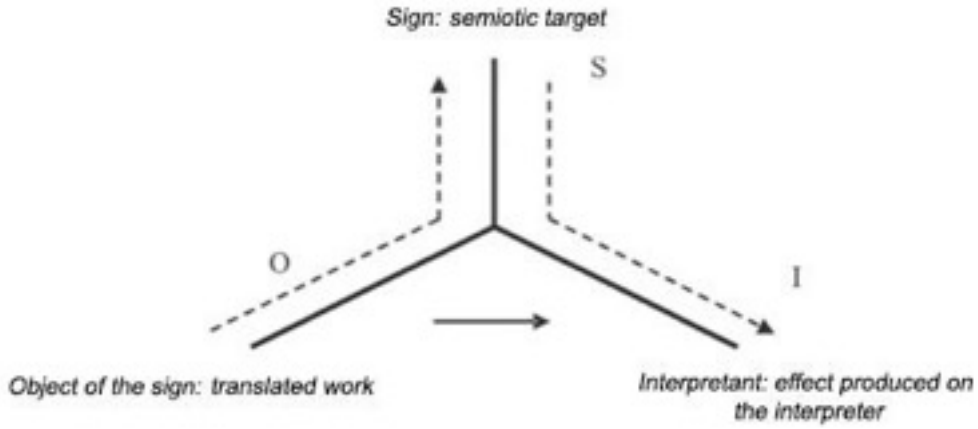

Figure 7.3: Triadic relation in which the sign is the target, the object of the sign is the translated work, and the interpretant is the effect produced on the interpreter.

Here we will explore the second model to describe a transformational IT, where the interpreter is the conceptual space of modern literature.

7.3 Intersemiotic Translation and Creativity

Although IT can be considered a widely spread artistic practice nowadays, as far as we know, it has not been theoretically framed as a creative phenomenon. 'Creative' and 'creativity' are terms of ordinary discourse that are used in unsystematic and inconsistent ways – 'It is plain, nevertheless, from the wealth of academic writing on creativity that there is a widespread belief, or perhaps hypothesis, amongst philosophers, psychologists, and others that such a concept can be defined' (Ritchie 2005). We will base the development of our argument on Margaret Boden's ideas on creativity. She defines creativity as

> the ability to come up with ideas or artefacts that are new, surprising, and valuable. "Ideas", here, includes concepts, poems, musical compositions, scientific theories, cooking recipes, choreography, jokes…and so on, and on. "Artefacts" include paintings, sculpture, steam engines, vacuum cleaners, pottery, origami, penny whistles…and you can name many more (Boden 2010: 29).

According to her approach, there are three categories of creativity: combinatorial, exploratory, and transformational (Boden 2010). The first type is related to new things that come up within a combinatorial process of familiar ideas or artefacts. The second consists in the exploration of particular conceptual spaces, such as concrete poetry, constructivist painting, postmodern dance, and so on. And the third type of creativity 'involves some transformation of one or more of the (relatively fundamental) dimensions defining the conceptual space concerned' (Boden 2010: 29)[16]. The transformation of conceptual spaces occurs through an otherwise impossible idea that 'can come about only if the creator changes the pre-existing style in some way, [...] so that thoughts are now possible which previously (within the untransformed space) were literally inconceivable' (Boden 2010: 34).

Applying Boden's terminology, IT is a semiotic relation, as modeled in the section above, between different conceptual spaces: from cubist literature to contemporary dance, from surrealist painting to automatic writing, from dodecaphonic music to

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[16] Boden also acknowledges the possibility of psychological creativity and historical creativity. The first is related to the processes involving an individual kind of creativity; the second involves the creation of something new in human history. We are interested here in the historical one.

abstractionist painting, and so on. Some IT cases can be considered transformational creativity phenomena. By translating from different conceptual spaces they create something new, surprising and valuable in their own conceptual space transforming it and creating new possibilities to be explored[17].

7.4 Transformational Creative Intersemiotic Translation: Gertrude Stein

Here we are interested in IT as a way to transform the target conceptual space by translating aspects, properties, or methods from another (source) conceptual space. One good example, mentioned before, is Gertrude Stein's IT from cubism in painting to literature. Stein (1874–1946) is among the most radical of the early twentieth-century literary Modernists. Her work was influenced by William James, her teacher at Harvard Annex, who directed her literary experiments toward questions about personality, consciousness, and perception of time (Levinson 1941; Dubnik 1984; Hoffman 1965). Intersemiotically, her writing translated the compositional techniques developed by Paul Cézanne and Pablo Picasso, creating a proto-cubist conceptual space in literature (see Hilder 2005; Fitz 1973; Perloff 1979).

The results of Stein's transformational IT are new, surprising, and valuable. Respectively, they inaugurate new habits in the conceptual space of Modernist literature; force the reader to drop conventional ideas about the previously established conceptual space; and converted Stein to be widely considered one of the most influential writers of the twentieth century.

[17] It is not trivial to explain what is new and what is valuable. Their evaluation depends on negotiation by social groups (Boden 1999: 351).

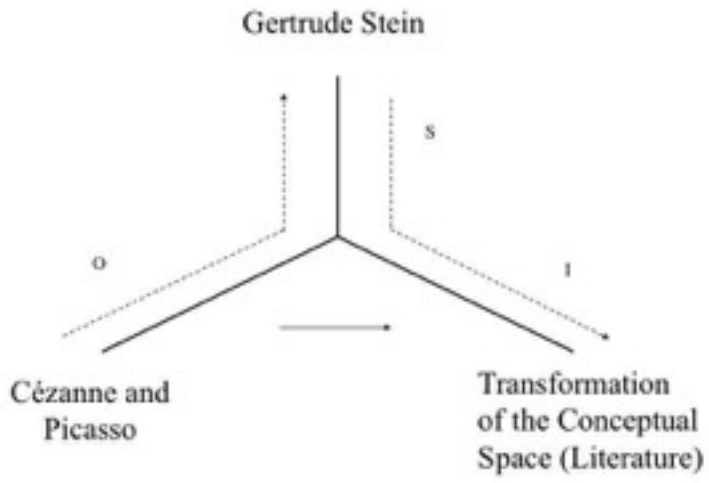

Figure 7.4: Gertrude Stein transformational IT from Cézanne and Picasso. A habit is communicated from proto-cubist and cubist painting, mediated by Stein's work, to the interpretant, which is a transformation of the conceptual space of literature.

We exemplify below with a written portrait by Stein named Picasso (1912) and a painting by Picasso called Ma Jolie (1911-1912) (Figure 7.5):

Fragment from Picasso	
One whom some were certainly following was one who was completely charming. One whom some were certainly following was one who was charming. One whom some were following was one who was completely charming. One whom some were following was one who was certainly completely charming. Some were certainly following and were certain that the one they were then following was one working and was one bringing out of himself then something. Some were certainly following and were certain that the one they were then following was one bringing out of himself then something that was coming to be a heavy thing, a solid thing and a complete thing. One whom some were certainly following was one working and certainly was one bringing something out of himself then and was one who had been all his living had been one having something coming out of him. Something had been coming out of him, certainly it had been coming out of him, certainly it was something, certainly it had been coming out of him and it had meaning, a charming meaning, a solid meaning, a struggling meaning, a clear meaning (Stein, [1912] 1974: 213).	 Ma Jolie, Picasso (1911-12)

Fig. 7.5: A comparison between a text fragment by G. Stein and a painting by Picasso

Ma Jolie is an example of Picasso's restrict pictorial vocabulary. The painting presents the brown and gray hues characteristic of Picasso and Braque's analytic phase, with slight variations. Stein uses a reduced number of vocables, repeated in different positions, unusually arranged, suggesting the multiple perspectives of Picasso. In Ma Jolie the composition is based on the superposition and

interpenetration of diverse cubic rectilinear semi-transparent planes, producing a multiperspective geometry of the object.

It is also notable that the metonymic procedure is dominant (see Heldrich 1997; Scobie 1997, 1988). The portraits are constructed through extractions or fragments juxtaposed by contiguity. In Picasso, there are affirmative sentences of an observed situation, and juxtaposed, in a translation of Picasso's procedure.[18]

Abreu (2008: 76) indicates another common element between Stein's writing and Picasso's painting: 'Both wanted to preserve each individual moment of perception in the present before those moments were systematized, by the intellectual knowledge of reality, in a concept of the object as it is "known"' (Abreu 2008: 76). In this way, according to Abreu, the influence by Cézanne over both of them is visible through the common interest for the perception process of the time.

7.5 Final comments

We have described IT as an irreducible triadic relation between conceptual spaces through habits and change of habits. In our example, Gertrude Stein's cubist prose may be defined as a medium for the communication of a regular pattern of sign-action (habit) found in Cézanne and Picasso's paintings. As a medium, Stein's prose is essentially in a triadic relation, to Cézanne and Picasso's paintings, which determine it, and to some effects on the conceptual space, which it transforms. That which is communicated from Cézanne and Picasso's paintings through Stein's prose to the conceptual space is a regular pattern of semiotic action.

Among the advantages of our approach, we mention: criteria to define a type of creative IT (transformational creativity) in the domain of Translation Studies, associating Boden's framework to describe a cognitive creative phenomenon with a philosophically robust theory of meaning, resulting in a cognitive semiotic account of IT. While Boden's approach is more concerned with the description of the effects of

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[18] In 'Portraits and Repetition' (Stein 1974: 115), Stein describes how her portraits result from a 'direct observation', not mediated by the memory or the object.

transformational creativity, our association suggests a possible semiotic operation to achieve such effects.

Our IT model offers a protocol to identify the relational dynamic between the creation of new artworks and artistic paradigms and their probable sources. Regarding the source of the IT (object), our model provides a criterion to identify which properties and concepts are relevant in an account of a conceptual space (e.g., the habits translated by Stein reveal relevant properties in proto-cubist and cubist painting). Regarding the target source of the IT (sign), our model helps to explain how the conceptual space is transformed.

Additionally, this perspective suggests a general model of the history of new artworks and artistic movements as IT processes. According to this model, art evolution should be understood as a translationally organized semiotic process. S, O and I become historical functional roles of the communication and transformation of habits. The inner relations and constraints between the three irreducible terms substitute the notions of ‘influence’ and ‘inspiration’ between artists, artworks and artistic movements. Further investigations are needed to explore this suggestion.

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8 Poetry translation: An open-source platform for epistemic engineering

Abstract: A poem can be described a context-dependent cognitive artifact that works as an experimental cognitive laboratory of language. Poetry translation is an example of an ill-defined although highly structured case of situated problem solving. It affords comparison between rival hypotheses and solutions, and description of the problem solving steps. In poetry, the translation task involves the *rebuilding* of a multi-level system of constraints (grammar, lexical, syntactic construction, prosodic scheme, sound). We model this operation by the frame of *situated problem solving* paradigm. To exemplify our argument we present Augusto de Campos' translation of John Donne's poem 'The Expiration'.

8.1 Introduction: the poem as a situated cognitive artifact

A poem is a multi-level system of correspondences, correlations, and contrasts among syntactic, prosodic, rhythmic and grammar structures, phonetic, graphic and visual entities (Lotman 1976; Jakobson 1988). It can be characterized as a hierarchical multi-level system of constraints (see Figure 8.1). When dealing with multi-level systems, the focus is on the levels of observation (or organization) of the systems, and how they *constrain* (restrain, select, or determine) the behavior or activity of other levels (Salthe 2009). The notion of hierarchy is closely related to levels of organization (see Salthe 2012, Poli 2007). Central to hierarchy theory is the attempt to provide an analytical framework for considering relationships among levels and their ordering in multi-level complex systems. On the higher levels are more stable components of a poem: such as the general rules of grammar. On the lower levels are more variable components, such as the specific font and the paper the poem is printed on. The components of the different levels asymmetrically constrain each other: grammar constrains the way the words are arranged, but not the typographic fonts they are written in, for example. Such constraints may not be explicit and straightforward: in certain cases the only constraining the typography causes on the referential message is whether the poem is efficiently legible or not,

while in other cases typography may be a central part of how the referential message is interpreted; this would correspond to the level of typography having a certain weaker set of constraints or a certain stronger set of constraints towards the level of referential message.

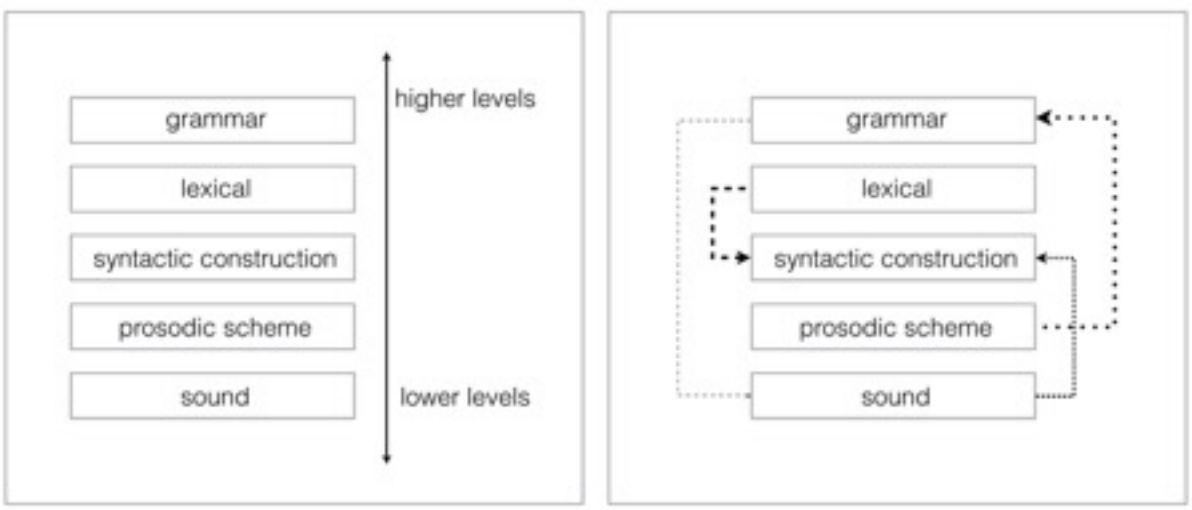

Figure 8.1: A poem as a multi-level system of constraints. The first frame shows different hierarchical levels of description of a poem. The second frame show a structure of constraints between these levels. Each arrow represents a multi-level constraint. Different sizes and types of lines and arrows were used to indicate different kinds and strengths of more or less salient constraints. Any given representation of the multi-level constraints of a poem is not exhaustive: many other different potential constraints can exist. Part of the task of interpreting, as well as translating, a poem includes choosing some more or less salient constraints as relevant.

A poem is an experimental laboratory for performing language experiments. Its experimental character lies in the fact that it allows for diverse possibilities of multi-level constraints which can be unusual in relation to most common, routine uses of language (such as in journalistic or instructional texts). In this sense, a poem submits the language to extreme conditions and provides a scenario (an "experimental laboratory") for observing the emergence of new semiotic cognitive behavior as a result. This process can be described as an “epistemic engineering” of language. A notable example is the verse as a tool that supersizes the experience of recursive temporal behavior through patterns of iterative structures (syntactic, grammatical, phonetic, rithmic) (cf. Jakobson 1983).

Our research question is: how to translate this multi-level cognitive artifact? According to our approach, a translator of a poem attempts to rebuild a cognitive and semiotic engineering experiment. This is a situated problem-solving task: the task of rebuilding a multi-level system of constraints. Assuming that a poem is an experimental cognitive laboratory, and a *strange* cognitive artifact (see Noë 2015) designed for testing of new patterns of language behaviors, a translation of poetry is a replication of a language experiment and an observation of how another artifact can produce analogous results.

8.2 Situated problem solving

The cognitive process of translation can be generally described as a problem-solving activity (Wotjak 1997, Levý 2000: 149). A problem solving tasks possess a formal structure of problem states organized in a problem space according to rules. This formal structure is instantiated in situational-specific materially-dependent artifacts (e.g. the "tower of hanoi" puzzle has a formal structure which can be instantiated in several different types of materials, from plastic or wooden pieces to digital virtual pieces, with various different shapes, colors, weights etc). Problem solving (Newell & Simon 1972) consists in going from an initial state of a problem to an end state of a problem, according to allowable moves determined by rules. It is not necessary that these rules are explicitly declared: they may also be a consequence of the physical properties of the materials that constitute or that are used in the problem solving task (see Zhang & Norman 1994, for examples of materially-dependent rules in versions of the tower of hanoi puzzle).

A well-known distinction in problem solving theory is between well- and ill- defined problems. Well-defined problems (such as classical puzzles) possess an easily identifiable rules and states, but, more importantly, an unambiguous solution set. Differently, an ill-defined problem may have: a varied gradient of adequate solutions, no solution known in advance (and in this case part of the task of the solver is to develop what counts as a better answer), no fixed set of rules (and thus no fixed set of choices, consequences to choices, and evaluation of choices) (Kirsh 2009: 268).
In the classical approach to problem-solving, problems can be seen as determining, for its solvers, an abstract formal structure of the problem that is invariant across

different instantiations of the task. A different approach is situated problem-solving, which is highly concerned with local and contextual influences to tasks, so that the formal structure of a problem is decisively instantiated and dynamically coupled to the activity-specific materially-dependent artifacts available to the solver at a given situation (Kirsh 2009: 271).

Poetry translation is an example of an ill-defined situated problem-solving task whose main operations concern the coupled reorganization of both cognitive artifacts (i.e., the poem itself in its linguistic context) and problem spaces (e.g., what counts as an optimal translation and how to perform it). These operations of coupled reorganization between higher and lower levels of description of a poem can be conceptualized as generation and selection of hypotheses regarding the multi-level constraining of descriptive levels of cognitive artifacts, including the functional properties of the artifact in a problem space. In this sense we call the situated problem solving task of poetry translation as a multi-level translation.

8.3 Multi-level poetry translation

Multi-level poetry translation is a situated problem-solving task in which the initial state is the source-poem and the end state is a target-poem which rebuilds in a target-language some chosen multi-level constraints of the source-poem. This task involves two logically subsequent phases (which don't need to follow a strict chronological order): (i) selecting for translation the best possible set of multi-level constraints from the source-poem and (ii) selecting the best possible way of reconstructing this set of multi-level constraints in the target language. The result of phase (i) has the capacity to significantly alter the problem space of phase (ii). The optimal goal of the translation is the replication, in the target-language, of the language experiment performed in the source-language by the source-poem. This goal provides criteria for the selections performed. In phase (i), *the best possible set of multi-level constraints to be translated* correspond to the set of multi-level constraints of the source-poem which most decisively scaffolds/embeds the linguistic experiment in the source-language. In phase (ii), *the best possible way to reconstruct the previously selected set of constraints* corresponds to an analogous scaffolding/embedding of a linguistic experiment in the target-language. In order to

perform the task phase (i), the translator must manipulate the source-poem as a cognitive artifact, performing a language experiment in the source-language, observing its results, and analyzing which constraints of the poem support these results. In order to perform the task phase (ii), the translator must construct rival hypothetical versions of the source-poem in the target-language and manipulate them as cognitive artifacts, observing their results and comparing to the result obtained by the source-poem experiment. The structure of the two phases is shown in tables 8.1 and 8.2, below:

Table 8.1: Phase 1 of the translation problem-solving task

Multi-level translation problem-solving task - phase 1	
Initial state	the source-poem: a cognitive artifact for the performance of language experiments in the source-language.
End state	a selected set of multi-level constraints that most decisively scaffolds/embeds the language experiment in the source-poem
Intermediate states	consideration of rival sets of multi-level constraints for translation
Rules for moving between states	manipulation of the source poem: performance of the language experiment, observation of the results, and analysis of which constraints of the poem support the results

Table 8.2: Phase 2 of the translation problem-solving task

Multi-level translation problem-solving task - phase 2	
Initial state	a selected set of multi-level constraints that most decisively scaffolds/embeds the language experiment in the source-poem (end state of phase 1)
End state	the target-poem: a cognitive artifact that replicates in the target-language a language experiment which can be performed in the source language by the source-poem
Intermediate states	consideration of rival hypothetical ways of reconstructing the selected set of multi-level constraints from the source-poem in the target-language
Rules for moving between states	manipulation of rival versions of the target-poem: performance of the language experiment in each version, observation of the results and comparison of the results with the results of the language experiment in the source-language

To exemplify this problem-solving task, we take a translation of an excerpt from John Donne, made by the Brazilian poet Augusto de Campos (1986: 75), of the poem “The Expiration”. The source and target poems can be seen in Table 8.3. Below, we use excerpts of Campos' writing about his translation activity to exemplify the multi-level translation task schematized above.

Table 8.3. Source and target poems of Augusto de Campos' (1986, pp. 78-79) translation of "The Expiration" by John Donne

The Expiration (excerpt) - John Donne	**A Expiração (excerpt) - Augusto de Campos**
So, so, leave off this last lamenting kiss, which sucks two souls, and vapours both away, turn thou ghost that way, and let me turn this, and let our selves benight our happy day; we ask’d none leave to love; nor will we owe any, so cheap a death, as saying, Go; go; and if that word have not quite killed thee, ease me with death, by bidding me go too. Oh, if it have, let my word work on me, and a just office on a murderer do. Except it bee too late, to kill me so, being double dead, going, and bidding, go	Susta ao beijo final a fome de beijar que as duas almas suga e a ambas evapora, e, fantasmas do amor, fantasiados de ar, façamos nós a noite em nosso dia agora; amar não custou nada, nada vai custar a morte que eu te dou, dizendo: -- Vai embora! -- Vai! Se este som mortal não te matar por fim, dá-me tal morte então, mandando-me partir. Ai! Se matar, que som igual ressoe em mim E ao matador que eu fui também o mate assim, Se não matar demais, por me fazer sentir dobrada a morte e dor, indo e mandando ir.

Source and target poems correspond respectively to the initial state of phase 1 and the end state of phase 2 of the multi-level translation task schematized above. Departing from the source poem, the first logical step is to perform a language experiment in the source language using the source poem as a cognitive artifact. The results of such language experiment by Campos are reported in the extensive quote below:

> "On the semantic level, the poem develops the title's image taken in the double sense of "breath" and "death", and changed to a sense of loving separation: the lover invites his beloved to breathe into the air the final kiss (through their breath the two phantom souls will leave their bodies) and suggests to himself to kill his love with a simple word: "go!" ("vai") that sets off separation and death. [The lover] asks, finally, that this word may echo in himself which will mean to die twice (being double dead) by "going" and "ordering to go" (going and bidding go).
>
> This conceptual equation finds echo and icon in the phonetic and graphic layers of the poem through a specific artifice: the reduplication, that here can occur with morphemes (so, so / go; go) with close phonemes in alliterative pairs (last lamenting / sucks two souls turn thou / turn this leave to love / word work), or even with repeated graphemes (we owe) / (we owe), and with a whole chain of double graphemes and phonemes especially involving b / d / g
>
> (...). Here it is in a graphic transcription that is meant to stress the iconopaic components:
>
> being double dead, going and bidding, go
>
> The double death is recorded and spelled out in this line in bb and dd and gg (...). Of the words beginning with consonants (which is all except one) two begin with b two with d and two with g. Among those that begin with d and g two (dead and going) begin and end with the same consonant. and the last two words (bidding, go) are connected by the consonant g. The entire line is permeated by scatterings of the b and d (in the phonic area there must still be taken into account the succession of nasal sounds (being / going / and / bidding)." (Campos, 1986, p. 75)

The main multi-level constraints of the source poem selected for translation by Campos go from the semantic level to the phonetic and graphic level, and concern what the author terms a "conceptual equation" of reduplication. In the semantic level such reduplication refer to lover and beloved echoing themselves in a double death and breath (the expiration). In the phonetic and graphic levels the reduplication refer to repetition of morphemes, phonemes and letters. There are others constraints found in the translation activity and which are not referred to by the author in this excerpt such as the structure of rhymes and stanzas.

Campos' selected set of multi-level constraints limits the space of possibilities of the translation tasks, but also suggests new possible levels to participate in the multi-level constraining, such as the typographic level: “in my transcreation I start with a lower-case letter and use fonts in which b and d are mirror-forms to obtain the maximum iconic rendition” (Campos 1986, p. 75).

The whole operation performed by Augusto as described above can be modelled as the "transcreation game" as shown in the tables below:

Table 8.4: Phase 1 of the "transcreation game" as performed by Augusto de Campos

The "transcreation game" - phase 1	
Initial state	source-poem (whole)
End state	consideration of rival -- but not chosen -- structures of constraints
Intermediate states	selection a structure of constraints between levels of description as relevant for translation, including the "conceptual equation of reduplication" as a constraint from the semantic level to the graphical and phonetic levels

Table 8.5: Phase 2 of the transcreator game as performed by Augusto de Campos

The "transcreation game" - phase 2	
Initial state	the selected set of multi-level constraints (End state of phase 1)
End state	consideration of rival -- but not chosen -- solutions for such relation
Intermediate states	target-poem (whole): selected solution

8.4 Conclusion

The definition of poetry as a cognitive artifact designed to investigate strange and unexpected patterns of natural language behavior has several predecessors (see Eco 2006) and is based on the notion that language is a self-constructed cognitive niche (Clark 2007), a cognitive technology (Clark 2001), or a cognitive artifact (Clark 1997). Here, poetry works as a collaborative open-source niche used to perform linguistic experiments and assessing the results of such experiments. Translation replicates a cognitive linguistic experiment to observe how another language produces analogous results. Translation of poetry is a rare example of an ill-defined although highly structured case of situated problem solving. It affords comparison between rival hypotheses and solutions, description of the problem solving steps, and it is generally accepted as an example of creativity. Here we have modeled poetry translation as the rebuilding of a multi-level system of constraints. Our approach suggests an epistemic function for poetry (and perhaps the arts in general; see Noe 2015) which can be characterized as language niche construction, and translation as a valuable phenomenon for the study of this function.

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9 Conclusion

The contributions of this thesis to Cognitive Semiotics and Philosophy of Art include, mainly: the interdisciplinary approximation between Process Philosophy, Semiotics, Distributed Cognition, Cultural Evolution and Philosophy of Art; the provision of new examples and insights to previously formulated arguments in the field; the suggestion of a conceptual framework to approach cognitive aesthetic phenomena. In this section we give a summary of the main contributions articulated along the previous chapters as well as a final theoretical formulation of art as meta-semiotic engineering and artists as niche builders.

9.1 Niche Builders & Meta-semiotic engineering

As argued in Chapter 2, semiosis (i.e., a meaning process) can be characterized as the communication of a habit (a historically-established regularity) that constrains interpretative activity. In our use, this is a highly processual approach to meaning proceeding from the premise that there is no such thing as units or building blocks of semiotic activity, but rather constraints that guide (reduce the number of possibilities) and thus confer relative stability to an ongoing development (a flux) of semiosis. Throughout this thesis, we have applied the (often overlooked) Peircean definition of semiosis as communication of a habit to several examples in situated problem solving and in the arts, and used it as the basis for our view of creativity and development of artistic paradigms.

Although not explicitly treating the notion of process, Chapter 3 description of the relation between iconicity, abductive inference and situatedness of reasoning relies heavily on this processual conception of cognition, and offers a visual model of communication of habits as reduction in number of interpretative possibilities (figure 3.5, reproduced below). The figure shows three diagrams with lines representing possibilities for moving between problem states. Each diagram can be seen as a mapping of possible chains of semioses regarding the problem solving task in question. Such well-defined mapping is only possible because we are dealing with a highly constrained cognitive environment with a well-defined set of cognitive

artifacts (see Situated problem solving, above). The first two diagrams -- labeled (a) and (b) -- show different 'maps' of possible problem states that can be attained in two versions of the Tower of Hanoi puzzle. Diagram (c) is comparison between the two other diagrams. Diagram (b) is much more constrained than diagram (a) -- that is, there are less possibilities to move in a direction other than the objective of the puzzle. This difference is precisely what constitutes the iconic meaning of one sign in relation to another. Meaning, in each version of the puzzle is thus expressed as regular, goal-oriented, constraining in possible cognitive activity.

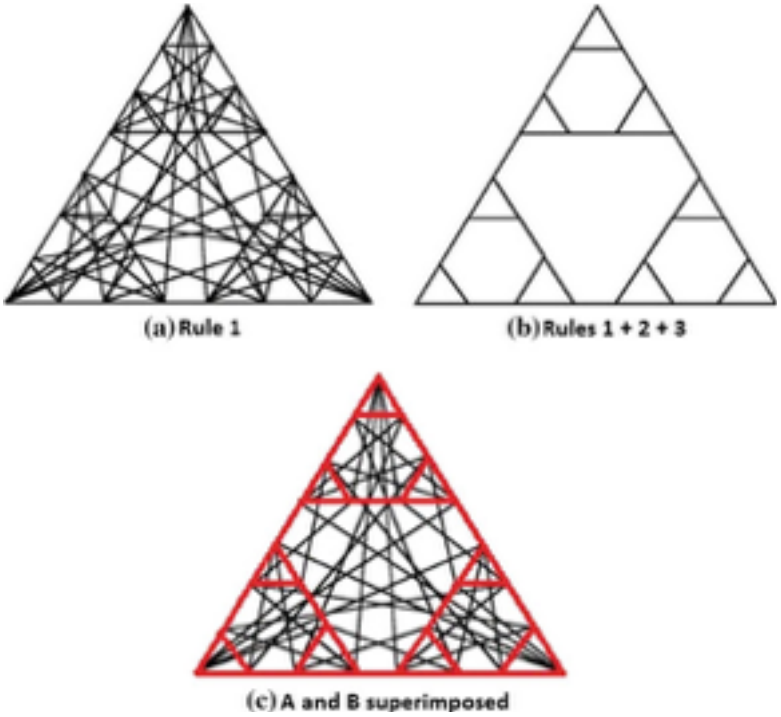

Figure 9.1 (reproduced as Figure 3.5 in chapter 3 of this thesis) illustrates the view that signs are sets of constraints in interpretative behavior. Diagrams (a) and (b) show problem spaces of possible cognitive performance in a problem solving task for different versions of the Tower of Hanoi puzzle game, in an experiment from Zhang & Norman (1994). The version (b) is more iconic than version (a). Iconic meaning, in this case, corresponds precisely to the constraints mapped.

This characterization of meaning as interpretative activity constrained by regularity of action lead to the insight that the Object of a Sign is a problem space: a set of systematically organized possibilities for action/cognition. Thus, H. Beck's Diagram of the London Underground System (Chapter 4) is efficient not for being an icon of the Underground System itself, but an icon of the formal structure of a problem

space. This conclusion has an important consequence for the notion of iconicity: If the Underground System itself is not the Object of S-O-I, than being able to discover more information of *any kind* about the Underground System has nothing to do with iconicity: such a definition ignores the processual and interpretant-dependent character of semiosis. The example analysis suggests that iconicity is more related to a habit of action being materially instantiated in a sign (externalization of constraints). This conclusion abstracts away from the notion of meaning as units that encode information about something else. According to such processual view, a clearer operational definition of icon is anything which, when manipulated, constrains cognitive behavior so as to guide action in accordance with a structure of behavior embedded in its Object. Thus, mathematical equations, graphs, diagrams of all kinds, are all icons, in the sense that they potentially guide action in a fruitful way, and not that they are containers of information (note that this definition still doesn't take into account 'how' they guide action). In the same sense, a noun is not an icon of the thing it stands for because it doesn't constrain cognitive behavior in accordance with the behavior of the thing it stands for (unless it is an onomatopoeia, for example), but it can be an icon, for example, of its etymological origins.

If meaning is essentially mediation of habits, how do we characterize a habit regarding its situatedness? That is, where are habits located? Chapter 5 stresses that according to Peirce's semiotics, meaning cannot be located in a sign, in some semiotic-head (intracranial or neuronally-based system of symbols), in the referent of the sign, or in the medium by which the sign is transmitted to its potential receiver and interpreter. We argue that Evolutionary Biology's notion of niche construction is a good candidate to conceptualize the locus of a situated, distributed and historically constructed phenomenon. Respectively, niche construction is environmentally-dependent, not reducible to a subset of elements (species, resources, environmental factors, etc) and inherently evolutionary.

A consequence of this argument is that iconicity ("externalization of constraints"), in the sense that it externalizes a habit and that it can have determinative power over its Object, is the only type of semiosis which makes a regularity pattern manipulable. This suggests that cognitive niche construction proceeds through iconic semiosis. In chapter 4, Beck's diagram design have taken advantage of a habit or form found in

electrical circuit diagrams. His London Underground Diagram (LUD) has served as medium through which this form has been applied to a new problem space: that of urban transportation, and has since constrained the cognitive performance (i.e. generated interpretants according to the semiotic form in question) of an uncountable number of users across the world. As the following passage speculates, this mediation actually constructs a new experience of the Underground System:

> "The experience the user has is, arguably, of a continuous homogeneous movement interrupted only by the stops in the stations, just like a straight line undisturbed by topographic issues and interrupted only by the chain of blobs or ticks that represent the stations. In this sense, a hypothetical user that is completely unaware of the geography of the city of London above the ground and is familiar only with the experience of the Underground might agree that, even intuitively, the LUD looks more like the Underground System than a geographically accurate map." (p. 60, chapter 4)

This process of emergence of novelty is the basis for our approach to creativity. Similarly to meaning, common temporal, spatial and causal loci for creativity are questioned in chapter 6: creativity is not to be found in a given entity (such as a “creative person”), nor in a given point in time (such as a “moment of insight”), and it is not caused by "mental abilities". According to this approach, creativity is causally distributed, and can be conceptualized through niche construction dynamics. More specifically, semiotic resources (i.e., cognitive artifacts: icons which mediate and have determinative power over the emergence of new habits) available in the niche embed opportunities for niche construction: dance shoes and one-point-perspective mediate constraints that orient dance towards the emergence of classical ballet, Cunningham's exploration of chance artifacts lead to innovations in choreography and the use of everyday objects, locations and patterns of motor behavior reframes the very concept of dance in the postmodern arts. Artistic paradigms evolve according to a self-constructed process of niche construction, and artists act as *niche builders*. The term "builder", which derives from the notion of "niche construction", should not to be understood as in an "architectonic metaphor": a niche builder doesn't depart from a set of units or elements ("building blocks") which she combines and structures in a certain way. A niche builder is part of an ongoing

evolutionary process, a flux of changes oriented by organizational constraints. More specifically, a niche builder is the agent of a semiotic relation S-O-I in which S is an icon which externalizes a habit of a problem space O, so that a new formal structure emerges in a problem space I, which may or may not be considered the same problem space as O (see figure).

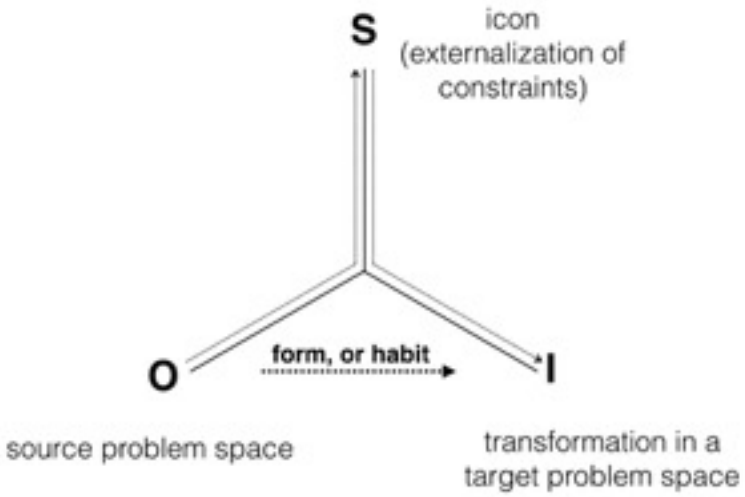

Figure 9.2: Niche building is an S-O-I relation in which S's externalization of constraints of a source problem space lead to further transformations in a target problem space

Most of the examples treated throughout the thesis can be considered potential niche building activities, as exemplified in the figures below:

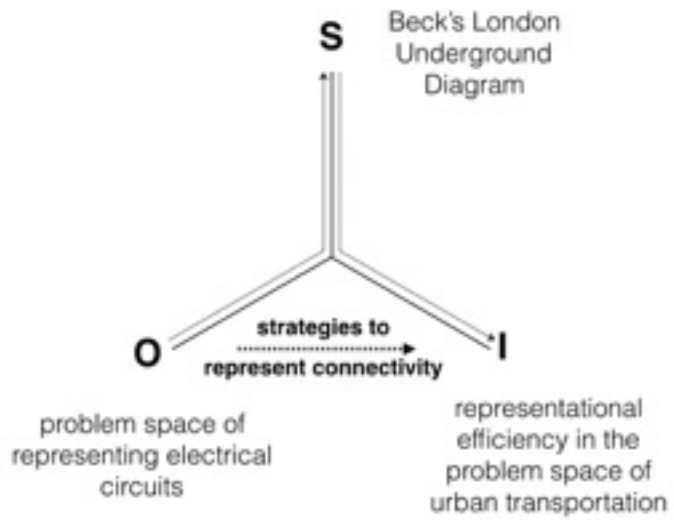

Figure 9.3: The design of the London Underground Diagram as a niche building process

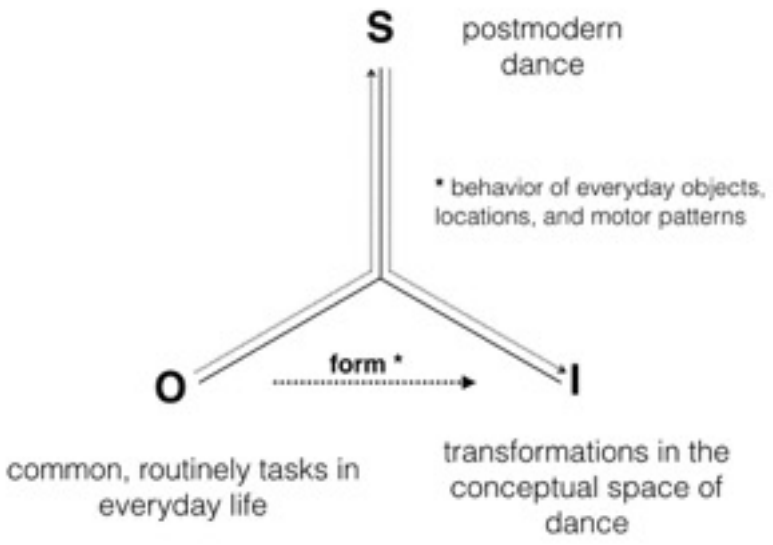

Figure 9.4: The emergence of postmodern dance as a niche building process

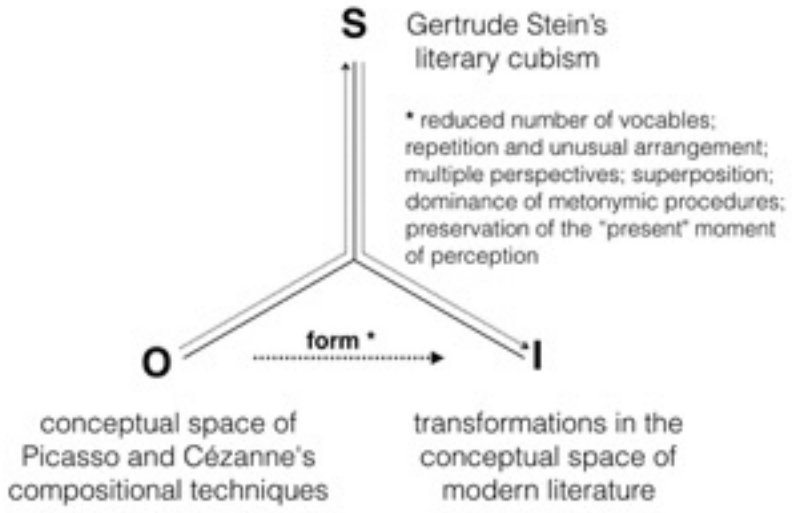

Figure 9.5: The design of the London Underground Diagram as a niche building process

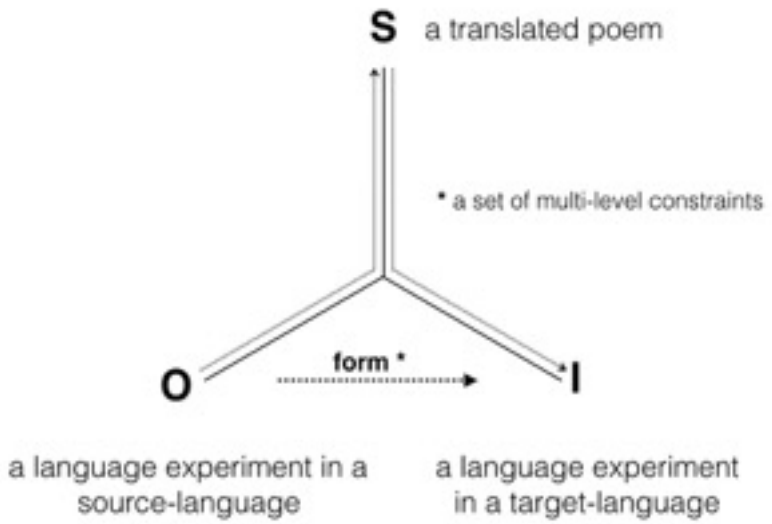

Figure 9.5: Poetry translation as a niche building process

Figure 9.2 shows an example of intersemiotic translation (IT) as a case of niche building. In chapter 7 we have indicated intersemiotic translation (IT) -- the communication of constraints between problem spaces -- as a fundamental operation in the evolution of artistic paradigms. In our example, Gertrude Stein's exploration of Picasso and Cézanne's pictorial compositional techniques has resulted in the creative transformation of modern literature. This indication builds on the previous insights that the Object of S-O-I is a habit of action (and its Interpretant is an effect of this habit), and that habits are localized in cognitive niches, so that meaning is structured in, and structures, cognitive niches. In another definition, a cognitive niche is a macro-level of semiotic activity (chapter 2), being thus both a cumulative result of semiotic activity and acting as boundary conditions for the emergence of semiosis as such. What is decisive here is that some iconic artifact possesses constraints capable of generating transformative effects in the habits of action of a niche. This seems to be especially true in the case of artistic artifacts. In chapter 8, we have argued that a poem functions as an experimental lab for performing language experiments: its experimental character lies in the fact that it allows for diverse possibilities of multi-level constraints which can be unusual in relation to most common, routine uses of language (such as in journalistic or instructional texts). Language acts a cognitive/semiotic niche (CLARK, 2005) embedding many rules of action that constrain different cognitive abilities, such as

reasoning, memory and attention. A poem is a cognitive artifact in which the usual rules of action of language are modified, so that language is observed to behave differently.

We suggest that this characterization of poems can be generalized to all kinds of artworks. Artworks function as epistemic engineering tools which externalize rules and afford manipulation of those rules. They are icons capable of determining, as an Object, an unusual or novel problem space with strange habits of action (see NOË, 2015). As this epistemic engineering drives niche construction, and niche construction on its turn function as the causal locus of boundary conditions which influence on the emergence of semiotic activity itself, this is a *meta-semiotic* engineering: a self-constructed process in which semiotic activity decisively reconstructs its own initiating and boundary conditions.

9.2 Final comments

The main arguments and contributions of this thesis can be summarized in six main points:

- Meaning is not a thing, but a process: signs are mediators of constraints in the flow of semiosis;

- Iconicity can be characterized as externalization of constraints;

- Cognitive niches (or semiotic niches) are the loci of 'habits' or 'forms', and the icon's directly presentation of a form is a mechanism of cognitive niche construction;

- An artwork is a a multi-level system of constraints and an experimental lab for meta-semiotic engineering;

- Artistic creativity and the evolution of artistic paradigms can be conceptualized as cognitive niche construction;

- Creative artists are niche builders.

These points suggest a framework for a pragmatist oriented cognitive aesthetics based on Peirce's process philosophy of sign and cognitive semiotics. This little explored approach is capable of providing new methods and premises for investigating "the aesthetic complex": (i) a notion of artistic creativity; (ii) a model of the relationship between meaning, creativity, artifacts and cognitive niches; (iii) a model of cognitive niche construction through iconic semiosis. This is a largely theoretical work, and further development should provide empirically testable hypotheses in Empirical Aesthetics, Cognitive Aesthetics and Experimental Semiotics, as well as attend to case analysis of the evolution of artistic paradigms in the Human and Social Sciences.

9.3 References

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NOË, Alva. **Strange Tools: Art and Human Nature.** New York: Hill and Wang, 2015.

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