



How does a word become a message? An illustration on a developmental time-scale



Joanna Rączaszek-Leonardi

Institute of Psychology, Polish Academy of Sciences, Ul. Jaracza 1, 00-378 Warsaw, Poland

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ABSTRACT

Recent changes in views on cognition underscore its embodied, situated and distributed character. These changes are compatible with the conceptual framework of ecological psychology. However for ecological psychology to propose explanations for a broad range of cognitive phenomena, including language, it needs an account of how to link the dynamics of coupling between the organism and the environment with the apparent symbollicity of informational structures. In this paper it is proposed that a theory of information in biological systems, advocated by Howard Pattee, may help forge this link. By treating informational structures as constraints on dynamics this approach helps to identify which processes, in which systems and on what time-scales are needed for structures to 'become messages'. I will illustrate how these processes might work on developmental time-scale in the domain of language, building on the work by Edward Reed (1995, 1996) and extending it using the view of linguistic structures as constraints.

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1. Introduction

Cognitive science seems to be making an 'ecological turn'. After years of domination of the information-processing framework, an increasing appreciation of the embodied, situated, and distributed character of cognition calls for alternative approaches. Ecological psychology has a lot to offer as it has always insisted on the inseparability of cognition from action in a specific environment. However ecological psychology has always had difficulty accounting for those aspects of cognition that seem to rely on abstract 'informational structures', or 'symbols', language included.

One way to account for the functioning of such structures as informative is to place their recognition and interpretation in the heads of individuals. This is an 'easy way out', taken by the information-processing representational approaches and, obviously, is not compatible with other tenets of ecological psychology. The main aim of this paper is to show that there is another, very promising, way of explaining the informational capacity of language, which draws on theories of information in biological systems (Pattee, 1969, 1972, 1982; Polanyi, 1968; Von Neumann, 1966).

In this approach, informational structures are understood not as 'content carriers' but as replicable constraints on the dynamics of

action and interaction (Pattee & Rączaszek-Leonardi, 2012; Rączaszek-Leonardi & Kelso, 2008). Their constraining role consists in binding selected degrees of freedom of interacting components, rendering a system functional within a given environment. This very general view of how structures may gain an informative role subsumes, I believe, ecological psychology's explanation of how meaningful perception (in terms of affordances, i.e. possibilities for action in the environment) emerges. The approach underscores, that lawful coupling between the organism and environment, which ecological psychology strives to describe, could not be specified without the boundary conditions of the evolved morphology of the body. At the same time, such view allows extension of the theory into the informational role served by the behaviours of others, including their language behaviours.

It will be thus argued that joining the forces of ecological psychology with the replicable constraints approach to language is a promising path to an ecologically valid theory of language. The former provides the framework and methods for identifying the dynamics of coupling between complex environmental variables and behaviour, while the latter, by providing the relation between informational structures and dynamics has potential to explain, how this lawful coupling becomes ecological, i.e., functional in a given environment.

The logic of the paper is as follows. I will start with a brief description of recent theoretical shifts that make the traditional

E-mail address: joanna.leonardi@gmail.com.

approaches to cognition and language increasingly awkward and ecological views more welcome. In the same section, I will point out that, in this general tendency to recognize the dynamics of situated behaviour, a vital part is still missing: a link of these dynamics to informational structures. This link is neither accounted for by dynamics-focused ecological psychology nor by attempts at grounding those structures through mapping to mental contents or the external world by more traditional cognitive-scientific approaches.

In the next sections I will therefore introduce the framework proposed by the theorists of information in biology (most notably by Howard Pattee), which proposes how to understand this relation ('How does anything become informative?'). I will briefly present both the original theory and its later extension into the domain of language. Then, I will show how this approach is compatible with ecological psychology's account of meaningful perception ('How does anything become an affordance?'), while providing an ability to extend it to explain how behaviours, actions of others and their outcomes, including language, might become informative, without proposing extensive mental-interpretive machinery ('The ecological way to language').

The framework would be incomplete without proposing concrete mechanisms through which the informational structures gain their controlling power. In the case of language, a comprehensive account of how a linguistic structure emerges and stabilizes as a functional constraint would require detailing many processes on multiple time-scales, including biological, cultural, ontogenetic and on-line. To make the task feasible, I will focus predominantly on the ontogenetic time-scale and, in a following section, provide an illustration of how a linguistic structure becomes informative in repetitive mother–infant interactions. I also hope to show, in this example, how the ecological approach, represented here by Edward Reed's work (e.g., 1996) and the replicable constraints approach are compatible and complement each other in identifying mechanisms and important variables. In the conclusions I focus on the perspectives of the integrated approach and its usefulness both for theory construction and for research.

2. The ecological turn in cognition and language

It looks like good times are coming for ecological psychology. The mainstream information-processing approach to cognition seems to have a limited capacity to deal with the embodied, situated and distributed nature of cognition in terms of rule-based processes operating on amodal representations. Where the theoretical ground provided by the information-processing approach becomes slippery, ecological psychology seems ready to offer a stable foothold. Ecological psychology has always been situated and embodied, known for never decoupling cognition from dynamic, environmentally situated action. What it can now offer, besides a clear theoretical framework that is well grounded philosophically (Gibson, 1966, 1979; Heft, 2005; Reed, 1989, 1996; Turvey & Carello, 1981), is a toolbox of methods explicitly designed to deal with time-dependent and interaction-dominant nested systems, which is indispensable for studying embodied and situated cognition. In offering a systemic approach, it also facilitates the integration of time-scales and levels of organization (Kello, Anderson, Holden, & Van Orden, 2008; Kelso, 1995; Van Orden, Holden, & Turvey, 2003), which is valuable both in the exploration of neural underpinnings of individual behaviour and in relating them to distributed and joint cognition – a field into which ecological psychology has recently ventured with success (Rączaszek-Leonardi, Nomikou, & Rohlfing, 2013; Schmidt & Richardson, 2008; Turvey, 1990).

Such an ecological turn is visible also in research on so-called

'higher cognition', including bastions of rule-based symbolic computations such as well-defined problem solving, numerical cognition and language (Cowley & Vallée-Tourangeau, 2013; Fischer, 2012; Hutchins, 1995; Thibault, 2004). Even in those domains, explanations based on sets of content- and context-independent rules residing in individual minds seem insufficient, which opens them to frameworks that can better deal with embodiment and situatedness.

In the case of language, this results in turning to traditional alternatives to generative approaches (such as functional and integrationist theories) and other rapidly-developing approaches that can deal with the embodied (e.g., cognitive linguistics), situated (e.g., pragmatic and contextual shifts in semantic theories, conversational analysis) and distributed (e.g., developments in integrationist linguistics and the distributed language movement) nature of language. In research, the ecological turn is evident in the growing interest in out-of-the-lab or at least quasi-natural communication (Clark, 1996; Garrod & Anderson, 1987; Ochs, Schegloff, & Thompson, 1996; Pedersen, 2012), experimental semiotics (Fay, Garrod, Roberts, & Swoboda, 2010; Galantucci, 2005; Galantucci & Garrod, 2011) as well as computational simulation approaches, which can account for multiple sources of structure in language, including local predictive processes, learnability, the structure of joint activities in the environment, or intergenerational transmission (Christiansen & Chater, 2008; Elman, 1990; Smith, Brighton, & Kirby, 2003).

In short, rather than accounting for individual skills in terms of internal rules, it becomes more important to show how language coordinates co-acting bodies, how it regulates interactions and adapts them to environmental demands. This results in a move from studying what is inside of individuals' head to what the head is inside of (Mace, 1977). Does this mean that times are also good for the ecological psychology in language research? On the one hand, its traditional merits, such as not detaching cognition from action, forging useful tools for studying dynamics, as well as its newer developments in the direction of social coordination seem to be excellent prognostics for its value in this area. On the other hand, apart, perhaps, from doing abstract mathematics, language seems to be among the human capacities that are the most removed from the immediate ambient environment and most independent from it, able to evoke objects and events that are not specified by current local experience. Perhaps this is one of the reasons why the field of ecological psychology traditionally has been concerned only with some aspects of language, where its physicality is most obvious.

Ecological psychology has had important input addressing problems in speech production and perception such as invariance and co-articulation (Fowler, 1980, 1986; Fowler & Turvey, 1981) and, relatedly, categorical perception (Rączaszek, Tuller, Shapiro, Case, & Kelso, 1999; Tuller, Case, Ding, & Kelso, 1994). A recent turn to interpersonal dynamics resulted in more ecologically situated studies on the role of language in physical coordination (Fowler, Richardson, Marsh, & Shockley, 2008; Varlet, Marin, Lagarde, & Bardy, 2011). Of great importance also are studies that, treating language as a complex dynamical system, show how linguistic structures emerge from local iterative dynamic processes (Dale & Lupyan, 2012; Elman, 1990; Tabor, 1995) and how, on the other hand, local language processing in individuals is determined by multiple forces on many time-scales (Rączaszek-Leonardi, 2010; Wallot & Van Orden, 2011a, 2011b). Yet the pragmatic and semantic aspects of language have been rarely tackled and when they have been addressed it has been, mainly on a theoretical level (see e.g., Verbrugge, 1985; Worgan & Moore, 2010). More attention has been devoted to language development, where theoretical work (Reed, 1995, 1996) has pointed to the importance of dynamic engagement in rich physical and social environments (more on this

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