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44 Iconicity in Peircean situated cognitive Semiotics

A psychologist cuts out a lobe of my brain . . . and then, when I find I cannot express myself, he says, 'You see your faculty of language was localized in that lobe.' No doubt it was; and so, if he had filched my inkstand, I should not have been able to continue my discussion until I had got another. Yea, the very thoughts would not come to me. So my faculty of discussion is equally localized in my inkstand. It is localization in a sense in which a thing may be in two places at once. (CP 7.366, 1902).

Although only recently a more systematic discussion upon the distributed nature of the mental processes have been established in empirical fields, the philosophical basis of this thesis and its variations have well-known precursors. Among them, the most quoted are William James, Wittgenstein, Dewey, James Gibson, Vigotsky, Merleau-Ponty, Heidegger (see Gallagher 2009, Kirsh 2009, Wheeler 2005). 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 fact, Peirce should be considered an important precursor of situated mind and distributed cognition thesis. But differently from the anti-cartesianism defended by some embodied-situated cognitive science, which is predominantly anti-representationalist, as recently explored in a Merleau-Pontyan (Dreyfus 2002), Heidegerian (Wheeler 2005), or a Gibsonian (Chemero 2009) trend, for Peirce, mind is semiosis in a dialogical – hence communicational – materially embodied form, and cognition is the development of available semiotic 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, languages, and so forth, as stressed by Skagestad (2004) and Ransdell (2003) with respect to the concept of intelligence augmentation. For Kirsh (2009: 297), “Peirce first mentioned this idea – that people use external objects to think with – in the late nineteenth century, when he said that chemist think as much with their test tubes as with pen and paper”.

The core of Peirce’s arguments combines two theses: the mind is a kind of semiosis; sign processes are extended within the spatiotemporal dimension, so

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that something physical has to instantiate or realize them. According to the first one, the mind is the nature of the sign-action (CP 5.313–14). The second thesis asserts that signs cannot act unless they are spatiotemporally realized. Thus, if a sign is to have any active mode of being, it must be materially embodied (or, at least, it results from a previous operation with material signs). A direct consequence of this combination leads us directly to the ideas on distributed cognition. The basic idea of distribution cognition thesis is that humans can alter the space for better organization of thought, by building artifacts that scaffold cognitive processes and increase and/or modify problem-solving activities, by simplifying choice, perception or internal computation and leading to the reduction of environment complexity (see Clark 1998 & Kirsh 1995). Cognitive artifacts are tools that work as prostheses capable of extending human capacities, creating new abilities and changing the way we structure and solve problems. More radically, it can be said that such mind-tools not only help thinking but rather that the mental activity itself is embedded in them. Mental activity takes place outside the head in a space designed and built to think (Sterelny 2003).

Peirce’s insights on the relevance of external semiotic processes in different forms of reasoning are interwoven in his cognitive semiotics. Semiosis exhibits a rich variety of morphological patterns. The morphological space of semiotic processes in which cognitive systems are embedded include proto-symbols (quasi-symbolic structures) and variations of indexical signs, besides symbolic and iconic processes (images, diagrams, metaphors). The icon is an important component in his semiotic view of mind, because it embeds a kind of signification especially dependent on the material of which the sign is made. We know little, however, about ‘how’ semiotic resources, their typological variations and their specific properties, are capable of changing or influencing cognitive performance, or as certain physical properties constrain different forms of inferences, e.g., abductive inference. According to Paavola (2011), in abduction the iconic character of reasoning is more prominent, which renders plausible that in this kind of inference external aspects are specially relevant. Magnani (2005), with focus in this particular property, has developed the concept of “manipulative abduction” to refer to those cases where the inference depends on the exploration of external resources – it “happens when we are thinking through doing and not only, in a pragmatic sense, about doing” (Magnani 2005: 274). It is described as concrete manipulative reasoning, an extra-theoretical behavior that implies the application of strategies related to extra-rational (emotional, esthetical, ethical, economic) components. (Magnani 2005: 274).

Peirce’s fundamental typology of signs exhibits a property capable of functioning as a conceptual criterion to distinguish different kinds of signs: the rela-
tive dependence of sign-object-interpretant (S-O-I) components in triadic relation
(S-O-I) (see Queiroz 2012). A symbol is an S-O relationship logically dependent of
I (CP 2.307). In a different way, an index is dependent of O. Constraints resulting
from the space-time existence of the object represented by the index are irrelevant
in symbolic processes. Icons, in turn, are deeply dependent on the material,
form and structure that they are made of – “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). According to this basic criterion, the icon is the only type of sign
which is S-dependent (that means, dependent on the sign material and struc-
tural organization itself) and is able to reveal, through its manipulation, some
information about the object. This operational property of iconicity is considered
a detrivilization of the notion that the icon is fundamentally based on a relation
of similarity (see Stjernfelt 2011), with important implications here. According
to Hookway (2002: 102), “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”. If the notion of iconicity attests the capacity of material features to be the
semiotic basis of important cognitive operations, and not only play a secondary
role, then it is a strong candidate to clarify situatedness and distributedness of
reasoning as a matter of manipulation of external resources.

Zhang & Norman are two of the scientists whose investigations have been
helping in the comprehension of external representational processes and problem-
solving tasks. As we try to demonstrate with the example of Zhang & Norman's
(1994) experiments with the Tower of Hanoi game, the icon is a main character
involved in the process of externalization of constraints. The way the artifacts
operate, in problem solving, creates a space of action which is dependent on
the material (and structural organization) of which the manipulated sign is
made. Zhang & Norman have used the tower of Hanoi game to study the influence
of external representations in cognition. More specifically, they were dealing
with the Representational Effect: difference in cognitive behavior caused solely
by external representational features. The Representational Effect is investigated
through the comparison of performance upon isomorphic representations in
problem solving tasks. We claim that the authors' experiment investigating the
level of isomorphism of rule representations (Zhang & Norman 1994: 20–23)
function as an example of externalized problem-solving based on iconicity.

There were three rules in the game for this experiment (see table 1) and two
ways in which these rules could be introduced in play: internally (given as a list
of instruction read before the experiment and memorized by the players) or
externally (automatically embedded in the material of play). Three isomorphs of the game were designed (see figure 1), which represented either internally or externally each of the rules. 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 were the worst: more time to solve, more number of steps required to solve and more wrong moves. For the most externalized version, the results were the best: less time to solve, less number of steps required and almost no wrong moves (see figure 2). This experiment, together with others in the same article, have led the authors to propose that more externalized representations are also more efficient representations for problem solving (see also Zhang 1997; Chuah, Zhang & Johnson 2000).

**Table 1:** The three rules of the Tower of Hanoi experiment. The rules could be introduced either externally (E) or internally (I), generating the isomorphs I123, I12-E3, I1-E23.

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

**Figure 1:** The three isomorphs used in Zhang & Norman’s experiment. (A) uses balls of different sizes moved between plates, so that all rules are presented internally; (B) uses disks of different diameters stacked one on top of the other between poles, so that rule 3 is presented externally; (C) uses cups of different sizes filled with liquid stacked one on top of the other plates, so that rules 2 and 3 are presented externally.
The criterion the authors have used to classify between internal and external rules matches a criterion for iconicity, namely, dependence of material properties, or S-dependence. The different isomorphs 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 inde-
pendently of the third term (I), because the constraints of S are a materializa-
tion of the formal structure of the game. The constraining upon the specific
material of play, which 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.

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. Accordingly, the claim for the efficiency of externalization of
constraints in problem solving is viewed here as a claim for the distribution of
problem-solving cognitive abilities through iconic artifacts.

Conclusion: If mind is exosomatically embodied
in signs . . .

The acceptance of external signs as part of human cognition leads to different
conceptions on the relation between cognition and environment that put much
more emphasis on the active participation of the latter in shaping our minds. We
actively participate in the construction of niches (semiotic structures and pro-
cesses physically available in the environment), which fundamentally alter our
capabilities (see Sterelny 2003; Sinha 2009; Bardone 2011). They make complex
semiotic processes available to attention, consciousness, perception, opening a
new range of semiotic operation; permitting, for instance, deep self-inspection
of complex semiotic processes.

We have used the Tower of Hanoi game experiment to identify a mechanism
through which iconicity influences in cognitive performance. Zhang & Norman’s
experiment indicated the process of externalization of constraints as a strategy
to improve performance in problem-solving tasks. This process of externalization
of constraints necessarily relies on the iconic character of signs because it
makes signification dependent on the materiality of the sign itself. Under this
framework, to distribute part of our tasks to external constraints in the ‘outside
world’ is an example of iconic semiosis.

How the dynamics of cognition depend on the material properties of signs
and the context of sign-action? The notion that we use external signs to think
with is uncontentious when signs are typically symbolic (which can be described
as borderline cases), such as maps and diagrams, algebraic notations, written
systems, etc. But the morphological space of semiotic events and processes in
which cognitive systems are embedded always include intermediary and mixed
classes of signs. The semiotic part of a theory of thinking with external resources should provide the formal and analytic tools for evaluating why certain things can function as signs that can be thought with. Peirce’s semiotics offers a highly consistent framework to investigate the use of different kinds of signs in cognitive processes. Peirce’s broad ideas concerning different types of signs and inferences are an important tool for advancing in the development of an externalist theory of mind. His treatment suggests that a reconsideration of the embodied-situated paradigm’s own philosophical foundations can behave in semiotic terms. Peircean semiotic theory of mind neither restricts representations to symbolic semiosis and inferential processes to deduction and induction as in orthodox representationalism, nor rejects representations as in anti-representationalism.