

## 2 Intersemiotic Translation as an Abductive Cognitive Artifact



*João Queiroz<sup>1</sup> and Pedro Atã*

AU: Please answer the attached query for this chapter. Thank you!!!

### 1. Introduction

Intersemiotic translation (IT) can be described as a cognitive artifact designed to distribute artistic creativity. Cognitive artifacts are part of material and cultural niches of human cognition. They have different forms and can be used in many different activities. Their varied morphology includes “material and mental” structures (Norman 1993), “designed for and opportunistic” entities (Hutchins 1999), and “transparent and opaque” processes (Clark 2004). For several authors, cognition is full of cognitive artifacts; even more radically, cognition is a network of artifacts. For many artists, intersemiotic translation is one of these tools, but what is its ontological nature, and how does intersemiotic translation work? As an augmented intelligence technique, intersemiotic translation works as a generative model, providing new, unexpected, surprising data in the target system and affording competing results that allow the system to generate candidate instances. To describe this process, we introduce a model of intersemiotic translation based on Peirce’s mature semeiotic. At the end of the chapter, we speculate about the role that abductive inference can have in the process of generating new ideas in an artistic domain. What we have done here must be considered a preliminary tentative model of intersemiotic translation as a cognitive artifact to externalize creativity.

### 2. “Mind Is Out There!”: Translator as a Cognitive Cyborg

Humans are natural-born cyborgs, symbionts “whose minds and selves are spread across biological brain and nonbiological circuitry” (Clark 2004, 3). This thesis is related to our ability to extend cognition through nonbiological devices, merging our cognitive activities with the operation of cognitive artifacts and creating an external and distributed cognitive system. Cognition is not a metaphor as “mind is just less and less in the head!” (Clark 2004, 4), or mind is “out of our heads” (Noë 2010; Wheeler 2005, 193). Humans couple bodies with a paraphernalia of

artifacts in order to augment perceptual, motor, and cognitive competencies. Cognitive artifacts are a constitutive part of our cognitive lives: We are able to alter conscious states and attention by using pharmacological drugs; we “freeze” reasoning and communicate it through the use of alphabets and other notation systems; and we organize, compare, and calculate the world through numbers, graphs, and diagrams. Various artifacts such as pen and paper, calculators, calendars, maps, notations, models, computers, shopping lists, traffic signals, measurement units, etc. are considered non-biological elements of a cognitive system (Hutchins 1999). Finally, the most impactful cognitive artifact that shapes human cognition is language, i.e. a deeply ingrained scaffolding device that radically augments what our cognitive systems can achieve in terms of categorization, memory, inference, learning, attention, as well as in building social relations and institutions (Clark 2006). These cognitive artifacts shape cognition. When we alter the constitution of our material environments of artifacts and the practices they afford, we can open new cognitive (and/or semiotic) niches (Clark 2006, 2010; Magnani 2007; Hoffmeyer 2007; Sinha 2015), giving rise to new patterns of semiotic activity which in turn feed back into the material environments themselves in a cumulative and ongoing process of niche construction (Laland et al. 2000). Humans are cognitive niche builders, extending the mind into space to think more efficiently.

The impact of this thesis, which is formulated in the context of discussions on the “extended mind” in the philosophy of cognitive science (Clark and Chalmers 1998; Menary 2010) is related to a challenge to the basic premises of “cognitive internalism,” the classical view of mind as a skull-internal processing system, connected to external semiotic resources through inputs and outputs. Extended mind emphasizes material and cultural environments of artifacts as constitutive of processes of reasoning and perception. This perspective has implications for the study of translation. First, cognition in translation is seen as dependent on the material and semiotic properties of cognitive artifacts (such as source and target texts and languages) and the operations performed on these artifacts to be cognition itself at work. Second, as source and target texts are different cognitive artifacts, any account of translation is also an account of a transformation in a cognitive system, a shaping or extension of cognition in a certain direction.

We are interested here in intersemiotic translation, a semiotic process, but also, according to the premises of Peircean semeiotic, a cognitive process. Our thesis is that intersemiotic translation works as a cognitive artifact for artistic creativity. In the next sections, we briefly define intersemiotic translation and introduce its conceptual premises located in Peircean semiotics. After that, we turn to the question of how intersemiotic translation works. To address this question, we characterize intersemiotic

translation as a generative artifact and take advantage of the notion of abductive reasoning to conceptualize it.

### 3. Intersemiotic Translation

Intersemiotic translation (IT) was defined by Roman Jakobson (2000 [1959], 114) as “transmutation of signs”—“an interpretation of verbal signs by means of signs of nonverbal sign systems.” After Jakobson’s definition, the term became broader, and now it designates relations between systems of different nature and is not restricted to the interpretation of verbal signs (Queiroz and Aguiar 2015). This process is observed in several semiotic phenomena, including literature, cinema, comics, poetry, dance, music, theater, sculpture, painting, and video. In this sense, the concept bears similarities to others like adaptation, ekphrasis, and transmediation. A difference is that the concept of IT is necessarily tied to the notion of semiosis (action of sign): It is grounded on the same logical and epistemological principles that ground the notion of semiosis, and it stresses a level of description in which communicational processes are treated as semiotic processes. The question “what is intersemiotic translation?” is thus related to the question “what is semiosis?” We approach this question from the domain of Peirce’s cognitive semeiotic.

### 4. Some Notions in CS Peirce’s Semeiotic

North-American pragmatist Charles Sanders Peirce,<sup>2</sup> founder of the modern theory of signs, can be considered a precursor of situated mind and the distributed-cognition thesis (Atã and Queiroz 2014). However, in contradistinction from the anti-Cartesianism defended by some radical embodied-situated cognitive scientists, which is predominantly anti-representationalist, 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 the development of semiotic artifacts such as writing tools, instruments of observation, notational systems, languages, and so forth, as stressed by Skagestad (2004) with respect to the concept of intelligence augmentation. Peirce’s concept of semeiotics as the “formal science of signs” and the pragmatic notion of meaning as the “action of signs” have had a deep impact in philosophy, psychology, theoretical biology, artificial intelligence, and cognitive science (Queiroz and Merrell 2009). Peirce defined semeiotic as a kind of logic, a science of the essential and fundamental nature of all possible varieties of meaning processes (semiosis) (Atkin 2016). This framework provides a pragmatic general model of semiosis (Fisch 1986, 321) as well as a list of fundamental varieties of representations based on

a theory of logical categories (Atkin 2013; Savan 1987–88). In brief, the categories can be defined as follows:

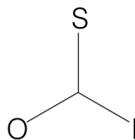
- Firstness: What is such as it is, without reference to anything else.
- Secondness: What is such as it is, in relation with something else, but without relation with any third entity.
- Thirdness: What is such as it is, insofar as it is capable of bringing a second entity into relation with a first one in the same way that it brings itself into relation with the first and the second entities.

Firstness is the category of vagueness and novelty (CP 1.25); Secondness is the category of reaction, opposition, and differentiation (CP 8.330); Thirdness is the category of conceptualization, habit, generality, and semiosis (CP 1.340).<sup>3</sup>

Semiosis is a concept that describes the most fundamental relations involved in processes of meaning and cognition as opposed to reactive, brute-force processes (EP 2:646). A description of the difference between semiotic (Thirdness) and non-semiotic processes (Firstness and Secondness) is, according to the Peircean model, a formal description and deliberately avoids using psychological and cultural notions. Thus, speaking in formal terms, this model differentiates between semiotic and non-semiotic processes by describing semiotic processes as irreducibly triadic relations while non-semiotic processes can be decomposed into monadic and dyadic relations (Burch 1991; Brunning 1997). According to Peirce, any description of semiosis should necessarily treat it as a relation constituted by three irreducibly connected terms, namely sign, object, interpretant (S-O-I, in short), which are its minimal constitutive elements (CP 5.484, EP 2:171) (see Figure 2.1):

by “semiosis” I mean [. . .] an action, or influence, which is, or involves, a cooperation of three subjects, such as a sign, its object, and its interpretant, this tri-relative influence not being in any way resolvable into actions between pairs.

(CP 5.484)



*Figure 2.1* The triadic relation S-O-I. Notice that a triad is different from a triangle. This visual difference is relevant since in a triad the three terms are irreducible, while in triangle two vertices are connected regardless of the third vertex (Merrell, 1997).

Triadic irreducibility is a requirement of any process that we might regard as “interpretative,” “cognitive,” or related to “meaning.” Cognitive and meaning processes are described as the action of a sign (semiosis). In this concise definition, “A sign, or representamen, is something which stands to somebody for something in some respect or capacity” (CP 2.228). The expression *stand for* is metaphorical. S in S-O-I is what *stands for*, the entity or process being employed by a cognitive system to *stand for* something else. O in S-O-I is something else that the sign stands for. This “standing for” relation involves a *constraining* or regulation of S by O (S is understood in relation to O). I in S-O-I is an effect produced in a cognitive system by the use of S as *constrained* by O. Semiosis in the cases that interest us here is thus an irreducible process through which a *constraining* factor (O) acts on interpretative behavior (I) because of the mediation of a certain entity (or group of entities) or process (S).

It is important to stress that there are no intrinsic attributes defining the ontology of S, O, or I. The functional role of S can be identified only in the mediative relation that it establishes between O and I. Similarly, the functional role of O is identified in the relation by which it determines I through the mediation of S. Finally, the functional role of I is identified by the fact that it is determined by O through S. Therefore, if we consider only dyadic relations, S-I, S-O, or I-O, or the elements of a triad in isolation, we cannot deduce how they would behave in a triadic relation, S-O-I (EP 2:391). Thus, the irreducibility of semiosis should be understood in terms of the non-deducibility of the behavior of the logical-functional elements of a triad on the grounds of their behavior in simpler relations. Another important point is that the complex (S-O-I) is the focal-factor of a dynamical process (Hausman 1993, 72). As a process thinker, it was quite natural that Peirce conceived semiosis as basically a process in which triads are systematically linked to one another so as to form chains.

Peirce also defined a sign 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. The concepts of semiosis and of mediation involve the same formal structure and are conceptions of the same phenomenon as regarded from different perspectives.

[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)

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). For Peirce, form is nothing like a “thing” (De Tienne 2003), but 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). Form can also be defined as potentiality (“real potential,” EP 2.388). According to Flower and Murphey, there is a transition in Peirce’s semeiotic from the notion of meaning as a qualitative conception carried by a sign to a relational notion according to which the meaning of a concept consists in a “law relating operations performed upon the object or conditions of perceptions to perceived effects” (Flower and Murphey 1977, 589). The qualitative conception involves reference to the sign’s ground while the “law” or necessary conditions of perception are relational rather than qualitative: “If the meaning of a concept of an object is to consist in the conditionals relating operations on the object to perceived effects, these conditionals will in fact be habits” (Flower and Murphey 1977, 590).

The notion of semiosis as “habit” (a general quality) 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). If semiosis is a triadic-dependent process in the sense that it connects sign (representation), object, and an effect on the interpreter (interpretant), the functional role of S can be identified only in the mediative relation that it establishes between O and I. Importantly, S is not a logical atom, an ultimate unit of analysis but it is part of a triadic-dependent ongoing process that is more precisely characterized as a “chain of triads.” Semiosis necessarily entails the instantiation of chains of triadic relations since a sign in a given triad will lead to the production of an interpretant, which is, in turn, a new sign. Therefore, an interpretant is both the third term of a previous triad and the first term (sign) of a subsequent triad (Savan 1986. See Figure 2.2).

AuQ1

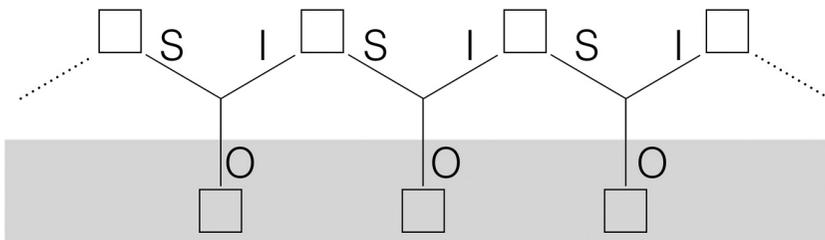


Figure 2.2 The triadic relation S-O-I forming a chain of triads.

## 5. Intersemiotic Translation as Semiosis

If translation is a semiotic process, the previous description also corresponds to a minimal formal description of what a translation is. In an intersemiotic translation, the semiotic relation S-O-I describes how a translation source is translated into a different semiotic system, resulting in a translation target. There are two possible ways of mapping a translation source and a translation target to the S-O-I triad (Queiroz and Aguiar 2015; Aguiar and Queiroz 2013): Either the source is the sign (S) and the target is the interpretant (I) (model 1, see Figure 2.3), or the source is the object (O) and the target is the sign (S) (model 2, see Figure 2.4):

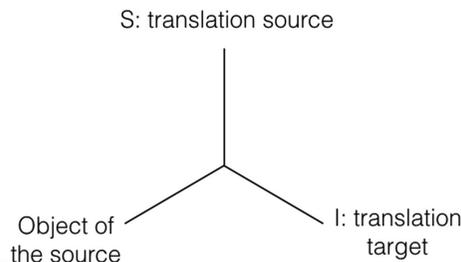


Figure 2.3 “Model 1” of intersemiotic translation. In this case, the translation source is a sign, which mediates an object so as to determine the translation target as an effect. Note that this model graphically represents the object of the source but not the effect of the target on its interpreters. Model 1 describes how, through a translation source, a certain pattern of constraints acts on a translation target.

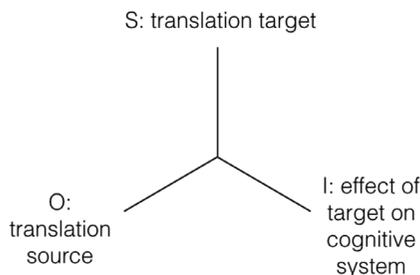


Figure 2.4 “Model 2” of intersemiotic translation. In this case, the sign is the translation target, which mediates a translation source (viewed not as a substance, but as a regulatory pattern), so as to determine an effect on a cognitive system. Note that this models graphically represents the effect of the target on a cognitive system but not the object of the source. Model 2 describes how, through a translation target, a translation source constrains the interpretative behavior of a cognitive system.

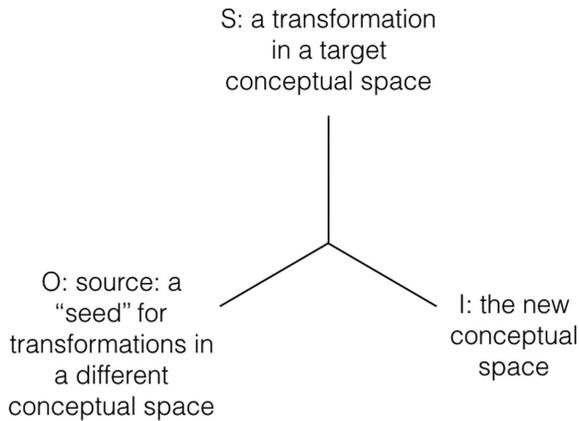
What are the implications of modeling an intersemiotic translation through model 1 or model 2? The two models are not two different types of intersemiotic translation but show different aspects of a same phenomenon. Model 1 puts the translation source in the functional role of sign and includes the object of the translation source in the model. It shows how the object of the translation source is co-dependent on the translation target: Different intersemiotic translations of the same source will stress, unveil and/or construe different semiotic objects. Model 2 puts the translation target in the functional role of sign and includes the interpreter of the target in the model. The object of the triad is the translation source. In this model, we have the notion that a translation target stands for a translation source. This S-O connection is, of course, dependent on interpretative effects being produced in a cognitive system. An obvious example of a cognitive system is an audience. Thus, Model 2 captures the notion that a work is perceived by an audience as a translation of another work.

## 6. Intersemiotic Translation as a Generative Artifact

One of the functions of IT explored by creative artists is to take advantage of the semiotic difference between source and target to generate competing and otherwise unprompted creative opportunities in the target system. During the creative process in an intersemiotic translation, a transformation in the target semiotic system leads to a cascade of further transformations in that system. The regulatory principles (the “structure” of thinking) that are used to regulate a conceptual space are interacting, changing, or being partly abandoned in favor of a different set of regulatory principles, which are being developed from the translation source. The translation source, in this case, functions as a generative structure, a “seed” which is being brought to act on a target semiotic system. Any translation choice that a creative cognitive system makes that establishes a transformation in a target conceptual space is a choice understood in reference to this generative seed. In this case, a transformation in a conceptual space occupies the functional role of sign while the translation source occupies the functional role of object. The interpretant that they cause, and in virtue of which they are brought together, is the notion (to be realized in the future) of a new conceptual space (see Figure 2.5).

## 7. Thinking With Signs and the Role of Abductive Inference

We take advantage of the concept of abduction as a way of explaining the inferential process involved in the use of intersemiotic translation as a cognitive artifact. Peirce’s conceptualization of inferences is developed



*Figure 2.5* Intersemiotic translation as a generative artifact. Because of the semiotic relation depicted, any transformation in a target conceptual space is taken to be a sign of a translation source. This intersemiotic relation between source and target is used to effect further transformations that (potentially, in the future) lead to a different conceptual space.

in the context of the normative science of logic. In this context, abduction is the inference connected to a first step of discovery, the generation of explanatory hypotheses at the starting point of scientific inquiry (Paavola 2012, 2011). Our interest here is in a different context: creativity in arts. This premise is at odds with a common view in philosophy of science that there cannot be a logic of discovery but only a logic of justification. According to such a view, discovery and creativity are far too irrational to fall under the scope of logic. How can the operation of distributed cognitive systems manipulating a morphologically diverse network of external artifacts in order to generate an artistic product be viewed as inferential?

Peircean semiotics are based on some premises that give a broad scope to the concept of inference. According to Peirce’s theory of mind, *thinking is semiosis*, and to conceptualize semiotic phenomena is to conceptualize cognitive phenomena. Furthermore, as argued previously, this is a formal or quasi-formal kind of conceptualization. Peirce’s system of categories is thus both quasi-formal as well as meant to encompass all kinds of sign use, or cognitive activity in general. Under this broad application, logical inferential activity is taken to be more ubiquitous than otherwise. It includes any kind of reasoning, and is also extended to certain perceptual processes (“perceptual judgments”) (CP 5.180–194). Such ubiquity of inferential processes in cognition is largely due to the notion of abductive inference (Paavola 2014).

In Peirce’s typology, inferences are classified into three irreducible types—abduction, deduction, and induction—corresponding to three

Table 2.1 Some properties of abduction, induction and deduction.

Inference Type	Security and Uberty		States that something...	Ampliative?	Conclusion
Abduction	↓ Greater security ↓	↑ Greater uberty ↑	may be	Yes, with explanatory considerations	Creation of a hypothesis
Induction			actually is	Yes, without explanatory considerations	Internalization of some observed regularity
Deduction			must be	No	Implication of something already implicit in the premises

subsequent phases in the process of scientific inquiry (CP 6.469–473; Hookway 2002, 273) (see Table 2.1). Abduction arises from the observation of a mass of facts that does not fit into the habits and expectations of the observer and culminates with the formation and selection of a hypothesis. Deduction develops necessary consequences of the previous premises. Induction performs generalization from a number of cases (CP 2.623). The characterization of abduction as the transformation of mass of facts into hypotheses and the first stage of inquiry brings it close to perception. For Peirce, perception involves an inferential 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 were 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). Here, abduction is like an “act of insight” that “comes to us like a flash” (CP 5.181). 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).

These descriptions of abductive inference typically consider an agent coming into contact with an already existing surprising situation and attempting to provide an explanation for it, a scenario which is appropriate for speculating about scientific discovery. There are some relevant differences when we use abduction to describe the use of intersemiotic translation in creative processes. As we are describing the “production” side of artistic process, it is not so paradigmatic to consider an agent that

encounters an already existing surprising situation. In this case, abduction is more close to setting a semiotic experiment to provoke the occurrence of surprising events and observe them. The agent, in this case, anticipates the observation of novelty, and attempts to provide some semiotic conditions for novelty to be created. This is a case in which abduction relies on manipulation of external resources, similar to Magnani's (2005, 274) concept of manipulative abduction: "when we are thinking through doing and not only, in a pragmatic sense, about doing." This is also a process of investigation centered on the iconicity of the sign, in the sense of uncovering the sign's qualitative and diagrammatic potentialities. According to Paaavola (2011), 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 (*ibid.*, 305). Paaavola has referred to these characteristics that only suggest a way in which they could be interpreted as clue-like characteristics. In their semiotic experiments, creative artists engage with the iconic, clue-like characteristics of their experimental setup. In a successful experiment, they are able to abduct surprising conclusion about how a sign behaves, what it can do, how it can signify its object in a new way.

## 8. Conclusion (for Further Developments)

We have suggested a treatment of translation through an association of two theoretical frames: Peircean semeiotic and the extended-mind hypothesis in the philosophy of cognitive science. Such association between the extended-mind hypothesis and Peirce's pragmatic notion of semiosis has not yet been attempted and impacts theoretical understanding of translation.

According to this treatment, a characterization of IT involves a description of the impact of the translation on the operation of cognitive systems. IT works as a cognitive artifact that shapes and extends cognitive operations: It distributes creativity by scaffolding transformation of conceptual spaces. This represents a shift in theoretical orientation from the notion of translation as a transfer of information load towards a notion of translation as a transformation or transmutation in a cognitive system.

Our treatment also includes a description of translation in terms of the Peircean model of semiosis. Although this has been tried before (Gorlée 2004; Robinson 2016), we propose it in a direction not yet explored, decomposing triadically the interacting components and attributing a crucial role to abductive inferences performed through manipulation of cognitive artifacts. We characterize the abductive role of the source-sign as that of a generative structure, which scaffolds transformations in a conceptual space.

## Acknowledgments

We thank anonymous reviewers for helpful comments during the preparation of this manuscript.

## Notes

1. Since 2008, João Queiroz has been coordinating several artistic projects on intersemiotic translation, from literature to comics, graphic illustration, photo-books, performance, and contemporary dance (see *Iconicity Research Group*, IRG: <https://iconicity-group.org/>). Since 2010, he has been working collaboratively with Pedro Atã, with whom he has developed theoretical models on this phenomenon.
2. We follow the practice of citing from the *Collected Papers* of Charles Sanders Peirce (Peirce 1931–35, 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 *Annotated Catalogue of the Papers of Charles S. Peirce* (1967) will be indicated by MS, followed by the manuscript number and pages.
3. For more on categories, see Hookway (1985), Savan (1987–88), Potter (1997), and Atkin (2016).

## References

- Aguiar, Daniella, and João Queiroz. 2013. "Semiosis and Intersemiotic Translation." *Semiotica* 196: 283–292.
- Atã, Pedro, and João Queiroz. 2014. "Iconicity in Peircean Situated Cognitive Semiotics." In *Charles Sanders Peirce in His Own Words—100 Years of Semiotics, Communication and Cognition*, edited by T. Thellefsen and B. Sorensen, 527–536. Berlin: Walter de Gruyter.
- Atkin, Albert. 2013. "Peirce's Theory of Signs." In *The Stanford Encyclopedia of Philosophy*, edited by E. N. Zalta. <<https://plato.stanford.edu/archives/sum2013/entries/peirce-semiotics/>>. Accessed October 7, 2017.
- Atkin, Richard. 2016. *Peirce*. Abingdon: Routledge.
- Brunning, Jacqueline. 1997. "Genuine Triads and Teridentity." In *Studies in the Logic of Charles Sanders Peirce*, edited by Nathan Houser, Don Roberts, and James van Evra, 252–270. Bloomington: Indiana University Press.
- Burch, Robert. 1991. *A Peircean Reduction Thesis*. Lubbock: Texas Tech University Press.
- Clark, Andy. 2004. *Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence*. Oxford: Oxford University Press.
- . 2006. "Language, Embodiment, and the Cognitive Niche." *Trends in Cognitive Sciences* 10 (8): 370–372.
- . 2010. *Supersizing the Mind—Embodiment, Action, and Cognitive Extension*. Oxford: Oxford University Press.
- Clark, Andy, and David Chalmers. 1998. "The Extended Mind." *Analysis* 58: 7–19.
- De Tienne, André. 2003. "Learning qua Semiosis". *S.E.E.D. Journal—Semiotics, Evolution, Energy, and Development* (3): 37–53.
- Fisch, Max. 1986. *Peirce, Semeiotic, and Pragmatism*. Bloomington: Indiana University Press.

- Flower, Elizabeth, and Murray Murphey. 1977. *A History of Philosophy in America*. Oxford: Capricorn Books.
- Gorlée, Dinda. 2004. *On Translating Signs: Exploring Text and Semio-Translation*. Amsterdam: Rodopi.
- Hausman, Carl. 1993. *Charles S. Peirce's Evolutionary Philosophy*. Cambridge: Cambridge University Press.
- Hoffmeyer, Jesper. 2007. "Semiotic Scaffolding in Living Systems." In *Introduction to Biosemiotics: The New Biological Synthesis*, edited by M. Barbieri, 149–166. Dordrecht: Springer.
- Hookway, Christopher. 1985. *Peirce*. Abingdon: Routledge & Kegan Paul.
- . 2002. *Truth, Rationality, and Pragmatism—Themes From Peirce*. Oxford: Clarendon Press.
- Hutchins, Edwin. 1999. "Cognitive Artifacts." In *The MIT Encyclopedia of the Cognitive Sciences*, edited by Robert Wilson and Frank Keil, 126–127. Cambridge, MA: MIT Press.
- Jakobson, Roman. 2000. "On Linguistic Aspects of Translation." In *The Translation Studies Reader*, edited by Lawrence Venuti, 113–118. Abingdon: Routledge.
- Laland, Kevin, John Odling-Smee, and Marcus Feldman. 2000. "Niche Construction, Biological Evolution, and Cultural Change." *Behavioral and Brain Sciences* 23 (1): 131–175.
- Magnani, Lorenzo. 2005. "An Abductive Theory of Scientific Reasoning." *Semiotica* 153 (1/4): 261–286.
- . 2007. "Creating Chances Through Cognitive Niche Construction." In *Knowledge-Based Intelligent Information and Engineering Systems*, edited by B. Apolloni et al., 917–925. KES 2007/ WIRN 2007, Part II, LNAI 4693. Berlin and Heidelberg: Springer-Verlag.
- Menary, Richard, and Robert Wilson. 2010. *The Extended Mind*. Cambridge, MA: MIT Press.
- Merrell, Floyd. 1997. *Peirce, Signs, and Meaning*. Toronto: University of Toronto Press.
- Noë, Alva. 2010. *Out of Our Heads: Why You Are Not Your Brain, and Other Lessons From the Biology of Consciousness*. New York: Hill & Wang.
- Norman, Donald. 1993. *Things that Make Us Smart*. Reading: Addison Wesley.
- Paavola, Sami. 2011. "Diagrams, Iconicity, and Abductive Discovery." *Semiotica* 186: 297–314.
- . 2012. *On the Origin of Ideas: An Abductivist Approach to Discovery*. New York: Lap Lambert Academic Publishing.
- . 2014. "Fibers of Abduction." In *Charles Sanders Peirce in His Own Words: 100 Years of Semiotics, Communication and Cognition*, edited by T. Thellefsen and B. Sørensen, 365–372. Berlin: Walter de Gruyter.
- Peirce, Charles S. 1931–35. *The Collected Papers of Charles Sanders Peirce*. Vols. I–VI, edited by C. Hartshorne and C. P. Weiss. Cambridge, MA: Harvard University Press; Vols. VII–VIII edited by A. W. Burks, same publisher, 1958. (Here referred as CP, followed by volume and paragraph number).
- . 1967. *Annotated Catalogue of the Papers of Charles S. Peirce*, edited by R. Robin. Cambridge: University of Massachusetts Press. (References to manuscripts and letters by Charles S. Peirce—MS and L—are in accordance with this catalogue).

- . 1998. *The Essential Peirce: Selected Philosophical Writings*. Vol. II, edited by Peirce Edition Project. Bloomington and Indianapolis: Indiana University Press. [1893–1913] (Here referred as EP, followed by the number of the page).
- Potter, Vincent. 1997. *Charles S. Peirce: On Norms and Ideals*. Amherst: University of Massachusetts Press.
- Queiroz, João, and Daniella Aguiar. 2015. “C. S. Peirce and Intersemiotic Translation.” In *International Handbook of Semiotics*, edited by P. Trifonas, 201–215. Berlin: Springer.
- Queiroz, João, and C. El-Hani. 2006. “Semiosis as an Emergent Process.” *Transaction of C.S. Peirce Society* 42 (1): 78–116.
- Queiroz, João, and Floyd Merrell. 2009. “On Peirce’s Pragmatic Notion of Semiosis—A Contribution for the Design of Meaning Machines.” *Minds & Machines* 19: 129–143.
- Robinson, Douglas. 2016. *Semiotranslating Peirce*. Tartu: Tartu University Press.
- Savan, David. 1987–88. *An Introduction to C.S. Peirce’s Full System of Semiotic*. Monograph Series of the Toronto Semiotic Circle. Toronto: Victoria College.
- Sinha, Chris. 2015. “Ontogenesis, Semiosis and the Epigenetic Dynamics of Bio-cultural Niche Construction.” *Cognitive Development* 36: 202–209.
- Skagestad, Peter. 2004. “Peirce’s Semeiotic Model of the Mind.” In *The Cambridge Companion to Peirce*, edited by Cheryl Misak, 241–256. Cambridge: Cambridge University Press.
- Wheeler, Michael. 2005. *Reconstructing the Cognitive World—The Next Step*. Cambridge, MA: MIT Press.