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Ecological meaning, linguistic meaning, and interactivity

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Abstract:

Human language is extraordinarily meaningful. Well-spoken or well-written passages can evoke our deepest emotions and elicit all manner of conscious and subconscious reactions. This is usually taken to be an insurmountable explanatory challenge for ecological approaches to cognitive science, the primary tools of which concern coordination dynamics in organism-environment systems. Recent work (Pattee, H. H. & J. Rączaszek-Leonardi 2012. *Laws, Language, and Life*. Dordrecht: Springer) has made headway in describing the meaningfulness of linguistic units — the kind of meaning that we perceive as mediated by specific symbols — within an ecological framework, by building an account based on Howard Pattee’s conceptualization of symbols as physical, replicable, historically-selected constraints on the dynamics of self-organizing systems (Pattee, H. H. 1969. How does a molecule become a message?. *Developmental Biology* 3(supplemental). 1016; Pattee, H. H. 1972. Laws and constraints, symbols and languages. In C. H. Waddington (ed.), *Towards a Theoretical Biology*, 248–258. Edinburgh: Edinburgh University Press). In order to propose an “interactivity-based” approach to linguistic meaning, this paper takes the following steps: first, it rejects the view of linguistic meaning as fully independent from organism-environment interactions, as exemplified by formal approaches in philosophical semantics. Second, it presents a cutting-edge example of an ecological approach to symbols, namely Joanna Rączaszek-Leonardi’s (Rączaszek-Leonardi, J. 2009. Symbols as constraints: The structuring role of dynamics and self-organization in natural language. *Pragmatics and Cognition* 17(3). 653–676. DOI:10.1075/pandc.17.3.09ras; Rączaszek-Leonardi, J. 2016. How does a word become a message? An illustration on a developmental time-scale. *New Ideas in Psychology* 42, Supplement C: 46–55. DOI:10.1016/j.newideapsych.2015.08.001) version of Pattee’s symbols-as-constraints model. Third, it reviews and critiques a recent attempt (Rączaszek-Leonardi, J., I. Nomikou, K. J. Rohlfing & T. W. Deacon. 2018. Language development from an ecological perspective: Ecologically valid ways to abstract symbols. *Ecological Psychology* 30(1). 39–73) to integrate the symbols-as-constraints model with Terrence Deacon, T. W. 1997. *The Symbolic Species*. New York: W. W. Norton and Company; Deacon, T. W. 2011. The symbol concept. In M. Tallerman & K. R. Gibson (eds.), *The Oxford Handbook of Language Evolution*, 393–405. Oxford: Oxford University Press) semiotic view of symbols, arguing that the properties ascribed to linguistic symbols, both by Deacon and very widely throughout the cognitive sciences, are not properties of individual instances of linguistic action. Rather, they belong to a particular mode of description that draws generalizations across the phenomenological experience of many language users. Finally, it lays out the core components of a novel “interactivity-based” approach to linguistic meaning. On this view, human beings engage in constant, hyper-flexible entrainment and enskillment that produces tremendous perceptual sensitivity to vocal and acoustic patterns. This sensitivity enables us to coordinate our in-the-moment behavior with large-scale behavioral patterns within a larger population, and to compare our own actions to those large-scale patterns. Thus, the most important contribution made by an interactivity-based approach is that it accounts adequately for the role played by population-level behavioral patterns in the control of short-timescale, here-and-now linguistic actions. In so doing, it offers the grounds for an ecological account of rich linguistic meaning.

Keywords: interactivity, meaning, symbols, distributed language, ecological psychology, semantics

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1 Introduction

The ecological turn in cognitive science has placed the concept of meaningfulness center stage. Rejecting the classical picture of cognition as mental processing of symbolic representations of the external world, the ecological psychologist takes a starting point in how the world becomes meaningful to the organism, and “what could be more meaningful to an organism than information that specifies the coordinative relations among its parts or between itself and the environment?” (Kelso 1995: 145) For instance, some organisms are able to sense

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magnetic fields and use these as a source of directional information. These organisms possess nerve cells that respond to changes in magnetic field strength, much as some retinal cells respond to changes in the spectral properties of light. This sensitivity enables them to take advantage of the directional information intrinsic to the Earth's magnetic fields. Loggerhead sea turtles, for instance, use regional magnetic fields as navigational markers during migration, changing their swimming direction as they encounter new fields (Cain et al. 2005; Irwin and Lohmann 2005). For loggerheads and other similar organisms, structure in magnetic fields is ecologically meaningful, i.e., intrinsically meaningful because their sensitivity to it enables them to regulate the dynamics of their movements in an adaptive manner.

The loggerhead example builds on a definition of meaning as “the way that some medium appears from the perspective of a living system” (Harvey 2015). However, if indeed meaning arises as organisms pick up information about relations among their parts or relations to the environment, how are we to understand the concept of *linguistic* meaning? In both his seminal *Semantics* (Lyons 1977a, 1977b) and its revision (1996), Lyons defines linguistic meaning most basically with reference to technical elaborations of ideas attached to the English noun “meaning” and the verb “mean,” and in particular to their application to words and sentences (both as spoken or written utterances and as constituent elements of languages). These many technical elaborations correspond to the many branches of natural-language semantics, from formal approaches (model-theoretic semantics, possible-world semantics, etc.) to lexical, computational, discourse, contextualist, and structuralist semantics, among many others. Perhaps the only feature these branches all have in common is the conviction that language is a distinct modality of action. On that view, there are distinct types of meaningfulness belonging to distinct types of action. Thus, according to any and all approaches in semantics, the bodily processes involved in speech production and perception are linguistic and can carry linguistic meaning, while other simultaneous bodily processes are not linguistic, and to the degree that they are meaningful at all, they carry other (ecological) types of meaning. From this perspective, vocal tract movements produce units of language capable of bearing linguistic meaning, whereas respiratory and postural movements produce only a stream of air.

The core of this idea is that during the execution of certain actions, a few parameters of bodily movement create physical structures that *have* or *carry* meaning in a sense that differs from the way that organism-environment interactions are ecologically meaningful. Respiration is carefully coordinated muscular activity required for a vast array of bodily functions. The information that guides respiratory movements is thus richly “meaningful” in the ecological sense of that term, but it is *not* “meaningful” in the alternate sense of bearing linguistic meaning.

This article is concerned with the relation between these two conceptualizations of meaningfulness: the ecological and the linguistic. This relation is difficult to spell out because its two relata have very different origins: ecological meaning is inspired by models of cognition as fundamentally interactive (Gibson 1979; Varela et al. 1991; Port and Van Gelder 1995), whereas conceptualizations of linguistic meaning are inspired by the phenomenological experiences of highly literate people engaged in speaking and writing. Moreover, these latter conceptualizations have been developed into a wide variety of mutually exclusive theoretical positions. It is thus very difficult to address linguistic meaning within a conceptual framework suited to ecological meaning, and vice versa. To do so requires either incorporating individual linguistic action within a model of organism-environment systems, or incorporating organism-environment systems within a model of individual linguistic action. We discuss both options in what follows, arguing that the second option can be ruled out on theoretical grounds (section 2), and that the most promising present attempt at the first option (the “symbols-as-constraints” view, introduced in section 3) is best approached as part of an interactivity-based model of organism-environment systems (sections 7 and 8), rather than as part of a sign-based model (sections 4–6).

The article thus revolves around four approaches to the relationship between ecological and linguistic conceptions of meaning. First, there is a class of strict approaches on which ecological meaning and linguistic meaning are related only in that both make use of the word “meaning.” These approaches prominently include a great deal of work inspired by Saussure (1972; although for recent exceptions see Stawarska 2015 and Litwin 2017), generative linguistics (Chomsky 1965), formal semantics (e.g., Bar-Hillel and Carnap 1953; Davidson 2001; Fodor and Lepore 2002; Kamp and Reyle 1993; Montague 1970), and some versions of cognitive linguistics (e.g., Langacker 1987; Langacker 1991; Wierzbicka 1980) and functional linguistics (e.g. Halliday and Matthiessen 2004), as well as most approaches in pragmatics (e.g., Grice 1989; Kaplan 1979; Recanati 2005; Sperber and Wilson 1995; Stalnaker 1999). These approaches are unified by the conviction that linguistic meaning is a property of a fixed inventory of language-specific and formally defined units — words and sentences — and those units can be used to communicate, think, and so forth because they carry this type of meaning. In such approaches, linguistic meaning is simply a distinct phenomenon from ecological meaning, which is understood as a property of relations between living organisms and their environments. In section 2, we argue that these approaches presuppose the strong and unwarranted assumption that linguistic actions and activities can be studied as an independent domain. That is, they simply assume — rather than demonstrating or even

arguing, in most instances — that linguistic meaning as just defined is a real and observable feature of real and observable phenomena such as interpersonal communication and silent thought.

For this reason, recent work in ecological cognitive science has sought to re-describe the phenomena associated with linguistic meaning as a variety of, or at least as continuous with, ecological meaning. This work includes some recent approaches in cognitive linguistics (e.g., Kröger et al. 2011; Mittelberg 2002; Zlatev 2007; Zlatev and Blomberg 2016) and some recent work in semantics (e.g., Bottineau 2008; Bottineau 2012). Our discussion in section 3 focuses on just one example, however: Joanna Rączaszek-Leonardi's model of linguistic symbols¹ as constraints on behavioral dynamics, a model based in the work of Howard Pattee (Pattee and Rączaszek-Leonardi 2012). This “symbols-as-constraints” approach integrates ecological psychology (e.g., Chemero 2009; Heft 2001; Reed 1995; Reed 1996; Turvey 2007) with the dynamical approach to cognition (e.g., Port and Van Gelder 1995; Iverson and Thelen 1999). It holds that linguistic action is characterized by increased complexity of the control mechanisms organisms bring to bear in organism-environment and organism-organism interactions (Rączaszek-Leonardi 2016; cf. Van Orden, Holden, and Turvey 2003). In particular, linguistic interactions tend to involve semi-stable behavioral elements — vocal, facial, and manual gestures that are repeated across many instances — whose history of uses within interactions allow them to function as constraints on present interactions.

This approach makes significant progress towards adequately capturing the relationship between ecological and linguistic meaning, but its recent developments seem to threaten that progress. In sections 4–6, we discuss a recent paper by Rączaszek-Leonardi et al. (2018) that updates the symbols-as-constraints view into the “symbol-ungrounding” view. This update consists largely in adding certain semiotic elements derived from Deacon's prior work (e.g., Deacon 1997, 2007a, 2007b) to the earlier model. We object to this addition on the grounds that it seems to commit to a specific semiotic model that is at odds with the dynamical underpinnings of the symbols-as-constraints model.

For this and other related reasons, we argue in sections 7–8 for embedding the symbols-as-constraints view within an interactivity-based approach to language and cognition rather than within a pre-existing linguistic or semiotic framework. This approach, based on the work of Steffensen (Harvey, Gahrn-Andersen, and Steffensen 2016; Steffensen 2012; Steffensen 2015; Trasmundi and Steffensen 2016; Uryu, Steffensen, & Kramsch 2014), does *not* add a semiotic layer of description to existing ecological-dynamical descriptions. Instead, it broadens the spatiotemporal scale of the phenomena to which those descriptions apply, operating under the assumption that linguistically-expert human action is unique not because it involves distinct types of meaning, but because it involves many more, and more heterogeneously-scaled, concurrent processes of meaningful organism-environment interaction than do other modes of action.

Our conclusion is that the only way to coherently relate ecological and linguistic conceptions of meaning is to understand the latter as an observer-dependent identification of a hugely heterogeneous class of phenomena with few or no unifying features. This identification can be addressed within ecological accounts of meaning by means of an interactivity-based version of the symbols-as-constraints view. By such accounts, there is no distinct type of meaning that can be called “linguistic.” Rather, particular situations or events that we — as observers — wish to describe in linguistic terms involve many varieties of ecological meaning, none of which are unique to linguistic actions.

2 The adiabatic separation of ecological meaning from linguistic meaning

A logical solution to the tension between the two meanings of “meaning” is to place them in two different and independent domains. This solution presupposes that what the semanticist is preoccupied with has nothing directly to do with how organisms orient and act in the world, and vice versa. As mentioned above, just such a working assumption has indeed been adopted by many positions in linguistics. For all practical purposes, they have approached meaning that takes place in human-human interaction, or that makes use of language skills, codes, or communication technologies as being independent of those forms of action, perception, and cognition that are understood to be non-communicative. In approaching linguistic meaning in this way, they apply what Jay Lemke calls the “Adiabatic Principle” to communication-related actions. Lemke explains the principle as follows:

Adiabatic basically means “it doesn't get through,” referring to energy, fields, or information. In its most basic form it is a statement about energy transfer, and it says that it takes time for energy to be transferred from one system to another; therefore, the faster something happens, the less energy is transferred. Conversely, very slowly varying processes appear as a stable background on the timescale of faster ones. This means, in effect, that a very fast and a relatively much slower material process cannot efficiently communicate with one another, cannot efficiently transfer energy. (Lemke 2000: 279)

Analogously, many branches of linguistics and semiotics treat processes that involve ecological meaning and processes that involve linguistic meaning as irrelevant to one another. They justify this separation by means of an assumption that linguistic meaning is tied to actions of a specific kind — what kind precisely depends on the theory in question, as we will see in a moment — that display specific properties enabling them to carry this special kind of meaning. Chomsky's (1965) competence/performance distinction is one canonical version of this assumption; Saussure's (1972) distinction between *langue* and *parole* is another. In both cases, specific actions are argued to be linguistic actions (performance, *parole*) because they are derived from or controlled by an inner, language-specific capacity (competence, *langue*) for pairing expression and meaning. Other widely accepted versions include strict modularity-of-mind claims (e.g., Sperber and Wilson 1995), and attempts to fully formalize semantic content (e.g., Carnap 1942; Montague 1970) or pragmatic implicature (e.g., Horn 2009; Stanley and Szabó 2000).

In each case, a special class of actions is defined (e.g., grammatically well-formed utterances by competent speakers) and a qualitatively distinct type of meaningfulness is attributed to these actions apart from all others. We trace such a view to the Adiabatic Principle because it presupposes a “doesn't get through” attitude where linguistic meaning has communicative implications only, as when communication is said to entail a cognitive mechanism such as the transfer of ideas or the establishment of a common ground (Clark 1996; Cowley and Harvey 2016). Communication, in turn, may be said to have ecological implications, as when a shared understanding of a problem allows agents to coordinate their behavior. However, no linguistic actions “get through” to the ecological domain, and since the effects of linguistic actions can be exhaustively described within a communicative domain, one can ignore the ecological domain in the treatment of linguistic actions. Communication is thus effectively an isolating barrier between descriptions of language and descriptions of ecological activities. Accordingly, the Adiabatic Principle upholds a sharp distinction between two unrelated concepts of “meaning:” *linguistic* meaning is a property of words and sentences, giving language a communicative function. *Ecological* meaning is a property of relations between living organisms and their environments (see Harvey 2015; Trasmundi and Steffensen 2016; cf. Chemero 2009; Thompson 2007). Adherents of the Adiabatic Principle assume that this distinction between linguistic meaning and ecological meaning points to a gap of either irrelevance or explanatory incommensurability between two different classes of phenomena.

However, theorists that hold such views carry the burden of proof in that it is not clear how these classes can be empirically distinguished, or why — on empirical grounds — such an effort would be motivated. Crucially, it requires showing that linguistic communication is an independent realm and not just a theoretical construct. In the light of this massive burden of proof, it seems to the present authors that it is both more parsimonious and more integrative to look for other ways to approach the relationship between ecological and linguistic meaningfulness, e.g. by taking a starting point in the view that language is inextricably integrated with inter-bodily coordination, richly multimodal perception and action, and task-oriented behavior.

In Section 3, we present one such model (the symbols-as-constraints model) that acknowledges the distinction between ecological and linguistic meaning as an indication of significant variability in the types of processes by means of which humans engage with the world, while still insisting on addressing all such processes within a single coherent framework. In this view, one asks: given that we are living organisms that rely on ecological meaning, how is linguistic meaning grounded in the dynamics of ecological meaning? How does ecological meaning give rise to the emergent properties that make us identify a realm of linguistic meaning?

3 Linguistic meaning as a variety of ecological meaning: the symbols-as-constraints view

In this section, we present Rączaszek-Leonardi's symbols-as-constraints model (Pattee and Rączaszek-Leonardi 2012; Rączaszek-Leonardi 2009; Rączaszek-Leonardi 2016). It contrasts in significant ways with classical views of action and agency (e.g., Newell et al. 1958), which hold that overt, observable behavior is the result of preceding, inner processes: the moving of the hand is traced to a neural “command center,” which instantiates what are traditionally called “intentions.” Intentions, as well as the entire inner machinery of knowledge and goals, are formatted as representations. In their critique of this view, Van Orden and colleagues (2003: 332) summarize it very succinctly: “Intentions are representations that set in motion a causal chain. To have the intention to act is to cause the act to happen.”

From a linguistic perspective, this classical model is a clear example of cognitivist computationalism — reminiscent of Chomsky and the distinction between I-language/competence and E-language/performance and Saussure's (2013) *circuit de la parole*, whose starting point is signs in the brains of individuals.² Likewise, stratificational models, which rely on trans-stratal realization (e.g., Halliday and Matthiessen 2004), assume that overt behavior (e.g., vocalization) is determined by the lexicogrammatical organization of meaning. Thus, it has

for decades and centuries been part and parcel of linguistic theorizing that the dynamics of overt, contextually embedded behavior are peripheral to language, whereas the symbolic aspect (i.e., code-based correspondences between sign-vehicles and sign-contents or the meanings of representational signs) is central. This basic assumption is occasionally supplemented, but never supplanted, by pragmatic theories (e.g., Grice 1989) that describe meaning disambiguation processes that occur when symbolic signs occur in real-life contexts.

The virtue of Rączaszek-Leonardi's alternative model of symbols-as-constraints is that it takes a starting point in the dynamics of human life: its initial concern is with biomechanical and sensorimotor constraints on movement, rather than with putative "underlying" causes of overt behavior. It assumes that human beings are living systems, incessantly engaged in their environment (which includes other human beings), such that ontologically their systemic dynamics are prior to any symbolic dimensions. In parallel with ecological psychology (Reed 1996), which also insists on explanatory models that discard mental representations, Rączaszek-Leonardi emphasizes that language is, first and foremost, a form of bodily action. Human existence is a continuous trajectory of activity and events, and it presupposes neither mental nor linguistic symbols. That is why the pre-linguistic baby can develop a form of life describable in terms of sign use: activity gives rise to symbols, rather than the other way around. So why, then, does language evolve in the first place?

Language, understood as a system of replicable constraints, provides further controls, energetically much cheaper to produce than actions or gestures, which can coordinate action and cognition in a precise, culturally specific way. By appearing at specific moments in an interaction, utterances become parts of events. Their carefully timed appearances are brought about by complex constellations of conditions and, with experience, they come to specify complex patterns of co-action. (Rączaszek-Leonardi 2016: 51)

It is in this sense that "symbols constrain dynamics:" in the ongoing stream of events, symbols "nudge" the overall dynamics and trajectories of the parties co-engaged in dialogue. In this view, symbols do not *carry* meaning *per se*. Instead, meaning emerges as symbols "co-create meaning together with individual and interactional dynamics" and therefore "the background [i.e., substrate] for language is thus the dynamics of *already meaningful* human co-action in the environment" (*ibid.*: 51, emphasis added). The strength of the symbols-as-constraints model is that it traces the causal efficacy of language to its ecological meaning. The concept of ecological meaning applies to many ways in which environmental structures and organisms' sensorimotor skills constrain the dynamics of organism-environment interactions (see, e.g., Chemero 2009; Trasmundi and Steffensen 2016; Wallot and Van Orden 2011); symbols, construed as constraints, are just one of many ways in which organism-environment interactions are organized. They may be more flexible in the constraints they impose than other environmental structures and easier for organisms to create and use to coordinate with one another, but they do not involve a novel or qualitatively distinct type of meaning — even if our rich phenomenological experience with language and literacy allows us to describe them as qualitatively distinct.

Because the symbols-as-constraints model prioritizes the constraints that symbols impose on dynamical systems rather than the symbolic properties of such constraints, the model needs to account for how symbols and dynamics co-evolved within the system that is constrained. The argument is that a given structure must meet two requirements in order to function as a symbolic constraint. First, it needs "a definite structural basis" (Pattee 1973; quoted in Rączaszek-Leonardi 2012: 301), which means that it must be *physical*. There must be a stable relation between that structure and the dynamical system within which it functions as a symbol so that identical/similar symbols constrain the dynamical system in identical/similar ways. To achieve that stability of the symbol-system relation, the symbolic structure must be replicable and its replication must be energetically cheap. The second requirement for a physical structure to function in a symbolically meaningful way is that it must have co-evolved with the processes whose dynamics it is capable of constraining. In this co-evolution, the symbolic structure has been *selected*: "selection is a historical process that underlies current function. [...] Symbolic structures are [...] memories of the choices of adaptive coordinations with reality, of constraints on existing dynamics that have led to adaptive results" (Rączaszek-Leonardi 2012: 302).

In the original work of Pattee, this line of thinking was exemplified by how DNA evolved to constrain protein folding. Rączaszek-Leonardi (2012, 2016) discusses at length how this original model maps onto natural human language. In this discussion, it is made clear that "the term 'language' pertains to all phenomena [of 'cultural and biological information transmission'] that are based on this general relation of [a] physical system of transmittable structures to the dynamics around which it arose" (Rączaszek-Leonardi 2012: 305). Irrespective of the nature of the dynamical system and of the symbolic structures, all examples share a "specific relation between symbolic and dynamic modes" of description (*ibid.*: 307), which two modes are derived from "Pattee's general principle of complementarity" (*ibid.*: 306). In Pattee's words:

I regard complementary models as an epistemic necessity. The inescapable fundamental complementarity is between the subjective and objective models of experience. This is a universal and irreducible complementarity. Neither model can derive the other or be reduced to the other. [...] In biology the *structure-function* complementarity is a universal necessity. Function cannot be logically derived from

only a structural description, and a structure cannot logically be derived from only a defined function. In evolutionary terms, structure-function relations appear to be “discovered” by natural selection and often appear as frozen accidents. (Pattee 2012: 18–19)

It should be clear from this exposition that the symbols under discussion are far from the traditional variety found in linguistics and semiotics, where symbols are defined in terms of their position in formal sign systems or taxonomies, or in terms of abstract representational properties. Rather, symbols can be defined as replicable physical structures that constrain the dynamics of self-organizing systems by means of their replicated structural properties, and a history of selection processes through which those properties and the constraints they impose have co-evolved.

Having presented and discussed the symbols-as-constraints model, we can return to our opening question: how do ecological and linguistic meaning relate? One option at this point is to settle the case, concluding that the symbols-as-constraints model is a model of ecological meaning, of which replicable *linguistic* constraints (in Pattee’s sense) are simply one variety. This option is unsatisfying, however, because it is not clear whether Pattee’s conception of symbol is adequate to account for the full richness of emotional, imaginative, and conceptual meaning that humans experience in the course of linguistic action. What type of entities constitute “symbols” in linguistic interaction, for instance? What of writing systems (e.g., Olson 1996) and the rich and complex multimodality of speaking and listening (e.g., Rosenblum 2010)? Because this is not clear, ending the story here establishes a built-in temptation to align Pattee and Rączaszek-Leonardi’s symbols-as-replicable-physical-constraints with other uses of the term “symbol,” such as uses in formal semantics or Peircian semiotics, regardless of whether these other uses display the appropriate systemic properties.

Section 5 discusses one such recent attempt at linking Rączaszek-Leonardi and Pattee’s view on symbols to a Peircian-inspired view developed by Terrence Deacon, which view is summarized in section 4. We argue later on that we think this integration fails (sections 6–7), and in section 8 we propose another strategy for developing the symbols-as-constraints view in a more interactivity-based direction.

4 Adding semiotics to symbols-as-constraints: reference and sign-types

In a recent article, Rączaszek-Leonardi and colleagues (2018) address the question of how a dynamical view of language relates to the symbolic properties that have been described by the linguistic tradition for centuries? With a reference to Harnad’s “symbol grounding problem” — “How can the meanings of the meaningless symbol tokens, manipulated solely on the basis of their (arbitrary) shapes, be grounded in anything but other meaningless symbols?” (Harnad 1990: 335) — Rączaszek-Leonardi and colleagues refer to this issue as one of *symbol-ungrounding*:

[T]his is a problem of (a) how grounded iconic and indexical informational forms can give rise to the degree of abstractness, arbitrariness, and formal properties of a symbolic system and at the same time (b) how they remain informational with respect to individual and interactive dynamics, that is, causally intertwined in linguistically mediated co-action. (Rączaszek-Leonardi et al. 2018: 57)

Rączaszek-Leonardi and colleagues add to the symbols-as-constraints view in two ways. First, they make it an ontogenetic account of the development of more advanced linguistic abilities from less advanced ones. This aspect of the account is discussed in section 5. This section 4 takes up the second addition, which is semiotic: in addition to the dynamical systems account of coordinated interaction and ecological psychology as a general theoretical framework, the paper adds cognitive semiotic elements to its theory and methods.

The semiotic addition seems to derive mostly from Deacon’s past work, in which he lays out his own understanding of Peirce (1931), signification, and varieties of meaning. While Deacon’s reading of Peirce is extremely nuanced (see Deacon 1976 for an overview), only a few elements of it are clearly present in the symbol-ungrounding approach, as it is presented in Rączaszek-Leonardi and colleagues (2018). In particular, Rączaszek-Leonardi and colleagues make extensive use of the three-part conceptual distinction between iconic, indexical, and symbolic varieties of signs, as well as a particular model of the way that more complex and abstract signs (“symbols”) build on simpler and more grounded signs (“icons” and “indexes”).

Underlying both of these aspects is the crucial notion that theories and analyses dealing with language and linguistic action are fundamentally theories and analyses of *reference*. That is, such theories and analyses are most basically concerned with the different ways that linguistic units refer. As mentioned, Deacon’s work focuses on three varieties of reference (iconic, indexical, and symbolic), and the article itself concerns a postulated ontogenetic progression from the first and second of these to the third. This progression depends, most importantly, on the manner in which symbolic reference “is understood to be a relation that is dependent on

a complex semiotic infrastructure created by prior communication" (*ibid.*: 43). The "complex semiotic infrastructure" includes both a history of communicative interactions as well as "systematic" relationships between signs; we will deal with this view in detail in section 5.

The focus on referring is present throughout much of Deacon's work, and his previous writing on language (e.g., Deacon 1997; Deacon 2011) emphasizes reference heavily. In some contexts, Deacon's writing on reference (in several different senses of the word) is rich and internally coherent. These include, among others, his in-depth interpretations of Peirce (e.g., Deacon 1976) and his detailed work on information theory (e.g., Deacon 2007a, 2007b). However, in the context of the ungrounding-symbols view, the focus on reference has to be evaluated with respect to its role as an addition to a pre-existing model (the symbols-as-constraints view). This requirement means that it has to be evaluated instrumentally: what do reference and icon/index/symbol terminology add to analyses of linguistic interaction, over and above what is possible within the symbols-as-constraints view alone?

The answer given by Rączaszek-Leonardi and colleagues is that Deacon's work in cognitive semiotics enables them to give a "finer grained account of the informational constraining process" (Rączaszek-Leonardi et al. 2018: 42) that links "linguistic utterances" to objects and events being referred to:

Semiotics provides a conceptual toolbox for analyzing the hierarchic typology of constraints and the historical processes they have to undergo to become means for regulating the social physics that the child finds himself or herself in. More important, the semiotic perspective forms a bridge between mere social physics and language by distinguishing different ways that sign forms can be grounded in the world of pragmatic co-action. (*Ibid.*: 68)

In other words, "semiotic analysis [...] enables us to illustrate how language functions in a rich network of semiotic relations other than symbolic and point out that such grounding is crucial for subsequently developing its symbolicity" (*ibid.*: 44). The semiotic elements that turn the symbols-as-constraints view into the symbol-ungrounding view are used for the analysis of reference relations between "informational forms" — such as "linguistic utterances" — and the various things that they signify, or refer to, or "mean." The value of the semiotic elements thus rests on the assumption that the referential properties of linguistic forms are the key properties of interest in understanding language development or understanding linguistic activity more generally. That is, labeling gestures (vocal or otherwise) as icons, indexes, or symbols only improves our understanding of the events taking place if the gestures' referential functions are the primary functions of interest, i.e., if "referring" is of greater explanatory significance than any other coordinative functions that might be taking place.

For instance, Deacon (1997: 71) lists these classic examples of symbols and the entities they refer to: "A wedding ring symbolizes a marital agreement; the typographical letter 'e' symbolizes a particular sound used in words ... [and] the words of this sentence symbolize a particular idea or set of ideas." These are classic examples of linguistic meaning in the sense described in sections 1–2: identifiable objects carrying specifiable meanings in a manner that cannot obviously be explained by means of organism-environment interaction. The letter 'e,' for instance, certainly does not uniquely specify either a sound or an articulatory gesture of the vocal tract. Reading is often silent, or partial, or rushed, or slurred; 'e's are written, inscribed, stylized, hinted at, etc. in a vast array of manners and for a vast array of purposes. In fact, there is nothing that can be said *in general* about the way that any of these objects enable or constrain action, perception, or cognition. Of course, Deacon is quick to note this himself:

No particular objects are intrinsically icons, indices, or symbols. They are interpreted to be so, depending on what is produced in response ... When we apply these terms to particular things, for instance, calling a particular sculpture an icon, a speedometer an indicator, or a coat of arms a symbol, *we are engaging in a sort of tacit shorthand*. What we usually mean is that they were signed to be interpreted that way, or are highly likely to be interpreted that way. (*Ibid.*: 71, our emphasis)

This is the key point: the terms "icon," "index," and "symbol" are shorthand labels for complex sets of properties characterizing whole interactional situations. Each term specifies a type of relationship between an "informational form" being perceived by a person and the object or idea that the form in question causes the person to engage or interact with. Note how tightly these terms narrow the focus of the symbols-as-constraints view. For Pattee and Rączaszek-Leonardi (2012), any replicable pattern of sensorimotor behavior can be a "symbol," so long as it constrains the ongoing interaction's dynamics by means of its replicated structural properties. This approach engenders rich descriptions of events with both qualitative and quantitative elements. By contrast, in the symbol-ungrounding view, "reference" seems to have both become the primary topic of analysis and taken on a classical semantic flavor borrowed from Deacon's other writing on semiotics.³

Our objection to this semiotic description is that it can do nothing more than put individual gestures into one of three categories. For instance, the first example presented by Rączaszek-Leonardi and colleagues (2018:

46–50) involves a mother following her infant’s gaze to a stuffed toy, asking him what he’s looking at, picking it up, and otherwise structuring the mother-infant interaction so as to enable the infant’s direction of gaze to control their joint attention. The description given is extremely detailed and informative, requiring some three pages of text and diagrams. The semiotic analysis at the end provides no new information, only identifying the infant’s gaze as having both indexical and iconic aspects. These properties lead to no new insights or predictions. Similarly, in example 3 (*ibid.*: 55–56), a mother matches vocalization duration to movement duration as she rolls her infant over onto his stomach and then again as she rolls him back; she may also match her pitch to one or more parameters of the movements’ dynamics (it is not possible to tell from the example). We then read that “semiotic analysis shows why speaking of early language use [such as this example] should not be confused with using language as a system of symbols” (*ibid.*: 56). The passage that follows consists of the assertions that “linguistic means of control [...] will, in time, become symbolic,” and that they will nonetheless remain grounded in iconic and indexical reference, such that their symbolicity will not be mysterious (*ibid.*: 57). It is not clear what this passage is an analysis of, or what it shows, or what it adds to the intriguing example presented immediately prior. The semiotic shorthand — and accompanying tight focus on the referential function of “linguistic utterances” and other “informational forms” — introduced by Rączaszek-Leonardi and colleagues (2018) seems to be of relatively little instrumental value for explicating their examples. If they are to have any utility at all, the category-labels “icon,” “index,” and “symbol” must be employed in making a broader theoretical point. It is to just such an attempt that we now turn.

5 Ungrounding symbols from icons and indexes

Deacon’s views on semiotics make a second major contribution to the ungrounding-symbols view, as the icon-index-symbol trichotomy is used to answer the authors’ central question: why is language not tightly linked to the contexts in which it has emerged? Our response to this part of the symbol-ungrounding model has three parts. First, we think it does not succeed because the key property that gestures, vocalizations, and movements need to display to count as “symbolic” — i.e., indexing other signs — is a ubiquitous property of coordinated activity and is not unique to word-like vocalizations. We explain this position immediately below. Second, its goals seem at odds with one another: it wishes to give an account of linguistic action in ecological terms, but does so by attempting to demonstrate that linguistic actions have semantic and formal properties that are at odds with ecological models. We explain this view in section 6. Third and finally, in sections 7–8, we suggest an alternative use of the symbols-as-constraints model that does not share the same difficulties.

As mentioned in the previous section, the symbol-ungrounding model addresses how “abstractness, arbitrariness, and formal properties of a symbolic system” emerge out of “grounded iconic and indexical informational forms,” while “remain[ing] informational with respect to individual and interactive dynamics” (Rączaszek-Leonardi et al. 2018: 57). The second requirement is clearly in line with the symbols-as-constraints view: it posits that linguistic symbols are physical structures that constrain the dynamics of ongoing actions and interactions. The first, however, is not compatible with the symbols-as-constraints view. It presupposes that human languages are “symbolic systems” characterized by “abstractness, arbitrariness, and formal properties.” Given this assumption, the authors ask how such symbolic systems emerge, seeking to answer this question: “how can language ever detach from this carefully orchestrated, multimodal enactments to become symbolic?” (*ibid.*: 57).

The meaning of “symbolic” here is provided by Deacon’s semiotics: the symbol-ungrounding view is centrally concerned with how units of language can refer symbolically rather than only referring iconically and indexically. In an earlier formulation, he writes that “symbols are mediated by some formal or merely agreed-upon link irrespective of any physical characteristics of either sign or object [i.e., thing referred-to]” (Deacon 1997: 70), and they are characterized by “their involvement in systems of conventional relationships” (*ibid.*: 71). Rączaszek-Leonardi and colleagues (2018: 58) agree, writing that “symbols must be doubly conventional: conventional sign vehicles with conventionally determined reference.” Accounting for the ungrounding of icons and indexes into symbols is thus a matter of accounting for conventionality and systematicity.

The key element in their explanation is an alleged shift from pre-symbolic signs that relate purely to situated dynamics to signs that relate to other signs:

Following the semiotic account provided by Deacon (1997), we propose that the ungrounding from the immediate stream of multimodal co-action is possible because of a shift from direct iconic and indexical relations of utterances to other multimodal events to using iconic and indexical relations between sign vehicles to disambiguate reference. Whereas presymbolic grounding relies on being causally and predictively involved as controls on multimodal interactions, symbolic grounding is mediated by systemic

icons and indexical relationships among linguistic forms themselves. (Rączaszek-Leonardi et al. 2018: 58)

Linguistic utterances, unlike most of other controlling actions or gestures, are thus embedded in parallel, both in ongoing multimodal interactivity in which linguistic forms are indices and icons controlling the interaction and (also as icons and indices) within complex linguistic structures. The latter loosens the grip of the first grounding, giving linguistic utterances partial freedom from the social physics they modulate. (*Ibid.*: 58)

The argument is that iconic and indexical signs gradually start indexing one another, and by so doing the linguistic elements constitute a network where not only the individual signs, but also the relations between them become constraints on dynamics. It is via this network that linguistic signs develop systematicity and compositionality as “those relations are effective constraints that provide the possibility for novel (e.g. combinatorial) forms of control” (*ibid.*: 45). “Linguistic utterances” become symbols as they become embedded in these combinatorial systems:

In language development, patterns stabilizing which utterances go together are provided by the adult’s utterances and by enactments of early dialogue. This grounding of utterances in other utterances provides a possibility for their partial ungrounding from simple causal and iconic relations to ongoing events. This is because the interactions now can be influenced not only by single (or undifferentiated) linguistic forms but also by the relations among them. (*Ibid.*: 65)

Here we come to our first major objection to the symbol-ungrounding view. The core property that signs must possess in order to qualify as Deacon-type symbols is that they must index other signs. For this property to distinguish between symbols and non-symbols, *some* signs must exhibit this property while others must not. The latter category of (non-symbolic) signs thus must *not* index other signs. Now, bear in mind that in the symbols-as-constraints view, *all* candidate “informational structures” (for which “signs” is shorthand) are physical structures that function as replicable constraints, or as symbols in Pattee’s sense of that term. For the present symbol/non-symbol distinction to work, it requires a class of physical Pattee-type symbols that do *not* index other such symbols. *However*, since the physical structures in question consist of elements of interactional behavior, they will by definition index other elements of interactional behavior. Interaction is behavioral coordination, and coordination is by definition co-indexical. Constraints on coordination dynamics are necessarily limitations on the degrees of freedom of motion or electrophysiological fluctuation of multiple components of living systems in relation to one another. To be a participant in an interaction constrained by Pattee-type symbols is to have one’s behavior constrained with respect to temporal, spatial, electromagnetic, dynamic, and experiential relationships between multiple such Pattee-type symbols. There is thus no set of signs that meet Deacon’s criteria for being non-symbolic, i.e., no set of signs that do not index other signs. As such, it is difficult to see on what grounds the authors identify certain elements of interactional behavior as symbolic, while others are identified as indexical and/or iconic — unless this identification was made on unrelated grounds, e.g., as an *a priori* distinction between actions that are intuitively “linguistic” in feel and those that are intuitively “pre-linguistic” or “non-linguistic.”

Rączaszek-Leonardi and colleagues assert that symbols are differentiated from icons and indexes because, unlike these latter two sign-types, symbols constrain dynamics with respect to “utterance-utterance relations” or “patterns stabilizing which utterances go together” (2018: 65). They provide an example (*ibid.*: 65–66) in which a mother sings a nursery rhyme while performing accompanying movements with her hands. They describe this as a linear and conventionalized sequence of manual gestures performed simultaneously with a linear and conventionalized sequence of vocal tract gestures. The idea is that the ordering of one sequence reflects or parallels the ordering of the other, helping the infant to understand the sequentiality — which is an utterance-utterance relation — of both the vocal and gestural movements, and that this understanding is an important functional feature of vocalizations. But these are hardly the only replicable relationships between signs that are being used to control coordination here. Nursery rhymes are usually sung; melodies are replicable sequences of pitch changes. The mother and infant are gazing at one another’s faces; mutual gaze is surely a replicable relationship between two sets of gaze-fixations (one performed by the mother, the other by the infant). What of the sequentiality and complex inter-gesture constraints of co-articulation and speech rhythm? The child appears to grasp the mother’s hands during her recitation — this must affect *some* parameters of her manual and articulatory movements, and thereby help the infant to anticipate similar changes as a result of grasping someone’s hands. And so on, *ad infinitum*. There is nothing unique or unusual about relationships between parameters of gestures, whether the gestures are articulatory, manual, facial, pedal, postural, or — more likely — complex combinations of these.

The more general point here is that the authors’ semiotic analysis forces an artificial narrowing of focus onto vocal parameters that can be pre-theoretically and phenomenologically identified as being “linguagy,” at

the cost of attention to all other parameters of coordination. The authors write that symbols are gestures that take place within a “linguistic layer” (*ibid.*: 45) of actions. This layer consists of “the context of other linguistic utterances, [and] ultimately emerges as a quite distinct layer of dialogical interactions” (*ibid.*: 68). They also describe utterances as belonging to a “linguistic modality,” comprising its own “modality-specific (linguistic) contingencies in the co-actions with infants” (*ibid.*: 59). Our best understanding of these claims is that they amount to asserting that linguistic activity is operationally or mechanistically separable from other concurrent activity. As far as we are aware, this assertion is nowhere defended in the article; moreover, as sections 1–2 made clear, we do not think it is easily defensible. All five examples given by Rączaszek-Leonardi and colleagues make this point forcefully: the dynamics of vocal, manual, postural, and facial movements are tightly intertwined in every case.

It is true generally that linguistic activity is sensitive to relations between multiple gestures and across multiple modalities (e.g., Dale et al. 2014; Dale et al. 2011; Fowler and Dekle 1991; Rosenblum 2008; Rosenblum 2010; Shockley et al. 2007; Treffner et al. 2008; Wallot and Van Orden 2011). We can see no empirical grounds whatsoever for the assertions that a narrow subset of vocalizations comprises either a distinct “linguistic layer” or a distinct “linguistic modality” of action or interaction dynamics. And if there is no distinct “linguistic layer,” the symbol-ungrounding argument falls apart: the development of adult linguistic abilities cannot be explained with reference to inter-sign relations if these are in fact ubiquitous across all interbodily coordination. This is our first objection to the symbol-ungrounding view.

6 The properties of “symbols” in “symbol-ungrounding”

Our second objection is that the symbol-ungrounding approach appears to set itself a contradictory goal: it aims to account for certain aspects of linguistic action in ecological terms, but it defines those aspects in strictly non-ecological terms. Put otherwise, it aims to resolve the “symbol grounding problem” by claiming, in effect, that the symbols were *always already grounded* in sensorimotor coordination. But in doing so it borrows a list of putative symbolic properties that are — so we will argue — partly phenomenological, partly metaphorical, and partly fictional. As such, they are properties that cannot *in principle* be accounted for as forms of sensorimotor coordination.

Our starting point here is acknowledging the fact that the behavioral dynamics of human interaction are vastly different when they are constrained by verbal expressions than when they are not. In the symbol-ungrounding view, these differences are to be explained by the involvement of a novel type of pattern in interactional behavior, which carries a special type of meaning. Following Deacon (e.g., 2011: 397), Rączaszek-Leonardi and colleagues (2018) call these gestures “symbols.” They assert clearly that linguistic symbols are a distinct type of sign which start to appear at an identifiable point in time during development, and that they display a set of extraordinary features that do not characterize pre-symbolic vocal and gestural interactions. These features are given in the following passage:

[L]anguage has the undeniable capacity of removing us from the here and now, evoking abstract relationships as well as nonpresent or even nonexistent entities. Due to its compositional structure, it also has its own syntactic combinatorial properties, and, crucially, its elements and structures seem to have a degree of “arbitrariness” and conventionality with respect to how linguistic forms relate to their semantic and communicative functions because the clues to these functions are usually missing from word sounds (Deacon 2011; Peirce 1931). (Rączaszek-Leonardi et al. 2018: 40)

These, then, are the special properties that linguistic symbols are supposed to convey: (i) distant and non-actual reference⁴; (ii) compositionality and combinatoriality; and (iii) conventionality or “arbitrariness” of meaning. Our position on all three counts is that these are *at most* phenomenological properties of certain very specific and very rare modes of action, all of which depend entirely on advanced literacy skills. That is, these are not operational or functional features of linguistic actions; they are characteristic of the *feeling* or *experience* of performing some very particular literacy-dependent modes of linguistic action. We will make a few remarks about each of (i)–(iii) before returning to this general point.

We begin with (i), the idea that linguistic units remove us from the here-and-now (or enables us to leave it) by letting us speak, think, or write with reference to distant, fictional, and otherwise absent entities. While the *feeling* of referring to absent entities is a common experience, especially concerning the use of declarative sentences to describe imagined situations, it is not an operational feature of linguistic symbols generally. There are three key reasons to think that this is so.

First, the idea of absent reference artificially isolates referential functions from all other functions that linguistic action can play. These include affective (e.g., Jensen and Pedersen 2016; Trevarthen 2008), rhythmic (e.g., Cummins, 2014; Port, 2008), perspective-taking (e.g., Duran and Dale 2014), and socializing (e.g., Duranti

et al. 2012) functions, among innumerable-many others. The very idea that language removes us from the here-and-now or refers to that which is distant or absent only makes sense with respect to decoupled reference or aboutness. Second, all linguistic action, of any kind, necessarily impacts what is immediately present and coupled to the speaker. Given the symbols-as-constraints model, all linguistic activities constrain current events, and as such they are all pragmatically relevant for the here and now, even during active discussion of past or hypothetical events. Third, gestural (including “linguistic”) coordination of dynamics is multiscale (Rączaszek-Leonardi 2010; Steffensen and Pedersen 2014). The activities coordinated need not play out on the timescale of seconds to tens of seconds, what Enfield and Sidnell (2014) call the “enchronic” timescale, in which human actions play out in our lived awareness. On the contrary, the verbal, prosodic, and graphical coordination of behavior plays out on a wide array of timescales, from milliseconds to decades. Given this, there is no reason to think that what is intuitively “present” in a given moment of speaking, reading, or talking ought to have any privileged status with respect to what can be coordinated by linguistic means. As Noë (2012) has argued at length, presence is not a binary state. Action and experience are both extended in time; perception, sensation, and the control of movement are not state-based but process-based. Entities are not simply present or absent to awareness or to perception; rather, they are present in different ways and by different means. Speaking generally, the so-called “now” is a highly elastic phenomenon; it is unclear what Rączaszek-Leonardi and colleagues are claiming when they suggest that symbols “remove” us from it.

With respect to the putative symbolic property (ii), compositionality and combinatoriality, we may ask in what sense language is compositional? It is certainly not compositional in the technical sense of this term, as this is a construct in certain semantic theories needed to justify “building block” models of meaning, wherein meaning is inherent in abstract and invariant lexical forms, which are then combined into sentences that express logical propositions (e.g., Fodor and Lepore 2002). Further, the notion of compositional meaning has been thoroughly criticized from distributed and integrationalist quarters (e.g., Love 1990; Taylor 2017; Thibault 2017), as well as from within semantics (e.g., Jaszczolt 2005; Recanati 2012; Travis 2008; Zuidema and De Boer 2009). Certainly, linguistic actions’ “meanings” — in the sense of the constraints they impose on interaction dynamics — can be brought about using shorter or longer utterances and, in writing and typography (but not in speech), the elements can be moved around and physically re-combined, but neither of these matches the technical concept of compositionality. The upshot of these considerations is that language is not compositional by nature, but can be *described* as compositional if one is literate and adopts a particular theoretical perspective.

With respect to (iii), conventionality and arbitrariness of meaning, we contend that observations of arbitrariness and conventionality always presuppose a comparative perspective. For example, in his account of the arbitrariness principle, Saussure exploits this comparative perspective when he illustrates arbitrariness with how the signified ox has two different signifiers: b-ö-f (“boeuf”) in French and o-k-s (“Ochs”) in German (De Saussure 1972: 100). Adopting this perspective is attending to what Love (1990) termed “the second order” of language, i.e., language effortfully and expertly conceptualized in terms of repeatable units. To engage in this effortful conceptualization is a fundamentally literate activity, dependent on what Linell (2005) calls “the written language bias in linguistics,” which is an inclination on the part of superlatively literate scholars to perceive and conceive of the stream of speech in terms of letter-like entities, such as phonemes, morphemes, words, etc. This second-order perspective sets aside all of the coordination dynamics that, from a symbols-as-constraints perspective, do the work of explaining how linguistic actions can exert any constraint at all.

By contrast, in “first-order” perspectives based on local interaction dynamics, where symbols constrain the unfolding of events, language is in a significant sense *not* arbitrary. When a child produces his or her first word, it is deeply motivated by how his/her caretakers have used this specific sequence of articulatory gestures to constrain events and interpersonal, affective relationships. While we agree that one cannot deduce semantic and communicative properties from phonetic properties, this observation misses the point. Because we are all embedded in this larger flow of events, no living speaker is ever confronted with the task of reconstructing symbolic meaning from phonetic properties because participants in interactions necessarily rely on pre-existing patterns of coordination on many timescales. Thus, attributions of arbitrariness are misleading at best, specious at worst.

In making this point, we find ourselves agreeing with Rączaszek-Leonardi and colleagues (2018). Later in the article, they write that “early iconic and indexical behaviors are already conventional and therefore partially arbitrary with respect to which aspects of behavior are taken to be significant. Conventionality and arbitrariness are thus not the exclusive property of symbols” (*ibid.*: 49–50). Moreover, and in keeping with the symbols-as-constraints view, they hold that no “informational form” is truly arbitrary they all depend on a history of selections for their constraining function.

Summarizing the three previous points, then: the symbol-ungrounding view is based on the claim that certain gestures and vocalizations take on special and extraordinary functions at some point during development. As given by Rączaszek-Leonardi and colleagues (*ibid.*), these functions all correspond to classic representational properties of language as described in philosophical and structuralist accounts of languages as formal symbol

systems. We have suggested that these properties are not grounded in operational or indeed in functional aspects of action, but instead in the phenomenology of a few modes of linguistic action that all depend on literacy. As such, they are unsuitable targets for a model like that proposed by the symbol-ungrounding view, given that view's basis in coordination dynamics and ecological meaning.

So this is our second objection to symbol-ungrounding: that it is an ecological approach trying to account for properties of language that are theory-internal constructs of formally-inclined branches of the philosophy of language. As such, its goals are self-contradictory.

In the next section, we give the final part of our response to the symbol-ungrounding approach, before section 8 relates the symbols-as-constraints view to our own interactivity-based approach to linguistic action.

7 Complementary descriptions of interaction: coordinated movements and population-level patterns

In this section, we suggest that there is another way to develop the symbols-as-constraints view. It is, simply put, to accept that human language involves replicable constraints on the dynamics of interactions, while denying that these replicable constraints can be equated with “symbols” as that term is used in other contexts. In particular, we argue that it is possible to accept the idea of symbols-as-constraints-on-dynamics but reject the notion that symbols carry linguistic meaning. We advocate an approach that does just this, which we call an “interactivity-based approach to language and cognition.” This approach includes only ecological meaning and holds that ecological tools — including the notion of symbols-as-constraints — can account adequately for the lived experiences of linguistic action that have been developed into conceptualizations of linguistic meaning. Human beings sometimes experience language as referential, abstract, systematic, and compositional, but these experiences are the result of advanced perceptual skills applied to the behavior of oneself and others. We focus on this aspect of the interactivity-based approach here and, in section 8, we give an overview of how it accounts for some of the more advanced functions of language use, offering an ontogenetic narrative parallel to that offered by the symbol-ungrounding model.

We begin here with a different interpretation of the putative symbolic properties discussed in section 6. We suggest that they are not properties of gestures or vocalizations *per se*, but are instead descriptions of the phenomenology of a few specific ways of using gestures and vocalizations. More specifically, they are descriptions of ways that an ongoing interaction is participating in population-level patterns of behavior. For instance, imagine speaking with a sibling about your parents. An outside observer might describe your utterance of the word *mother* as referring to an absent person, that is, as establishing a reference relationship between a vocalization pattern and an absent human being who is herself much too far away to affect the ongoing dynamics of your conversation with your sibling. But this is a misleading portrayal of events. Basically, it explains the interactional dynamics by narrowly relating a specific behavior (uttering *mother*) to a specific referential content. But, upon closer inspection, things are more complicated: the observer first has to identify your vocalization as a replication of a behavioral pattern (a sequence of vocal tract gestures) common among members of your social network, and then ask what that behavioral pattern — *in general*, or *in all cases* — *tends* to do, or how it *tends* to affect perceptual, imaginative, and other activity during conversations. This second question, asking for a generalization or a broad tendency, is thus no longer a question about you and your sibling or the events of your particular conversation; it is an observation of many interactions involving many people over a long span of time. It is a generalization about experiences that some of these people might reasonably be expected to have as part of their sensorimotor engagement with one particular instance of this replicable sequence of vocal tract gestures. This mode of description then leads to the conclusion that your own, ongoing conversation must in some sense be “about” your own mother, who is absent. But crucially, this conclusion is a *non sequitur*: such generalizations are facts about the whole history of the population-level pattern of behavior, not facts about your replication of it here-and-now.

Looking beyond the (artificially isolated) behavioral pattern, your sensorimotor activity will have some other set of effects on the ongoing interaction — that is, it will exert constraints on the coordinated movements, physiology, and affect-laden experiences of the ongoing conversation. While these constraints may be related to your actual mother in many ways, those ways are complex, multifarious, and vastly multi-scalar, and certainly not reducible to a simple relation of “reference” or “meaning” or “symbolizing.” For instance, the constraints imposed on the interaction by the utterance of the gesture-sequence “mother” may involve physiological traces (i.e., memories and other bodily effects) of childhood experiences in which your mother was involved. Or they may change how that sequence affects you the next time you replicate it. Or they may enable you and your sibling to partially reproduce familiar interaction patterns in posture, pitch, volume, and gaze-behavior, patterns first shaped during interactions involving your mother or affected by her.

It is helpful to compare this hypothetical example to Rączaszek-Leonardi and colleagues' (2018: 52–55) example 2, which illustrates how the mother of a drowsy infant synchronizes her repeated utterances of *hello* with the opening and closing of his eyes. She demonstrates two very different behavioral patterns, and her switches between them are governed by the aperture of the infant's eyes, which thus functions as a control parameter. One pattern is a mix of touches, talk, and care-taking activity, performed while the infant's eyes are closed. The other is the articulation of *hello* with a distinct rise-fall prosodic contour, accompanied by a big smile, which is performed when the infant's eyes are open. Her performance of these two behavioral modes carefully structure the dialogical system (Steffensen 2012) in which the infant is embedded such that opening his eyes reliably elicits a smile and a vocalization with a fixed gestural sequence and a fixed intonation pattern. Over time, continued embedding in similarly-structured dialogical systems will enable the child to pick up on more nuanced aspects of this interaction and to assume greater control, treating utterances of *hello* as initiators of interaction and using such utterances to initiate interactions himself. Those future *hellos* are causally related to these first, early *hellos* in that they are replications of a habitual pattern of interactional behavior that the infant first participates in here.

The key point is this: *from the perspective of dynamics and the flow of events*, the infant from example 2, when uttering *hello* later in life, will be instantiating exactly the same kind of connection to his mother that you did when uttering *mother* in our hypothetical example above. Both utterances are built from complex habits for multimodal interactional behavior formed during prior mother-child interactions, and approached from such a dynamical perspective, the goal of the description is to account for the events taking place, including how they were performed.

However, if one takes a population-level perspective, one can describe the utterances as instances of different "words," and generalizations can be drawn about the typical, or average, or most frequent "meaning" of those words. In fact, it is *only* from such a population-level perspective that one can attempt to identify what constraints "words" most commonly impose, across the full range of interactions where the behaviors have been replicated. And from *this* perspective, *mother* will have a meaning related to mothers while *hello* will not; this does not change the fact that in our chosen examples, the utterances of *mother* and *hello* had *exactly the same* connections to the speakers' mothers.

This, then, is our position: so-called "symbolic" properties are loose, extremely approximate generalizations about the phenomenological effects of participating in, or replicating, population-level patterns of behavior. We are thus claiming that the interaction-level description of behavior and the population-level description of stable patterns of vocalization belong to two distinct but complementary models of conversation. This concept is borrowed from Pattee:

Complementary models [...] are models of a system that may be formally incompatible in the sense that no one model is logically or mathematically derivable from, or reducible to, the others, and all such models are necessary for a complete understanding of the system. (Pattee 2012: 18-19)

This idea echoes Maturana's (Maturana 1970; 1978) assertion that statements can only be evaluated with respect to specified observers. A dialogue-level description of behavior is given from the perspective of the participants in the interaction: to them, it makes no difference whether the behavioral pattern in question is fully idiosyncratic or totally aligned with patterns across a larger population. In fact, that is what lies behind the phenomenon of cryptophasia, in which twins develop coordinative behaviors whose purposes and functions are utterly opaque to outside observers (see e.g., Hay et al. 1987). At this level of description, idiosyncratic and population-aligned vocalizations function in the same way and give rise to the same behavioral coordination. In contrast, a population-level description of replicated vocalization is given from the perspective of an outside observer familiar with the interactional behavior of the community-at-large, such that it is possible to make generalizations about similarities and differences between multiple replications of a behavior.

So far, we have discussed two complementary levels of description. It is crucial to emphasize that these levels are epistemological only. It is thus a crucial feature of how symbols constrain behavior that humans are capable of *taking a population-level perspective on their own ongoing interactions*. For the individual speaker, interactions feel as if they are composed of repeated, materially stable "words," and as speakers we experience our vocalizations as having clear (and combinatorial) "meanings." The reason is not that material stability or semantic content are properties of the behavior patterns we enact; rather, it is because we are capable of comparing our behavior to many other past and hypothetical behaviors in many other contexts even as we are actively in the process of performing it. In Rączaszek-Leonardi and colleagues (2018: 58) terms, "symbolic properties" are not the result of "conventional sign vehicles with conventionally determined reference;" they are the result of non-referring, non-symbolic coordinated behavior performed simultaneously with active judgments about that behavior's population-level implications (which can be described in terms of conventionality, value, normativity, dictionary definitions, and so forth).

In section 8, we offer a tentative conceptual model of how this ability to take a population-level perspective is developed and used. The model falls within our interactivity-based approach and it is intended to be strictly

ecological. It presupposes both that language is behavior and that behavioral patterns maintain and/or modify features of organism-environment systems. In what follows, we describe some of the ways in which interactions are embedded in meshworks of coordinated behavior and how helpful it is that we can become aware of this embedding.

8 The interactivity-based model and the harnessing of population-level dynamics

In this section, we propose a model for how humans develop the ability to take a population-level perspective. The account is loosely ontogenetic, and begins with the basic precondition for the development of linguistic abilities. From this starting point, we present five components of our model in a stepwise fashion.

The first component is derived from an insight from Rączaszek-Leonardi and colleagues (2018), namely that in ecologically embedded cycles of action-perception, vocalizing behavior has the feature of being discernible. That means that it can be perceived as more salient than other concurrent behaviors. We agree with Rączaszek-Leonardi and colleagues' argument for this salience, namely that "the linguistic modality is accentuated by an increase in the probability of responding to language-like vocalizations with language" (*ibid.*: 63). The key insight here is that the salience of linguistic actions does not require purpose-specific mechanisms, capabilities, or modalities. All it requires is a coordination process where the caregiver picks up on this aspect of the infant's behavior by reproducing similar behavioral patterns, which selectively creates vocalization-specific affordances for the infant. This same process will, when the infant grows up to be a caregiver, prompt him/her to respond to his/her infants' language-like vocalizations in turn. Thus, the first component of our model is vocalization-specific affordances, which are products of caretaker-infant dialogical systems.

The second component of our model is the degree of enskillment that is enabled by the constant presence of extraordinarily nuanced vocalization-specific coordination, both intra- and interpersonally. An interpersonal relationship that has engendered a joint orientation towards vocalizing behavior has thereby created the necessary preconditions for the enskillment and refinement of that behavior. While we can all gasp in amazement as we watch a violin virtuoso exert his or her skills, we rarely notice the same dexterity when it is exerted in coordinating the movements of jaw, tongue, glottis, and other articulators to produce extremely complex vocalizations created through the interweaving of many formants, simultaneously and over time. We often praise the violinist for practicing for decades to achieve such skills, but we forget that we have all spent our entire lives honing our articulatory dexterity. Rather than taking it for granted that everyone learns to speak (*à la* Chomsky), perhaps we should dwell at the fact that the many skills involved in speaking are the results of the infant's intense engagement in vital, affect-laden interpersonal activities. On that view, both violin and vocal expertise rely on agents developing the capability to establish extremely tight couplings of action and perception. Both violinists and speakers can perceive minute deviations from intended actions and compensate for them within tens of milliseconds. We have no reason to assume that this is a vocalization-specific capability. In fact, the extensive human mastery of tools suggests a generalized tight coupling of action and perception that allows human beings to monitor the execution of actions, and thus control and adjust them, on a very fast timescale.

This second component of our account has two consequences. First, the tight couplings between action and perception give rise to behavioral hyper-flexibility, i.e., the ability to adapt one's behavior on a very fast timescale *vis-à-vis* the perception of minute fluctuations of the organism-environment relation. For instance, when we thread a needle, we need to micro-adjust our manual-digital movements of both hands simultaneously. The same hyper-flexibility is needed when we produce and discern speech sounds that are articulatorily very close. For instance, the IPA lists five distinct vowel sounds in the front open, near open, and open mid area —/ɛ/, /œ/, /æ/, /ɐ/, and /a/— and distinguishing between these requires no lesser a degree of enskillment than does threading a needle. Second, the tight coupling between action and perception has equipped the human species with the capacity to modify the flow of time in performing an action: we can prepare, practice, explicate, explore, speed up, slow down, model, and visualize actions. This adaptivity to temporal dynamics (cf. Cowley and Steffensen 2015) requires hyper-flexible control of both action and attention, for instance when the student of a foreign language can slow down their speech production and simulate vocal qualities with which they have no habitual experience.

The third component in our model is control: having developed behavioral hyper-flexibility, we have the embodied skills required to engage in controlled and controlling vocalization behavior. For instance, we can coordinate the timing of our movements, which allows us to engage in synchronized joint speech (Cummins 2018) and in sequential turn-taking behavior (Wilson and Wilson 2005). But we can do more than that: we can also engage in "mimesis." Merlin Donald describes the mimetic skill as the "extension of conscious control into the domain of action [... which] enabled early hominids to refine many skills, including cutting, throwing,

manufacturing tools, and making intentional vocal sounds” (2001: 261). Thus, not only can we control our behavior, we can also adapt it to external prompts, circumstances, and conditions. We can, for instance, use a written sequence such as / məl ɪ gə tɒ ni / as an affordance for our articulatory behavior, as we use the text as an instruction of how to pronounce the name of an Indian soup. And, more commonly, we control our vocal behavior using information found in the vocalization of other people (cf. Golonka 2015), including information about articulatory gesturing (Browman and Goldstein 1989; 1996) and about the extremely complex variables described as intonation, rhythm, and voice quality (e.g., Tilsen & Arvaniti 2013; Cambell and Mokhtari 2003; Cummins 2009).

Of course, speech and writing are always embedded in other activities that constrain and organize them. These activities all have interactional dimensions — whether face-to-face, inscription-based, or directed at oneself — and so vocal behavior is always intertwined with the behavior of others. In other words, we can both control our own behavior in response to complex environmental information, and control our environments by providing information in our own speech and writing. Thus, control consists of partial and reciprocal organism-environment coordination between us and our environments.

When it comes to vocalization behavior, infants engage in prosodic and gestural mimesis, and they develop the ability to control vocal behavior in relation to how it affects whole-bodied behavior and how it is intertwined with our ecological surroundings. In their joint work, Rączaszek-Leonardi and Deacon refer to this intertwining as “social physics,” by which term they mean the use of vocal and gestural signs to act upon one’s environment through the behavior of others. For instance, an infant might say “drink milk” and thereby coordinate the movements of a caregiver so as to bring milk to themselves. However, while caregiver-infant interactions are crucial for the development of a wide range of behavioral patterns, the mimetic skill is not confined to this specific social relation. The first author of this article used to utter / hɛnd saɪt / and / sɔ fɪs / as English terms, but was later confronted with his British colleague uttering / haɪnd saɪt / and / sə faɪs / (“hind-sight” and “suffice”), and he picked up on this difference as relevant and as an affordance for modifying his own vocal behavior. Notice that this example involves both learning (i.e., coordination over long timescales), and what Howard Giles (2016) calls “communication accommodation” (which includes matching one’s speech rate, intonation, pronunciation, and word choice to those of one’s interlocutor), and that both phenomena presuppose the ability to adapt one’s behavior to that of others.

Here, with only three of the five elements of our model in place, we can integrate it with the core of the symbols-as-constraints view. So far, we have suggested that the development of language ability involves vocal discernibility, behavioral hyper-flexibility, and mimetic skills (“control”). Together, these create the conditions under which some behavioral snippets could become “symbols” in Pattee’s sense of symbols-as-constraints. Such a symbol would need to be a physical form (in this case, a piece of coordinated behavior) with replicable structural features, such as a sequence of articulatory gestures, uttered with certain prosodic properties and under specific interactional or environmental conditions. It would need to be replicated multiple times within the same dialogical system, i.e., as an interaction between the same people and under the same background conditions. Over time, replications of this piece of behavior would come to constrain the ongoing dynamics of the dialogical system, for instance by causing the participants to anticipate and/or perform certain responses (Pattee and Rączaszek-Leonardi 2012; cf. Steffensen 2012; Trasmundi and Steffensen 2016).

This brings us to the fourth component of our model, where an interactivity-based account deviates from that of Rączaszek-Leonardi and colleagues. This component is the participation in population-level patterns of coordinated behavior. Humans participate in many different dialogical systems during development. They coordinate with multiple caretakers, with peers, with teachers, and so on. Each of these interactions slightly modifies a child’s skills and habits for sensorimotor coordination and, as such, has the potential to affect which symbolic-behavioral “snippets” the child can participate in replicating. We can then ask: what difference does it make whether Pattee-type symbols (henceforth, “Pattee-symbols”) replicated in one dialogical system (e.g., infant-caretaker) are idiosyncratic to that system, or whether they approximate those replicated by other members of the larger community in their own interactions?

We suggest that the difference is very great and that it has far-reaching implications for language development. Pattee-symbols that are specific to a single dialogical system would be defined by structural properties that included behavioral idiosyncrasies typical of the individuals involved. For instance, rather than a piece of behavior defined by articulatory gestures, prosodic contours, and features of a joint task in which the utterance is embedded, a dyad-specific Pattee-symbol might be defined by the fundamental frequency or voice quality of one participant, or an unusual articulatory feature such as a lisp. The clearest example of this situation is cryptophasia, as described above. Under semi-cryptophasic conditions, language development is restricted in scope: behaviors will only be perceived as replicated if they are performed by the same person who performed them last, and under similar conditions.

By contrast, if Pattee-symbols are stabilized over longer periods of time by means of many interactions between many members of a speech community, a whole network of behavioral “snippets” and constraining

functions will stabilize over time, each of them defined by structural features that any member of the community is capable of replicating. These symbol-constraint-behaviors would stabilize, notice, not as behavioral habits or skills of individuals, but as patterns in the habits and skills of the group or population. The importance of this stabilized network lies in how it allows single interlocutors to exploit their behavioral hyper-flexibility: rather than engage in the full array of symbols-constraints-behaviors, they can “appropriate” (Dufva et al. 2014) individual actions through conscious modeling of population-level patterns, e.g., through rehearsal, repetition, and so on. Thus, Pattee-symbols function in the dynamics of “first-order languaging” (Thibault 2011), and they acquire their massive impact on behavior because the agents rely on Pattee-symbols that are aligned with population-level patterns.

This introduction of stabilized, population-level symbols into embodied, situated coordination gives rise to what we have termed “interactivity” (Harvey et al. 2016; Steffensen 2013; Steffensen 2015; Steffensen et al. in review). Very briefly, we understand interactivity as “sense-saturated coordination,” that is, as sensorimotor coordination between human beings and their environments that is constrained by long-term stabilized Pattee-symbols that an observer can describe on a population level. In this view, the crucial ontogenetic transition is not from iconic-indexical sign relations to symbolic sign relations. Instead, it is from action-perception cycles, which operate on a relatively narrow set of temporally and spatially “local” scales in which trajectories of bodily movement are coordinated, to non-locally modulated action-perception cycles, where agents align their behavior with population-level dynamics (Steffensen 2015; Steffensen and Cowley 2010; Uryu et al. 2014).

Perhaps the most prominent means of such “harnessing” of population-level patterns of behavior as constraints on one’s own sensorimotor activity is the enacting of Pattee-symbols that are elements of a population-level, second-order language. Individuals become able to appropriate these Pattee-symbols through a wide variety of mechanisms, including sensorimotor enskillment that is sensitive to statistical regularity, as in vocal-auditory entrenchment (e.g., Cowley 2016; cf. Port 2010a, 2010b) and entrainment (e.g., Fusaroli et al., 2016; Schurger et al., 2017). Just as important, though, is the deliberate shift of perspective that children learn to make from simply being constrained by replicated forms over to recognizing the forms as “replications of something” (to paraphrase Love 2004) — that is, as replications of prior performances of the same Pattee-symbol. Cowley (2011) refers to this deliberate perceptual shift as “taking a language stance;” as suggested in section 7, this stance-taking lies at the heart of our experiences of linguistic action as referential, combinatorial, and conventional or “arbitrary.”

The fifth and final component in this model is the idea that we find ourselves in an ecology that is deeply and irreversibly saturated with other (past and present) agents’ concepts and behaviors. This is an unavoidable consequence of the fourth component: as individuals continue to harness population level dynamics repeatedly over time, they will gradually saturate their surroundings, habits, practices, and relationships with trans-situational, population-derived structures of behavior. Doing so adds to the hyper-flexibility of their behavior, as they can draw on other agents’ past and present behavior in order to achieve novel cognitive results (Steffensen 2013). Elsewhere, we have discussed this theme in terms of an Extended Ecology Hypothesis (Steffensen 2011; Steffensen and Fill 2014), and we will not repeat the argument here. Suffice it to say that the highly peculiar dynamics of human languaging behavior have thoroughly changed the world in which we find ourselves; language is not just a behavioral category, it is a novel ecological arrangement. Linguistic behavior is ecologically transformative because it instantiates a uniquely effective mode of multiscale bodily coordination, not because it comprises units with special inherent properties.

In conclusion, tracing human ecological uniqueness to language itself is insufficient, and we must trace it further to the behavioral dynamics that include discernibility of behavioral “modes” (such as speech), behavioral hyper-flexibility, mimetic skills, and the harnessing of population-level patterns in multiple ways. In this section, we have attempted to establish a model that accounts for the phenomenology of language as a product of ecologically meaningful action, rather than as indicating the need for a distinct type of meaning. Our hope is that the model demonstrates the possibility of employing the symbols-as-constraints view without adding any technical conceptual elements from semiotics to it.

9 Conclusion

The richness of linguistic meaning is usually understood to be an intractable puzzle when approached from an ecological perspective. Approaches that adopt this perspective offer nuanced accounts of meaningful experiences by identifying the forms of organism-environment sensorimotor coupling that characterize them. In effect, this amounts to identifying the neural, bodily, and environmental conditions that enable coordinated patterns of movement to exert certain effects. For instance, sponges feel squishy because they deform in a particular way when pressure is applied to finger-sizes areas of their surfaces, and so on (cf. Buhrmann, Di Paolo,

& Barandiaran 2013; Chemero 2016; Noë 2016). In contrast, it is a watchword of linguistics that language is resistant to this treatment because the information conveyed by speech and writing (their “linguistic meaning”) is not conveyed by their physical structure, but rather by the linguistic units that these instantiate. As such, the sensorimotor coordination involved in producing speech sounds tells us little to nothing about why we perceive those sounds as being extravagantly, specifically meaningful (cf. Golonka 2015).

We have argued that this position mistakes population-level generalizations for operational or occasion-specific details and that ecological approaches apply smoothly to meaning that — at first glance — appears to be mediated by symbols. In making this argument, we have built on Pattee & Rączaszek-Leonardi’s (2012) symbols-as-constraints model of linguistic symbols as replicable constraints on coordination dynamics, which we consider one of the most promising contemporary approaches to linguistic meaning from an ecological perspective.

While we fully endorse the symbols-as-constraints model, we find it crucial *not* to align Pattee-type symbolic structures with the kind of symbols that are legion in semiotics and linguistics. Accordingly, we have argued against Rączaszek-Leonardi and colleagues’ (2018) recent ungrounding-symbols model, because it does seem to split Pattee’s symbols into Deacon’s three categories of signs such that only some replicable constraints are symbols in this sense, while the others are icons or indexes. We have argued that the symbol-ungrounding view is an unproductive development of the concept of replicable constraints, for two reasons. First, the icon-index-symbol trichotomy does little or no descriptive or analytical work; Rączaszek-Leonardi and colleagues (2018) present clear analyses and excellent examples using ecological terminology and dynamical systems theory, but the semiotic terminology does not appear to enrich these in any way. Second, the exceptional behavioral effects that Deacon and others attribute to linguistic symbols mistake one level of description for another. They attribute generalizations across the lived experience of many individuals engaged in many instances of linguistic action to properties of single, observable instances of linguistic action. The mistake here is to observe similarities across multiple uses of a given behavioral pattern within a speech community and to conclude, on this basis, that each use is in some sense a derivation from a common, invariant form. Not only is this assumption unwarranted and unparsimonious, it fundamentally misconstrues the nature of the observations on which it is based. Thus, such observations conflate a population-level perspective that can be adopted by an outside observer of an interaction with a functionally relevant, interaction-internal perspective.

Our view thus contrasts with the symbol-ungrounding account, on which symbols’ behavioral effects are attributed to the unique properties of symbolic structures such as partial abstraction, signifying other signs, etc. Given a developmental environment in which caretakers ceaselessly coordinate their vocalizations with infants’ vocalizations, vocal coordination quickly becomes especially perceptually salient. That salience — and the constant enskillment it promotes — enables the development of hyper-flexible control of vocal behavior, as we learn to couple our vocal activity to a vast range of order parameters in our environments. Hyper-flexible control and stable population-level patterns of vocal behavior together provide the conditions for “interactivity,” which is roughly the control of bodily movement by means of coordinating its dynamics with population-scale patterns. Individual instances of linguistic behavior are thus unremarkable in themselves; their felt meaningfulness is due to the way they harness large-scale behavioral patterns comprising very many previous actions by very many other members of a speech community.

The interactivity-based approach has two key virtues as a perspective in ecological cognitive science: it succeeds in addressing linguistic forms of meaning and meaningful experiences, and yet it does so without introducing unnecessary conceptual elements that appear to muddy the waters of analysis and hinder the clear description of events. For these reasons, it has much to offer to the growing body of non-mentalist research on language and cognition.

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Notes

1 Note that there are three distinct uses of the term “symbol” in this article. *The first*, introduced in section 3, stems from the work of Howard Pattee (e.g., 1972, 1969) and follows the usage in Pattee and Rączaszek-Leonardi (2012) and Rączaszek-Leonardi (2009, 2016). In

this usage, a “symbol” is an alternative description of a physical structure that constrains the dynamics of biological systems in specific ways. *The second*, introduced in section 4, comes from the work of Terrence Deacon (e.g., 1997; 2011), based on his reading of C. S. Peirce (1931; see Deacon 1976). In this use, “symbol” is a type of sign, one third of (Deacon’s version of) the icon-index-symbol trichotomy; their distinguishing feature is the conventionality of both sign-vehicle and signified entity. *The third* usage of “symbol” is important in sections 5 and 6, but is less clear. Rączaszek-Leonardi and colleagues (2018) use the term in a manner that seems sometimes to correspond to Pattee’s usage, sometimes to Deacon’s, and sometimes to a structuralist conception of “linguistic symbols” as English words with intrinsic semantic content, following the usage of, e.g., Fodor and Lepore (2002).

2 One reviewer asks if it is fair to Saussure to present him as a linguistic internalist: “Also, Saussure’s [theory] is a more social semiotics than you acknowledge.” We certainly agree that Saussure perceived his *semiology* as “a science which studies the role of signs as a part of social life” (2013: 18). However, that does not change the fact that, to Saussure, a necessary component for his speech circuit to function is brain-based knowledge structure, which structures — in that they are not neurophysiological — have the same status as representations in the work of computationalist cognitive scientists: “Linguistic signs, although essentially psychological, are not abstractions. The associations, ratified by collective agreement, which go to make up the language are realities localised in the brain” (*ibid.*: 17). Further, to Saussure, “the starting point of the [speech] circuit is in the brain of one individual [...] where facts of consciousness which we shall call concepts are associated with representations of linguistic signs or sound patterns by means of which they may be expressed” (*ibid.*: 13).

3 Pattee sometimes uses “reference” as a theoretically neutral synonym for “constraint,” describing any replicable constraint as the “referent” of the structure instantiating it. And Rączaszek-Leonardi notes that the model does not exclude the possibility of linguistic reference as one of the very many functions of replicable constraints in human interaction (Pattee and Rączaszek-Leonardi 2012).

4 Notice just how closely the authors’ argument in favor of this dislocation property resembles well-known arguments for symbolic representations in cognitive science. For instance, Ohlsson (2011: 29–30) makes the following argument for why cognition is representational:

Few buildings in the world are as well known and recognizable as the Eiffel Tower in Paris. Visualize the Eiffel Tower; try to see it in your mind’s eye! An attempt to comply with this exhortation creates a transient state of mind of a special sort, usually called a *visual image*. The image stands in a special relation to the Eiffel Tower itself: It is an image of the Eiffel Tower. Borrowing a term from linguistics, the image *refers* to the Eiffel Tower [...]. The exercise of visualizing something that is not present proves that mind is representational. The visual image – the state of mind that endures during visualization – is a representation. [...] Something that refers to some other thing is by definition a symbol or a representation of that other thing.

Interestingly, while Ohlsson uses this exercise to argue that “representation is no mere epiphenomenon” (*ibid.*: 30), he also realizes that this claim builds on the *phenomenological experience* of engaging in representational activities: “The subjective experience of the image is real to the person whose experience it is and so cannot be argued away or declared nonexistent. [...] The conscious experience of visualizing, of deliberately representing something in the mind’s eye, is familiar to all but a few” (*ibid.*: 30).

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