Cognition can be distributed, extended, enacted, embodied and systemic (but does it matter which?)

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The emergence of cognitive psychology as a discipline largely coincided with the adoption of the computer metaphor for the mind that casts cognition as a computational process. From this perspective, thinking is understood in terms of information processing that takes place solely in the brain. To propose that thinking could be extended beyond the boundaries of the brain was, for many, a radical and even ridiculous approach. However, the notion of thinking being extended beyond the physical confines of the brain is to date seen as less radical and often described under various labels, namely that cognition is *distributed* (Hutchins, 1995; Kirsh & Maglio, 1996), *extended* (Clark & Chalmers, 1998), *grounded* (Barsalou, 2010), *embodied* (Glenberg, 2015; Wilson, 2002), *enacted* (De Jaegher & Di Paolo, 2007; Varela, Thompson & Rosch, 1991) and *systemic* (Vallée-Tourangeau & Vallée-Tourangeau, 2017). The theoretical notion behind these views posits that interacting with agents and objects fundamentally changes thinking in a way that is different from *non-interactive* performance. The approach to thinking and cognition from a distributed perspective has driven new areas of research in applicable areas such as mathematic education (Vallée-Tourangeau, 2013), problem solving (Guthrie, Vallée-Tourangeau, Vallée-Tourangeau & Howard 2015), and forensic psychology (Baber, Smith, Cross, Hunter, & McMaster, 2006).

An important point to address here is whether is it useful to think about these terms as being theoretically different from each other, or whether they should fall under the same category. Rowlands (2009) suggested that the Extended Mind Hypothesis (EMH) has four components: that (i) information in the external world is relevant to cognitive processes, (ii) internal and external cues are (mostly) intertwined and are both recruited in mental processes, (iii) manipulation of the external information is related to real-world actions and is therefore 'goal related', and (iv) internal processes are (mostly) directly related to the use and manipulation of external information. The question here is whether or not these four elements are unique to the EMH. On the surface this appears to be a *no*; the similarities between these theories includes sharing the fundamental core of the distributed framework (i.e., that cognition is co-constituted with the body and the external environment in which it is embedded).

However, there are disparities between these views including the emphasis placed on the role of the sensori-motor network, their application to the study of both cognition and language, the extent to which the body and environment are partially or wholly integrated into the cognitive process, and even how these theories are defined among philosophers and cognitive scientists (Borghi, Scorolli, Caligiore, Baldassarre, & Tummolini, 2013; Kiverstein & Clark, 2009; Rowlands, 2009; Walter, 2010). Thompson and Stapleton (2009) discuss how enactivism centres on how elements of the environment are integrated into thinking processes as opposed to extended mind theories which provide an extension of thinking into the environment. Proponents of 3E and 4E Cognition suggest that the mind can be embodied, embedded, enactive (3E) and extended (4E), but do not equate these as identical processes (Fuchs, 2017; Gallagher, 2017; Menary, 2010). Instead, such views suggest that thinking is governed by the physical and sensori-motor system (*embodied*), is an emergent product from the interaction with the physical and social environment (*embedded*), reflects goal-directed actions (*enacted*) and is scaffolded by the cognitive properties of a system configured by an agent and resources outside the agent (*extended*).

As noted, these different views on cognition all share the same fundamental premise. However, it does appear that the emphasis on the level of physical interactivity between an agent and an object is not consistent across these views. This potentially represents a significant divide across the viewpoints. Embodied Cognition suggests that "*cognitive processes are constrained by our body*" (Borghi et al., 2013, p. 1), therefore putting greater emphasis on the physical movements of the agent rather than on the environment. The notion of being embodied has been adopted in the study of concepts relating to the argument that concepts are not represented amodally, but are represented across areas of the sensori-motor cortex (Barsalou, 2016; Borghi & Cimatti, 2010).

In support of the argument that concepts are embodied, numerous studies have been cited where task performance is often facilitated (or even hindered) by the physical movements required of the participants (see Shipp, Vallée-Tourangeau & Anthony, 2018). Glenberg and Kaschak (2002) found that reaction times on sentence sensibility judgements were faster when participants indicated their answer

with an action that was congruent with the direction implied by the sentence. For example, participants were faster to respond 'yes' for sentences such as *"Susan closed the drawer"*, if to do so the action required a movement away from the body; in turn they were faster for sentences such as *"Susan opened the drawer"* if the action to indicate their answer required a movement toward the body. Similarly, a systemic perspective on cognition emphasises the physical interaction with the environment; the nature of this interaction guides and constrain how someone *thinks*. For example, participants are more successful on both insight and transformation problem solving tasks when they can interact with a physical model of the problem rather than mentally simulating solutions (Vallée-Tourangeau, Euden & Hearn, 2011; Weller, Villejoubert & Vallée-Tourangeau, 2011).

The question becomes whether these terms describing cognition as being either distributed, extended, enacted, embodied, grounded or systemic, can (or even should) be integrated under one umbrella? The answer seems to be *no*. While these views converge on the notion that thinking cannot be cashed out in internal computational terms, what is constituted into cognitive processing and mental representations is, at present, debatable. A literature search for these terms on Scopus revealed that there are more published articles which use the terms *embodied cognition* than all the other terms combined. As this suggests the scientific community are in favour of describing cognition as being embodied, perhaps we should describe all distributed and systemic processes as being embodied? Again, the answer is a *no*. Embodied cognition is often used to describe the role of the body in relation to conceptual processing (Shipp et al., 2018), a definition which does not fit the other categories. However, the view of cognition being systemic could also be applied here; both terms examining what could be described as the online processing of physical objects. Therefore, labelling cognition as being either embodied or systemic automatically takes a more active viewpoint in comparison to describing cognition as being distributed, extended, enacted or grounded. With the absence of a physical component, it could be argued that such alternate terms simply view cognition as being contextually based (or even situated). This does not apply to the inclusion of physical components and hence embodied and systemic approaches must be considered more than just cognition in context.

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