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Towards a new ecological conception of perceptual information: Lessons from a developmental systems perspective

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ABSTRACT

Over the last decades or so, empirical studies of perception, action, learning, and development have revealed that participants vary in what variable they detect and often rely on nonspecifying variables. This casts doubt on the Gibsonian conception of information as specification. It is argued that a recent ecological conception of information has solved important problems, but insufficiently explains what determines the object of perception. Drawing on recent work on developmental systems, we sketch the outlines of an alternative conception of perceptual information. It is argued that perceptual information does not reside in the ambient arrays; rather, perceptual information is a relational property of patterns in the array and perceptual processes. What a pattern in the ambient flow informs about depends on the perceiver who uses it. We explore the implications of this alternative conception of information for the ecological approach to perception and action.

Adding information to matter and energy is something like speaking of nations exchanging dollars, yen, and profits. The third term belongs on a different level. Not another form of currency, it describes a certain disposition and the use of currencies. Just as time or information can, under certain circumstances, "be" money, matter and energy can sometimes "be" information. (Oyama, 1985/2000, p. 40)

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1. Introduction

The concept of information is a highly debated notion in the study of perception and action. Indeed, among the issues that separate contemporary approaches to perception–action is the idea of what information is and where it resides. Proponents of indirect theories of perception have asserted that the information involved in perception exists both in the environment and the perceiver. Roughly speaking, this theory holds that the stimulus information that impinges on the senses is impoverished and needs to be enriched (e.g., Fodor & Pylyshyn, 1981; Neisser, 1967; Ullman, 1980). Thus, information residing in the animal enriches the impoverished stimulus information that the senses receive from the environment. Advocates of the direct theory of perception, by contrast, have claimed that all the information that is needed for perception is "out there" in the environment. Gibson (1966, 1979/1986), the founder of the ecological theory, asserted that the ambient energy arrays contain information that is rich and sufficient for perception. Because information in the arrays is specific to environmental properties, enrichment processes can be dispensed with. Perception is simply the extraction of specifying information that resides in the ambient array.

Since its inception in the 1960s and 1970s, J.J. Gibson's ecological theory of perception and action has inspired many researcher, giving rise to a fruitful experimental program, the results of which are piling up (e.g., Fajen & Warren, 2003; Riley & Turvey, 2001; Runeson, Juslin, & Olsson, 2000; Turvey, Shockley, & Carello, 1999). The central question in this program has been: "What specifying variable in the ambient array is used to perform a particular task?" (see Fajen, 2005, for a nice overview). Although the direct perception theory has gained currency over the last decades, several empirical studies have revealed an inadequacy of their concept of information. Participants were found to vary in the informational basis of their perception or action (e.g., Jacobs, Michaels, & Runeson, 2000; Jacobs, Runeson, & Michaels, 2001; Menger & Withagen, 2009; Michaels, Arzamarski, Isenhower, & Jacobs, 2008; Michaels & de Vries, 1998; Runeson & Andersson, 2007; Runeson et al., 2000; Withagen & Michaels, 2005b; Withagen & van Wermeskerken, 2009). Furthermore, several studies have revealed that participants often rely on variables that correlate with, but are not specific to, the to-be-perceived property (e.g., Caljouw, van der Kamp, & Savelsbergh, 2004; Jacobs et al., 2001; Michaels, Zeinstra, & Oudejans, 2001; Tresilian, 1999; van de Langenberg, Kingma, & Beek, 2006; van der Kamp, Savelsbergh, & Smeets, 1997). This means that in the ecological approach to perception and action a new conception of information is called for. In this paper, we sketch the outlines of such a conception.

First, we give a portrayal of the Gibsonian theory of direct perception and its conception of information. Then, we summarize some empirical studies that have casted doubt on the Gibsonian notion of information. We argue that Chemero's (2003b, 2009) alternative ecological conception of information solves important problems, but insufficiently explains what determines the object of perception. Drawing on recent work on information in developmental systems (Oyama, 1985/2000, 2000), we then sketch a new conception of perceptual information. It is argued that perceptual information resides neither in the environment nor in the perceiver. Instead, perceptual information is a relation between patterns in the ambient array and perceptual processes. We end with exploring the implications of this conception of information for the ecological approach to perception and action.

2. J.J. Gibson's theory of perception and its conception of information

Although the central tenets of the direct theory of perception can be traced back to Aristotle (Lombardo, 1987; see also Heft, 2001), this theory is often conceived of as a relatively modern approach to perception. This is perhaps due to the fact that this theory is often attributed to James Gibson, who developed arguably the most influential direct theory of perception in the 1960s and 1970s. At the time J.J. Gibson developed his ecological view, cognitive psychology was in its ascendancy. This more traditional psychology comprises a theory of perception that is almost diametrically opposed to the perspective that J.J. Gibson laid out. The cognitive theory treats perception primarily as a mental affair (see, e.g., Fodor & Pylyshyn, 1981; Neisser, 1967). It is argued that the senses receive impoverished information from the environment. The energy patterns that impinge on the sense organs do not