Imposing vs finding unity

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Abstract. The target article argues that embodied cognitive neuroscience converges on a mechanistic approach to explanation. We argue that it does not. Even some of the article's *paradigms* for embodied cognitive neuroscience are explicitly non- or anti-mechanistic.

The target article is a bold attempt to unify embodied cognitive neuroscience under the banner of *mechanism* (M&M, p. 5). Below, we offer some takeaways from the article. But first, we want to consider the compatibility of *mechanism* with embodied neuroscience.

Mechanism is a commitment "to identifying the spatially localized parts and their interactions that constitute a phenomenon" (M&M, p. 3), where those parts are "robustly identifiable, stable, manipulable … and plausible" components of a (brain and environment) system (M&M, p. 2). This is a plausible framework for some research in neuroscience, but the article acknowledges a tension between it and *embodied* neuroscience. It dismisses that tension in a footnote (M&M, p. 5, fn. 5), but we are skeptical that it can be set aside lightly. Consider two of the article's proposed *paradigms* for embodied cognitive neuroscience: Anderson (2010) and Chemero (2009).

Anderson (2010, M&M p. 5), and especially his more fleshed-out (2014), claims that cognitive operations are not performed by dedicated components but by neuronal assemblies created and dissolved on the fly in response to task demands. A corollary is that, while localized parts matter they may be less important than the global network properties that determine their function or role, and "componential" models of brain function may be insufficient (2014, p. 308). Anderson draws this out in the case of Starburst Amacrine Cell dendrites (2014, p. 155), which he shows are "not functionally related to [their] surrounds as a component to a higher-level system; nor is the higher-level system related to the SAC dendrite as one of its components" (2015, p. 9). Kiverstein & Miller (2015, cf M&M p. 5) extend the point further: components of the brain change function significantly over time, especially in the changing "context of a wider organism-environment system" (Kiverstein & Miller, 2015, p. 2). That means the localized parts constituting a particular phenomenon will not be "robustly identifiable" and "stable" but will be, at least sometimes, *ephemeral*. If this strand of thought in embodied neuroscience is correct, then "identifying the spatially localized parts and their interactions that constitute a phenomenon" will not be a universalizable approach to explaining cognitive phenomena.

Chemero (2009) stands in even starker contrast with mechanism. He explicitly rejects the attempt to find an "underlying mechanism" for any cognitive task — even in a broad sense of the word "mechanism" (2009, p. 80-81, 96). Instead, he aims to provide "covering-law explanations" (p. 78), i.e., dynamical equations "that predict the behavior of agents in their environments" (p. 77). His main examples, the Haken-Kelso-Bunz model and its later developments, model "aspects of human behavior as a nonlinearly coupled dynamical

system" (p. 85) — in the case of HKB, as *oscillators*. These explanations might be dismissed as merely predictive (though they *do* seem to describe the constitution of a phenomenon at a high level), but regardless they are thoroughly anti-mechanistic: they describe high-level structural relationships between brain, body, and environment that capture cognitive phenomena. They do not aim to identify or localize the parts of the system, let alone assign responsibility for a phenomenon to those parts. Likewise, Favela (2014, 2020, 2021) emphasizes dynamical laws and concepts from complexity science (e.g., criticality and scale-free distributions), which describe system-level properties and events. In this strand of embodied neuroscience, the explanatory work is done not by the system's localized parts but by its "graphical/network properties and the dynamics thereupon" (Silberstein & Chemero 2013, p. 960, cf Silberstein 2021).

These examples should make clear that embodied cognitive neuroscience — even restricting ourselves to the target article's paradigms — does not converge on mechanism. It uses a range of approaches, some explicitly non- or anti-mechanistic. So, what can we take away from the target article if embodied neuroscience cannot be unified under mechanism? A lot, actually. Typically, fields are not unified by *imposing* a single explanatory framework on developing research programs. They are unified by scientists building bridges between research programs, exposing their points of connection, and showing how they can inform each other and help reach each other's goals — by finding pathways *through* the diversity of approaches, rather than flattening that diversity. In this light, our takeaway from the target article is not a *unification* of embodied cognitive neuroscience with mechanism, but an elaboration of *one* potential point of contact between them. Specifically, it draws our attention to the instances in which it may be useful to think about brain-body-environment systems in mechanistic terms. The approach built on this point of contact is distinctive and worth developing, even if embodied cognitive neuroscience does not converge on it.

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