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Semiosis and embodied cognition: The relevance of Peircean semiotics to cognitive neuroscience

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The interpretant [...] creates in the mind [...]
an equivalent sign, or perhaps a more developed sign.
(CP 2.228)

The theory of the interpretant is the most extensive and important part of Peirce's theory of signs [...]. Most frequently Peirce explains the interpretant as the effect produced by a sign upon the mind of the person who receives and understands the sign.
(Savan 1976: 29)

Semiosis is that which makes synthesis possible.
(Savan 1976: 16)

Abstract. Valentina Cuccio and Vittorio Gallese stimulated renewed interest in semiotic contributions to the cognitive neurosciences by bringing C. S. Peirce and his theory of signs to elucidate important notions that provide the foundation for understanding embodied cognition and its critical role in explaining both literal and figurative (abstract and concrete) concepts from phylogenetic and neurobiological perspectives. This is not surprising since Peirce always framed his theory of signs in terms of cognition, a point noted by many Peircean scholars (including David Savan, Ivo A. Ibri, Piotr Konderak and others). Cuccio and Gallese focus on Peirce at the level of Firstness, and include the important principle of abductive inference as well as iconicity (a principle of Peirce's sign–object triad). In the following analysis, we identify other important contributions of Peirce for cognitive neuroscience and modelling of embodied cognition by shifting the lens from Firstness to Thirdness, from abduction and iconicity to Peirce's theory of interpretants. Our analysis will include a presentation of the Peircean sign complex and its relevance in defining signification, semiosis, and synthesis (including acquisition,

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maintenance and production) of knowledge. Finally, we will argue that Peircean interpretants are essential to explicating the notion of embodied cognition as presented by Gallese and George Lakoff in their 2005 seminal work.

Keywords: cognitive neuroscience; Peircean semiotics; interpretants; Thirdness; neural multimodalities

1. Cognitive neuroscience approaches to embodied cognition

> *[...] a Peircean perspective requires a much more complex set of sign types, a movement away from simple binary relations, and the introduction of a relatively defined, nonarbitrary, system-based iconicity as a driving structural principle of the generation and organization of memory within and across languages.*
> (Andrews 2014: 60)

> *As we shall see, circuitry across brain regions links modalities, infusing each with properties of others. The sensory-motor system of the brain is thus "multimodal" rather than modular. Accordingly, language is inherently multimodal in this sense, that is, it uses many modalities linked together – sight, hearing, touch, motor actions, and so on. Language exploits the pre-existing multimodal character of the sensory-motor system.*
> (Gallese, Lakoff 2005: 456)

1.1. Sensory-motor system and multimodalities

One of the important contributions found in Gallese and Lakoff (2005) is the evidence they provide in defining the sensory-motor system of the brain as *multimodal*. The multimodal perspective, in contrast to a modular view of neural processing of cognition and language, is defined by Gallese and Lakoff as a fundamental shift in perspective where there is neural integration of different sensory-motor regions (or modalities):

> As we shall see, circuitry across brain regions links modalities, infusing each with properties of others. The sensory-motor system of the brain is thus "multimodal" rather than modular. Accordingly, language is inherently multimodal in this sense, that is, it uses many modalities linked together – sight, hearing, touch, motor actions, and so on. Language exploits the pre-existing multimodal character of the sensory-motor system. If this is true, it follows that there is no single "module" for language – and that human language makes use of mechanisms also present in nonhuman primates. (Gallese, Lakoff 2005: 456)

Gallese and Lakoff (2005: 473) aspire to a "unified explanatory framework" that brings together neuroscience, neuroimaging, and neural computational research with both cognitive linguistics and cognitive neurolinguistics. Thus, they argue that there can be no "language module" of any kind, and conclude that "language makes direct use of the same brain structures used in perception and action" (Gallese, Lakoff 2005: 473). This fits with notions of language processing in the brain as connected to and piggybacking on neurological structures used for other sensory-motor functions (Andrews 2014: 129). Bateman (2018: 1) also notes the utility of Peirce's categories (including modes of inference and the sign-complex) for analysing multimodal phenomena such as language and evokes Jakobson's pioneering application of sign–object relations to linguistic analysis, as well as subsequent methodological developments of Jakobsonian linguistics, to elucidate the multi-dimensional, inclusion and simultaneous relationships between the different sign-types/functions at play in every instance of multimodal semiosis.

Gallese and Lakoff (2005: 468) insist that both abstract and concrete *concepts* are embodied, interactional, dynamic and cannot be defined as "reflections or representations of external reality". Concepts for Gallese and Lakoff (2005: 468) are "elementary units of reason and linguistic meaning" that are both embodied and equivalent to the term 'schema' found in Lakoff's earlier work. It is important to connect the approach used by Gallese and Lakoff in defining embodied cognition with Dwight Bolinger's seminal work on the relative *non-arbitrariness* of the linguistic sign (see Bolinger 1965[1949]).[2]

The goal of the present analysis is to explain the relevance of semiotic theory, and in particular Peircean sign theory and his category of Thirdness and Interpretants, to 21st-century cognitive neuroscience research and understanding the neural processing of language(s) in the human brain.

1.2. Peircean sign theory as epistemology

Peirce's epistemology is uniquely positioned to analyse the notion of embodied cognition as presented by Gallese and Lakoff, especially from the perspective of understanding languages as among the most powerful meaning-generating

[2] In response to Gallese and Lakoff, Bradford Mahon and Alfonso Caramazza (2008: 69) suggest a *domain-specific sensory-motor hypothesis*: "[...] the way in which concepts are organized and represented is determined by the use to which those classes of mental representations have been, and are, put." On the other hand, Mahon and Caramazza (2008: 61) explicitly deny the possibility of any connection between linguistic forms and meanings: "The relation between the language effectors (e.g. mouth for spoken language) and concepts is arbitrary." This puts them irreconcilably at odds with the larger framework of non-arbitrariness proposed by Gallese and Lakoff.

systems known to humans. Peirce's sign theory does not focus on linguistic forms, but rather types of inferences and categories that provide for all types of signs encountered, processed, and produced by human agents. Embodied cognition likewise approaches the problem of a neurological interface between nameable linguistic "concepts" and sensory-motor activations by recognizing that the production and perception of linguistic forms constitute a sensory-motor event and the whole game is being played on the same substrate. Both Peirce and cognitive neuroscience approaches to embodied cognition sound the death knell of an ontological binary between form and meaning.

What David Poeppel (2008) calls a needed adaptation in neuroscience's "ontological commitments" is an example of an important shift in the discipline's frame to what would qualify as epistemological, as well as his *cartographic imperative*, which insists that localization is not equal to explanation; rather, localization can be best used as an intermediate goal. The implication of this shift is a move from static questions of 'where' to dynamic 'how' inquiries into the processes of the human brain. While cognitive neuroscience approaches this question from the perspective of neurological function and anatomy, an epistemology expands the scope of analysis to explain how humans *know*. It is here that Cuccio and Gallese (2018) make the important connection between embodied cognition and Peircean sign theory. Konderak (2016: 83) also suggests an intimate link between semiotics and the cognitive sciences, stating that "the philosophical (mainly epistemological) consequences of Peircean theory of signs make the theory especially appropriate for an analysis of cognitive-semiotic phenomena".

Peirce's epistemology, employing three modes of inference (*abduction, induction, deduction*) founded in three categories (*Firstness, Secondness, Thirdness)* speaks directly to the cognitive processes of the researcher pursuing similar inquiry via a different method (CP 5.171; Fann 1970: 7; Andrews 1994: 9–28, 2014: 59–64).

1.3. Human languages and embodied cognition

> *Languages are dynamic, hierarchical, learned, relatively autonomous systems of eaning generating paradigmatic and syntagmatic symbols that signify and communicate to self and other via speech communities and communities of practice throughout the life cycle.*
> (Andrews 2014: 32)

> *For an event to become linguistic, a great many brains must play in unison.*
> (Bolinger 1965: 233)

While semiotics and embodied cognition both speak to the full gambit of human sensory-motor perceptions and performances, our goal is to explore semiotics as a framework for the neural operations behind language specifically; this guides our

focus in several ways. The first and foundational upshot of this goal is a constant focus on *the processes of meaning-generation*; rather than static renderings of the outcomes of dynamic signification, proper application of Peirce will constantly be centred on plural signs in action. Further, a linguistic focus mandates that the analysis move beyond isolated individuals and into ecologically valid spaces where *languaging* actually occurs – in *speech communities* and *communities of practice*.[3] The Peircean sign complex equips us with tools and terms necessary to schematize the constant negotiations of meanings between multiple sign users. Ultimately, the focus on language as instantiated in cultures and communities already points to embodied cognition by positioning languages as one among many shared *repertoires of embodied action and signification* for interacting with the cultural-physical spaces in which cognition takes place (McConnell-Ginet 2004).

As we explore additional semiotic implications for *embodied cognition* and *signification* more broadly, we offer the following: (1) a brief review of the Peircean sign complex and modes of inference; (2) recent research from the neurosciences on the dynamic mapping of language and music in human brains. These two foci provide powerful examples of complex sensory-motor systems, and the importance of *distributed cognitive cultural networks* (Donald 2004) to the emerging research around embodied cognition (introduced by Gallese and Lakoff in 2005). We will also address the role of iconicity in *non-arbitrariness of the sign* and emergent meanings, while emphasizing interpretants as necessary for a fully developed, thirdness-oriented application of Peircean sign theory to the cognitive neuroscience of embodied cognition.

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[3] One of the fundamental linguistic principles that are relevant for understanding embodied cognition can be found in Jakobson's articulation of the speech act model (also referred to as 'the speech event model'). Jakobson's model requires a minimum of six factors and functions as the "constitutive factors in any speech event, in any act of verbal communication" and "each of these six factors determines a different function of language" (Jakobson, 1987[1960]: 66). In other words, there is a one-to-one relationship between each of the individual six factors (the basic and obligatory minimum of factors present in any speech act) to six related functions (the meaning-generating outcomes) and they are realized in a hierarchy (with one or more dominants) that is negotiated by the participants of the speech act (addressers and addressees, including unintentional participants) in any given realization. This means that any given speech act is defined by *shifting hierarchies* and *polysemy*. A simple example is "How are you?" In American English, this is typically said to *open the channel*, make *contact* between the addressers and addressees; in this sense, it is often seen as a predominantly *phatic* speech event. However, this speech act could also have different *dominant* functions – the *referential* and *conative* functions – if the addresser knows that the addressee has been ill and is seeking real information from the addresser about their health is an example of how other dominants may emerge. See Appendix I for the full Jakobsonian speech act model and definitions of 'speech community' and 'communities of practice'.

2. Peircean sign theory

2.1. The sign complex

The Peircean sign complex is irreducibly triadic. All types of meanings are emergent, arising from the interplay between a sign, its objects, and its interpretants (cf. Fig. 1). Signs say *something* about *something* and are interpretable by *someone* interacting with them:

> A sign must first have an inner ground, an internal structure, character, or quality. [This is the sign proper, also called representamen.] Second, it must stand for some correlate external to itself. [This is the object.] Third, it must exemplify some general rule which enables the sign to mediate between its object and some translation (or interpretation) of itself, such that this translation is a sign of the same object represented by the first sign. [This general rule is the interpretant.] (Savan 1976: 3) (see also: Andrews 1990: 47; CP 2.303)

Peircean sign theory requires a multimodality perspective as one of the fundamental principles underlying the sign complex and signs in action (i.e. semiosis).

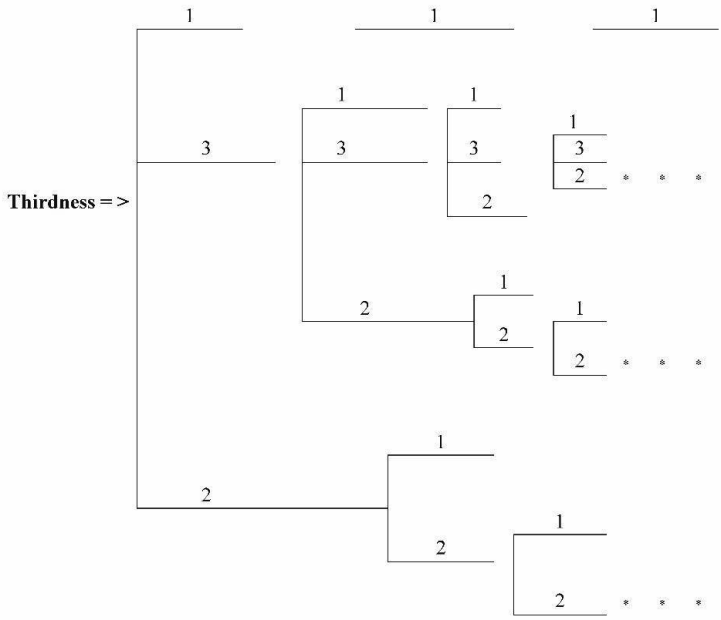

Figure 1. Diagram demonstrating the recursive relationship between Peircean categories of *Firstness, Secondness,* and *Thirdness*. (Adapted from Savan 1976: 9; also in Andrews 1990: 49.)

Note that Peirce (CP 2.303) distinguishes between two meanings of 'sign' – *sign* (as sign complex) and *representamen* (Firstness level of the sign complex) (see Fig. 2). The Peircean sign is evaluated in three ways – (1) in terms of its relation to itself; (2) its relation to its objects; and (3) its relation to its interpretants. Fig. 1 below shows a diagrammatic representation of the categories of *Firstness, Secondness* and *Thirdness*.

Peirce also provides several typologies for classifying signs, including a division into three categories: *Firstness, Secondness,* and *Thirdness* (CP 5.171; see Fann 1970: 7; Savan 1976; Andrews 1994: 9–28; 2014: 59–64).

Fig. 2 provides a two-dimensional diagrammatic representation of the Peircean Sign Complex that addresses six fundamental principles:

(1) The sign complex is apprehended as a simultaneity (single temporal point), not sequentially.[4]
(2) Firstness and Secondness are embedded in Thirdness, and require interpretants in order to be realized and fully embodied.
(3) Multimodalities include all three categories, implying both *semiosis* (*the sign in action*) as well as *signification*, and are realized at the level of Thirdness.
(4) The Sign Complex requires embodiment (i.e. brains and users are embedded in the sign complex itself). This includes (a) Representamen as Firstness; (b) users via dynamic objects and forms via immediate objects as Secondness; and (c) the emergent result is manifest in Thirdness via the trichotomy of interpretants.
(5) The Sign Complex is never a singular, only a multiplicity (within and across brains) and involves a potentially infinite number of signs.
(6) The so-called "final" interpretant is a set of constant emergent properties (similar to the "limit" of a function in mathematics).

[4] Dr. George Ojemann, one of the pioneers of cortical stimulation mappings (CSM) in surgeries, and his teams have collected data on language mappings in the brain for over 50 years. One observation that he shares is worth repeating here regarding a typical view of language processing in the brain as serial (from one region to another): "That was indeed the guess [...] and it was wrong. Our studies didn't find evidence for serial brain wave changes. All sites seemed to be turned on at once, at the beginning of the language event, and they stayed on during the whole event [...] parallel activation of dispersed cortical areas" (Calvin, Ojemann, 1994: 227).

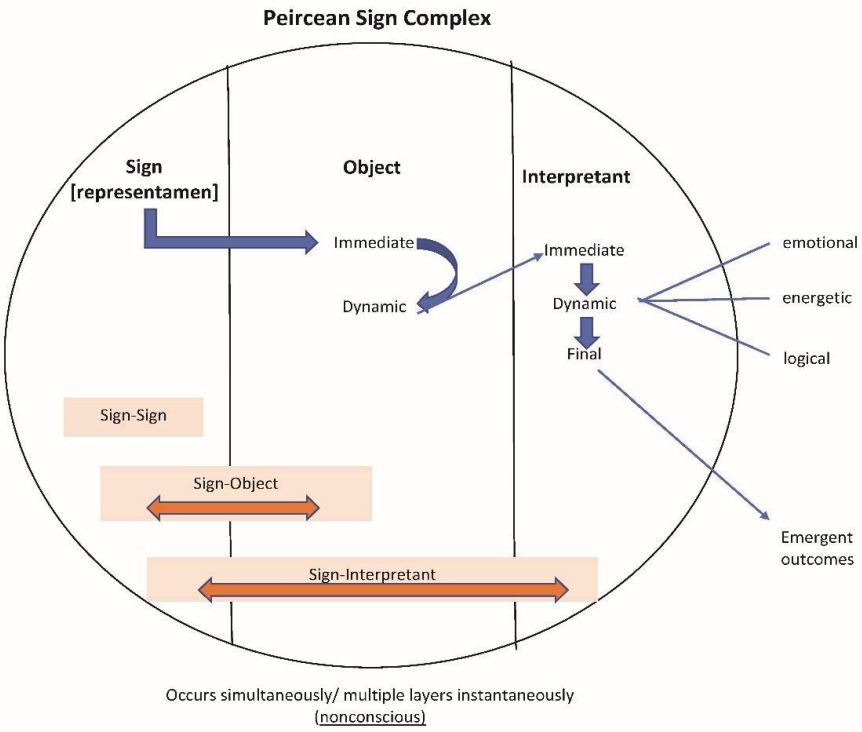

Figure 2. A diagram depicting semiosis as a process occurring across the Peircean Sign Complex constituted by a sign's correlates (Representamen, Object, Interpretant) and their triadic relationships (Sign–Sign, Sign–Object, Sign–Interpretant).

2.2. Embodied cognition and the shift toward multimodalities

> *Sensory-modalities like vision, touch, hearing, and so on are actually integrated with each other and with motor control and planning.*
> (Gallese, Lakoff 2005: 459)

> *[...] we will argue that a key aspect of human cognition is neural exploitation – the adaptation of sensory-motor brain mechanisms to serve new roles in reason and language, while retaining their original functions as well.*
> (Gallese, Lakoff 2005: 456)

> *The theory of the interpretant is the most extensive and important part of Peirce's theory of signs. [...] Only through its interpretant can a word be a sign of a class or a law.*
> (Savan 1976: 29)

As we shift the focus of the conversation about embodied cognition to language(s) specifically, and include Cuccio and Gallese (2018) on Peirce, we are faced with the task of defining meaning within the different theoretical approaches to embodied cognition, including Peirce's specific definitions of meaning.

Cuccio and Gallese (2018: 3) utilize the *multiple representation approach* and demonstrate how abstract and concrete concepts are explained by such an approach:

> Among the embodied approaches to cognition that suggest different modalities of representation for abstract and concrete concepts particularly interesting, timely, and increasingly influential, are the so-called *Multiple representation theories* [...]. Different variants of multiple representation theories are currently discussed. They differ in some respects, but all share the basic idea that concrete and abstract concepts representation relies on both sensorimotor and linguistic information [...]. We will provide an embodied account of both abstract and concrete concepts coherent with the multiple representation approach. We will propose that, although differing in certain respects, they both might have a bodily foundation and both make use of linguistic information.

Using Cuccio and Gallese as a starting point, we will (1) show how Peircean sign theory supports their hypothesis and (2) expand their preliminary analysis from categories of Firstness (including iconicity and abductive inference) to categories of Thirdness and interpretants. Two of the most cited philosophers of Peircean sign theory are T. L. Short (1981, 1986) and David Savan (1976). Both demonstrate that *meanings* in mature Peircean theory are explicitly identifiable with the *interpretants* and Thirdness (Short 1986: 108–9; Savan 1976: 7–9). Briefly stated, Thirdness is always a generality (not a single event) that is necessary for rule-based change and translation from one sign into another, and all Peircean definitions of *meaning* involve *interpretants*. In linguistic terms, the basis for the generation and existence of meanings is given by *signification*.[5]

[5] *Signification* is the human ability collectively to invent innovative and dynamic external symbols. Without signification as the initial and primary ability that underlies human language and all of human cognition, there can be no nonhereditary collective memory. Signification always requires the translation from one system into another, and the process is potentially infinite and unbounded (Jakobson 1985: 206; CP 4.127). Merlin Donald (2004: 43) provides an expanded perspective on signification by identifying the key to understanding human language as a collective phenomenon: "[t]he isolated brain does not come up with external symbols. Human brains collectively invent symbols in a creative and dynamic process."

Symbols are invented, according to Donald (2004: 43), by means of executive skills "that created a nervous system that invented representation out of necessity". It is worth noting that the 'symbols' of Donald and Peirce are not conceptually equivalent to the arbitrary, abstract, amodal 'symbols' of analytical philosophy which Gallese and Lakoff (2005: 456) reject in favour of embodied schemas.

Other Peircean scholars like Ibri *et al.* (2023: 238) argue that "a reconsideration of the embodied-situated paradigm's own philosophical foundations can behave in semiotic terms". According to the authors, "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 and inferences as in anti-representationalism" (Ibri *et al.* 2023: 239). For this reason, "Peirce can be considered an important precursor of the situated mind and distributed cognition thesis" (Ibri *et al.* 2023: 235; see also Donald 2004). Ibri *et al.* (2023: 242) conclude by suggesting that "Peirce's semiotic realism united to his modal take on cognition provides a logical and philosophical framework for the understanding of cognition as a general and pervasive feature of our intelligible Universe. Situatedness and embodiment might be the necessary conditions for the actualization of cognitions, but semiosis is the sufficient condition for its reality."

2.3. Understanding non-arbitrariness

A crucial principle found in Gallese and Lakoff (2005: 456) is the importance of the non-arbitrariness of the sign (understood as "embodied" and mapped within the sensory-motor system itself) and why this is critical for understanding multimodal processing of language and the notion of embodied cognition itself. Their view is firmly based in a semiotic sign that can never be characterized as "arbitrary", i.e. no relationship between forms and meanings as was heralded in 19th-century works (the best-known being Saussure's doctrine of signs originally published posthumously as *Cours de linguistique general* in 1916 and in English in 1959).

The rejection of the arbitrariness of the sign is one of the major differences in Gallese and Lakoff with Mahon and Caramazza (see Footnote 2). The justification for embodied cognition itself is embedded in the important interaction between forms and meanings and requires, for Gallese and Lakoff (1005: 455), recognition of the importance of concepts as "elementary units" in the construction of linguistic meaning.

Terrence Deacon (2022) also frames his essay on the importance of semiotics in cognitive neuroscience around the importance of relative categories of non-arbitrariness, and, as found in Cuccio and Gallese, refers directly to iconicity and the icon/index/symbol sign–object triad. Two of the most important contributors to understanding the perspective of a relative non-arbitrariness are Jakobson and Bolinger. In fact, Jakobson played a central role in introducing Peircean sign

theory to the field of linguistics (Andrews 2020).[6] And, while Bolinger's early characterizations of non-arbitrariness in his 1947 essay pre-date his interaction with Peircean sign theory, he fully embraces Peircean signs in his later works, especially in his 1986 book *Intonation and Its Parts*.

In the following sections, we will revisit Peirce's characterizations of iconicity and abductive inference (as categories of Firstness), and suggest how Peircean categories of Thirdness and interpretants play an essential role in incorporating a fully developed semiotic theory to elucidate the fundamental notions integral to a theory of embodied cognition.

3. Multimodalities as Thirdness

> Multimodality. *Mirror neurons and other classes of premotor and parietal neurons are inherently "multimodal" in that they respond to more than one modality. Thus, the firing of a single neuron may correlate with both* seeing *and* performing *grasping. Such multimodality, we will argue, meets the condition that an action-concept must fit both the performance and perception of the action.*
>
> Functional clusters. *Multimodality is realized in the brain through* functional clusters, *that is, among others, parallel parietal-premotor networks. These functional clusters form* high-level units – *characterising the discreteness, high-level structure, and internal relational structure required by concepts.*
>
> (Gallese, Lakoff 2005: 457–458)

3.1. Interpretants as the outcome of multimodalities

Cuccio and Gallese's 2018 article positions Peircean sign theory as an essential component for the field of cognitive neuroscience. As stated in Cuccio and Gallese (2018: 3):

> Commonalities between abstract and concrete concepts will be explained by recurring to the Peircean notions of *icon and abductive inference* (CP 2:247). According to Peirce, icons are the kind of signs on which abductive inferences rest [...]. It will be claimed that the mechanism of Embodied Simulation [...] can be described as an *icon* [...]. It will be suggested that the ability to interpret iconic relationships might have provided, both phylogenetically and ontogenetically, the ground for the acquisition of abstract and concrete concepts. Abductive inferences will be presented as the inferential process on which the ability to interpret icon/Embodied Simulation rests.

[6] Andrews, Edna 2020. Jakobsonian linguistics. In: *Encyclopedia of Slavic Languages and Linguistics Online* [Greenberg, Marc L., editor-in chief; Grenoble, Lenore A., managing editor.] is available at: https://referenceworks.brill.com/display/entries/ESLO/COM-036085.xml.

Building on this introduction of icons and abductive inferences (Firstness), we propose that the Peircean framework requires Thirdness, including interpretants, in order to analyse multimodal processes at any level. Peirce places iconic signs squarely within Firstness, where "[A]n Icon is a Representamen whose Representative Quality is a Firstness of it as a First" (CP 2.276). Firstness, quoting Peirce, "is that one of the three which is regarded as of the simplest nature, being a *mere possibility*" (CP 2.235). However, when a possibility is embodied, it is no longer a mere possibility, but a sign capable of mediating interpretation of the sign (CP 2.228). Therefore, to discuss embodied cognition using Peircean terms, one must also consider the sign complex as a whole and recognize that *Thirdness,* via interpretants, is necessarily operative at every level of realized semiosis (cf. Fig. 1). Furthermore, Peircean signs are realized at both the individual level and the community level, generating emergent, dynamic meanings which grow in use and experience (CP 2.302).

Peirce is clear in his insistence that humans themselves are signs thinking in signs so that "everything which is present to us is a phenomenal manifestation of ourselves" (CP 5.283). When we think, the thought-sign is always "interpreted by a subsequent thought of our own" (CP 5.284). And, the outcome of the thought-sign, the "proper significant outcome of a sign", is the *interpretant* of the sign (CP 5.473). In Peircean sign theory, meanings are emergent and can only be achieved through interpretants. As Peirce himself acknowledges, "What the 'meaning' of an intellectual concept is can only be solved by the study of the interpretants, or proper significant effects, of signs" (CP 5.475).

3.2. Multimodality as mediation

> *Now Thirdness is nothing but the character of an object which embodies Betweenness or Mediation in its simplest and most rudimentary form; and I use it as the name of that element of the phenomenon which is predominant wherever Mediation is predominant, and which reaches its fullness in Representation.* (CP 5.104)

The sift to a premise of multimodality allowed Gallese and Lakoff (2005: 456) to propose an "interactionist theory of meaning" based on "neural exploitation – the adaptation of the sensory-motor brain mechanism to serve new roles in reason and language." Building their case on the premise of multimodality. This leads them to focus on the sensory-motor embodiment of human cognition, thus linking language processing to multimodal and sensorimotor aspects of languaging, arguing that "language exploits the pre-existing multimodal character of the sensory-motor system" (Gallese, Lakoff 2005: 456). Gallese and Lakoff emphasize the importance of multimodality over modular approaches, including

"supra-modality" in rejecting any need for higher association hubs to combine discrete mono-modal inputs upstream. Insisting that sensory-motor cortices themselves are interwoven with multiple modalities including both "action and perception" (Gallese, Lakoff 2005: 459), they identify premotor areas containing "neurons that integrate motor, visual, and somatosensory modalities" as well as auditory inputs, "for the purpose of controlling actions in space and perceiving peripersonal space" (Gallese, Lakoff 2005: 456).

Any application of a Peircean framework to the sensory-motor system requires the level of Thirdness and interpretants in order to explain *how the neurological basis of perception, including sensorimotor phenomena and languages, is mediated*. Savan (1980) provides an important clarification on the immediate and dynamic objects embedded in any Peircean sign by pointing out that in applying Peircean sign theory to languages, the immediate object is embodied in actual linguistic forms, and the dynamic objects are the users (speakers and hearers). Peircean philosophers and scholars, including Short (1986), Savan (1980), Michael Shapiro (1988) and Umberto Eco (1979), clearly explain why mature Peircean thought explicitly identifies *meanings* with *interpretants* (the concept that "creates in the mind [...] an equivalent sign, or perhaps a more developed sign" [CP 2.228]; "[...] the meaning of a sign is the sign it has to be translated into" [CP 4.132]; "the proper significate outcome of the sign" [CP 4.127]). In other words, interpretants necessarily follow from the sign and represent Peircean Thirdness – where meanings become possible. It is Thirdness that can most clearly explain multimodalities as given in Gallese and Lakoff's (2005) original explication of embodied cognition.

4. Understanding linguistic approaches to non-arbitrariness

Embodied cognition as articulated in Gallese and Lakoff (2005) introduces into cognitive neuroscientific discourse a version of non-arbitrariness found previously in linguistic approaches, in particular the Prague School of Linguistics in the early 20th century followed by semiotic approaches to languages and cultures. Roman Jakobson was central to both of these early trends and never accepted the 19th-century Saussurean binary sign – a sign where relationships between forms and meanings were characterized as arbitrary. Jakobson played a critical role in facilitating a shift in perspective from binary signs to a more nuanced Peircean triadic sign complex that is realized in a spectrum of relative non-arbitrariness via interpretants. It is precisely the linguistic perspective that predicted much of the 21st-century emergence of multimodalities and networks in the cognitive neurosciences.

Our goal in introducing Thirdness as a requisite aspect of cognition is to rearticulate Jakobson's and Bolinger's declaration that "the sign is not arbitrary" as a relativized, positive, spectral (and distinctly plural) assertion where signs are systemically embedded, embodied, and emergent. Thus, while Jakobson's (1987[1960], 1985a, 1985b, 1995) and Bolinger's (1965[1945]) analyses, inspired by categories of Firstness, paved the way for the eventual application of interpretants in linguistic analysis (cf. Eco, Savan, Shapiro, Andrews), it is Peircean sign theory in its fullness, and categories of Thirdness in particular, that provides an adequate framework for connecting Gallese and Lakoff's approaches to cognition, multimodalities and the introduction of a new theory of *embodied cognition*.[7]

5. Interpretants as outcomes of multimodalities

Gallese and Lakoff's schema-based account of embodied cognition provides several examples to embody interpretants as operations "of brains in cultural space" (Andrews 2014: 198). *Emotional* interpretants (i.e. subjective experiences of emotion) are characterized as multimodally-mediated sense impressions, while *energetic* interpretants reflect motor and premotor activations as well as the interpreter's responses. *Logical* interpretants, in contrast, correspond to enduring systems of identification, prediction, and interaction with phenomena and their respective classes. This triad subdivides the *Dynamic interpretant* or "whatever interpretation any mind actually makes of a sign" (CP 8.315).[8]

Fig. 1 shows how interpretants are embedded in recursive sequences of triadic interpretants, emerging from Immediate and generating Final interpretants, the constantly emerging and changing protocols that govern "the working and perception of the dynamic object" (Andrews 1994: 16).[9] While all interpretants are vital and depend upon one another to function, at the end of this chain is the *Final interpretant,* or "that which would finally be decided to be the true interpretation if consideration of the matter were carried so far that an ultimate opinion were

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[7] Both Jakobson and Bolinger transition to Peircean Thirdness and interpretants in their later works, in different ways and using different vocabularies. For details, see Jakobson 1985[1977] and Bolinger 1986, 1989.

[8] The Dynamic Interpretant is the single event in actual time-and-space wherein the Dynamic Object (Second of Secondness), including the spatio-temporally situated sign-users, mediates the development of a sign into a particular sensation, action, or thought (Second of Thirdness) through a symbol (Third of Secondness). See Hardwick 1977: 111, Savan 1976: 42–44.

[9] Immediate interpretants consist "in the Quality of the Impression that a sign is fit to produce, not to any actual reaction" (CP 8.315)

reached" (CP 8.184), extending the full sign complex beyond a solitary brain.[10] While this trajectory is actualized in the embodied *Dynamic Object*, human beings, as "habit-change" (CP 5.476; Savan, 1976: 48), the final "full semiotic effect of a sign" (Savan 1976: 49) must occur in the *distributed cognitive cultural network*s in which sign-users participate and the sign systems that mediate their ability to do so (Donald 2004: 35). Human communication is wholly dependent on meaning-generating shared systems (including languages and music). These shared systems founded in community-based procedures for negotiating linguistic norms mediate our cognitive frameworks via Final interpretants. Both *semiosis* (the sign in action) and *signification* are realized at the level of Thirdness as multimodal signs translated into multi-user networks of "many brains playing in unison" (Bolinger 1965[1949]: 233).

6. Conclusion

Cuccio and Gallese's original and important application of Peirce and his theory of signs to evidence of embodied cognition represents a groundbreaking turn toward the interpretation of neuroimaging data via ecologically valid, phenomenological heuristics. While their initial analysis resides primarily at the level of Firstness, the present paper has attempted to expand the application of Peircean sign theory to elucidate the vital role of Thirdness and interpretants at every level of semiosis. Peircean interpretants are particularly useful for explicating embodiment in the "interactionist theory of meaning" presented by Gallese and Lakoff as meanings are not only generated, but made possible through interpretants, and more precisely culminating in the emerging of *Final interpretants* in any act of semiosis.

The present discussion places a particular emphasis on embodied cognition, multimodalities and non-arbitrariness which are vitally intertwined, and the analysis of each must refer to the others. Both the sensory-motor system of the brain and language processing are irreducibly multimodal. Additionally, the hierarchical nature of language, as well as the mutual embeddedness of sign-relations, point us to the non-arbitrariness of signs and mandates an analytical shift from 'the sign' to *semiosis* as a systemic process.

Peircean semiotics is a critical step in building the arguments underlying embodied cognition as presented by Gallese and Lakoff. From this systemic

[10] "The Dynamical Interpretant is a single actual event. The Final Interpretant is that toward which the actual tends" (Hardwick 1977: 111). This hypothetical and dynamic telos "does not consist in the way in which any mind does act but in the way in which every mind would act" (CP 8.315).

approach, the present paper contributes a schematic clarity regarding the Peircean object – namely, the identification of objects with actual forms and actual speakers. Objects should not be understood simply as things, but rather as relations within dynamic systems. These relations minimally include embodied forms and sign-users.

7. Future directions

Cuccio, Gallese, and Lakoff have shifted the fundamental questions in cognitive neuroscience with their innovative perspectives. Their emphasis on multimodalities provides not only a new set of research questions, but a new synthesis that can lead to multidisciplinary applications of a Peircean approach to *embodied cognition* not only in the context of the neural processing of human languages, but also other forms of sensory-motor functions, including musicianship, building cognitive reserve and memory systems.[11] Recent studies of lifelong musicianship and the building of cognitive reserve focus on resting state fMRI analysis of networks and important connections with white matter integrity in subcortical fiber tracts (including Andrews *et al.* 2021, 2023; Eierud *et al.* 2023; Leipold *et al.* 2021).

Future work on embodied cognition might therefore take the form of applying Peircean sign theory, and in particular notions of Thirdness and interpretants, to other disciplines across the neurosciences, acoustic and physical sciences, and social sciences. There is already recent research from the cognitive neurosciences on the neuroimaging of the processing of language(s) and musicianship using both functional and structural imaging, including fMRI, DTI, resting state functional connectivity – all of which highlight the importance of *distributed cognitive cultural networks* as one of the foundational notions to inform new research projects.[12]

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[11] For a new approach to modelling *musical acts*, which by definition include signification and communication in the performing and cultural contexts, see "Understanding meaning generation in languages and music: A new approach to linguistics and musical *Signification* acts" (Ling, Lowry forthcoming).

[12] For examples of these approaches, see Andrews *et al.* 2021, 2023, 2024a, 2024b; Eierud *et al.* 2023; Gallo, Abutalebi 2024; Pliatsikas 2024.

APPENDIX I

Three important linguistic notions central to understanding the ecologically-valid language processing: Jakobson's *speech act model*, Hymes' *speech communities* and McConnell-Ginet's *communities of practice*.

The Jakobsonian speech act model presents six factors and maps them onto six functions to yield the diagram reproduced below in Fig. 3. As Jakobson (1987[1960]: 66) states in this important work, we cannot begin to examine specific, individual functions like the *metalingual function* or *poetic function* until we provide "a concise survey of the constitutive factors in any speech event, in any act of verbal communication".

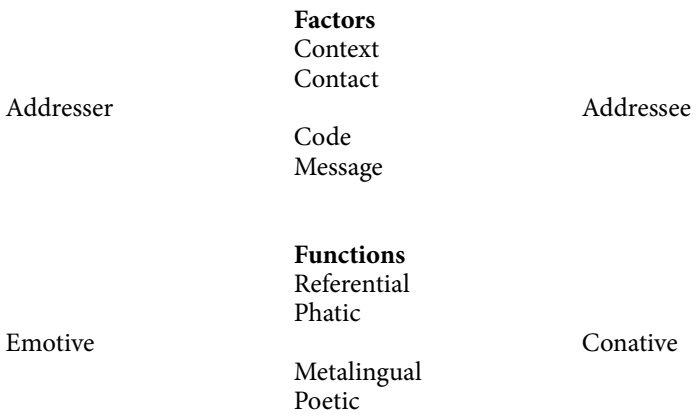

Figure 3. Jakobson's speech act model of six factors mapped onto six functions (adapted from Jakobson (1987[1960]: 66).

Dell Hymes (1972: 54) defines a speech community as "a community sharing rules for the conduct and interpretation of speech, and rules for the interpretation of at least one linguistic variety." For Hymes, these communities are based on face-to-face interactions and heterogeneous. Speakers are members of multiple speech communities and these memberships are dynamic.

McConnell-Ginet's (2003: 71, 72) definition of community of practice reads:

> A community of practice (CofP) is a group of people brought together by some mutual endeavor, some common enterprise in which they are engaged and to which they bring a shared repertoire of resources, including linguistic resources, and for which they are mutually accountable. [...] Communities of practice are not free-floating but are linked to one another and to various institutions. They draw on resources with a more general history – languages as well as various kinds of technologies and artefacts.

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Семиозис и воплощенное познание: актуальность семиотики Пирса для когнитивной нейронауки

Интерес к семиотическим трудам Чарльза Пирса в последнее время получил резонанс в области когнитивных нейронаук, в частности в исследовании авторов Куччио и Галлес (2018). По мнению Куччио и Галлеса, теория знаков Пирса играет важную роль в развитии «воплощенного познания», особенно в двух областях – в семантике слова в буквальном и переносном значениях и в филогенетическом и нейробиологическом смыслах. В самом деле Пирс сам подвел когнитивную основу своей теории знаков (см. работы Савана, Ибри, Кондерака и т.п.). Главное направление работы Куччио и Галлеса включает принцип Пирса «первичность», «абдукцию» и «иконичность» (один из уровня триада *знак-объект* Пирса). В данной работе авторы предлагают более глубокий разрез и расширение применения теории Пирса, моделирующей понятие воплощенного познания, где не первичность, а *третичность* и *интерпретанты* торжествуют. Описание пирсовской системы

знаков и значимость этой системы представляют необходимость такого подхода в определении сигнификации, семиозиса и синтеза в развитии, поддержки и произведении знаний. Интерпретанты Пирса являются неотъемленой частью понятия воплощенного познания, представленного в трудах Галлеса и Лакоффа (2005).

Semioos ja kehastunud kognitsioon: Peirce'i semiootika olulisus kognitiivsele neuroteadusele

Valentina Cuccio ning Vittorio Gallese on õhutanud uuenenud huvi kognitiivsetesse neuroteadustesse tehtavate semiootiliste panuste vastu, valades C. S. Peirce'i ja tema märgiteooria abil valgust olulistele mõistetele, mis moodustavad aluse, mõistmaks kehastunud kognitsiooni ning selle kriitilist rolli nii sõna-sõnalistest kui ka ülekantud (abstraktsetest ja konkreetsetest) mõistetest aru saamisel, lähtudes nii fülogeneetilisest kui ka neurobioloogilisest vaatenurgast. See pole üllatav, sest Peirce raamistas oma märgiteooriat alati kognitsiooni terminites – asjaolu, mida on täheldanud mitmedki Peirce'i-uurijad (sealhulgas David Savan, Ivo A. Ibri, Piotr Konderak jt.) Cuccio ja Gallese keskenduvad Peirce'ile esmasuse tasandil, ning kaasavad abduktiivse järeldamise olulise põhimõtte ning ikoonilisuse (ühe Peirce'i märk–objekt kolmiku põhimõtetest). Analüüsi käigus tuvastame Peirce'i teisi olulisi panuseid kognitiivsesse neuroteadusesse ja kehastunud kognitsiooni modelleerimisse, nihutades fookuse esmasuselt kolmasusele ning abduktsioonilt ja ikoonilisuselt Peirce'i tõlgendite teooriale. Analüüsi käigus tutvustatakse Peirce'i märgikompleksi ja selle olulisust tähistamise, semioosi ja teadmiste sünteesi (sealhulgas omandamise, säilitamise ja tootmise) defineerimisel. Lõpuks väidame, et Peirce'likud tõlgendid on olemuslikud vajalikud, selgitamaks kehastunud kognitsiooni mõistet, nagu seda esitlevad Gallese ja George Lakoff oma 2005. aastal avaldatud alustrajavas töös.