In search of a new looking glass: cognitive science is not dead, it is just asleep

Article

Published Version

present" (Pacherie 1999). This characteristic of perception sets the standard for what we consider "real" in the most basic sense and, by the same token, allows us phenomenologically and cognitively to distinguish an act of perception from an act of dreaming or imagining. As for imagination, it also inherits from perception many of its traits, and therefore should also be explained in perceptual terms, regardless of the fact that, as Jean-Paul Sartre (2004: 207) pointed out, they work intimately together. In summary, (visual) perception, imagination, dreaming and hallucinations share a phenomenal nature, but there are also important differences between them (cf. also McGinn 2004: 209).

« 11 » Another bugging general issue concerns the rationale the authors offer to defend the embodied approach to the dream experience. It is correct to say that dreams pose a challenge to the (enactivist and) embodied approach since an online interaction between the agent and its surroundings is required to operate and make sense of the world on the agent's part. Embodiment, however, is at odds with lived experience, as the body during dreaming is usually inert (except for the inner bodily functions) and there is no overt behavior on the agent's part, something the authors are well aware of. So, imagination is supposed to be the link that somehow relates embodiment with dream content and dream breadth (§15). But it is very hard for me to understand how imagination is to do the job, as imagination also suffers from the same problems as hallucinations and dreams regarding the lack of functional and casual anchoring mentioned above. One would suppose that *memory* could do the job, as it can somehow link content derived from online interaction with the world, with content derived from inner activity within the body (brain activity, for instance), pretty much in the same way Hume related perception to ideas. But there is not a satisfying discussion in this respect, only a hint when speaking of "enactive imagination" (§17).

« 12 » Finally, I sympathize with the idea of considering dreams and hallucinations as "creative, imaginative processes" and also with the implicit idea that we should not saddle the study of hallucinations and dreams with a veridical/nonveridical dichotomy at the outset, highlighting instead the emotional component in the experiences (§17). But if cognition is indeed a "form of embodied action" (§18), then it remains to be shown how off-line mental phenomena can be seen as embodied and, at the same time, recognized in their essential (functional and phenomenological) similarities and differences.

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Received: 13 February 2016
Accepted: 21 February 2016

In Search of a New Looking Glass: Cognitive Science Is Not Dead, It Is Just Asleep

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> Upshot • Solomonova and Sha draw inspiration from the work programme that sparked the enactive extension to cognitive science, and propose a framework for dream scientists. This case study for a renewed cognitive science highlights key points that are worth developing, in light of current practices in neuroscience.

« 1 » Elizaveta Solomonova and Sha Xin Wei present a powerful account of the neurophenomenology of dreaming as a nascent discipline within the cognitive science framework extended to enaction. The discipline of cognitive science, which has run out of steam in recent years (Miller 2003; Varela, Thompson & Rosch 1991), needs to reinvent itself. Taking inspiration directly from the work programme devised by enaction theorists, Solomonova and Sha take the bull by the horns and, by describing a full framework for the study of dreams, also roll out a complete case study for a renewed cognitive science!

« 2 » Dreaming is probably one of the most difficult topics to study empirically, understandably, and it is amusing to see such a fruitful discussion emerging from that notorious blind spot in cognitive science. In my opinion, the authors describe the right steps, in the right order, almost in an exact alignment with the founding fathers of enaction. A few points deserve to be noted, which may not be straightforward to all cognitive scientists, and certainly not to all neuroscientists.

« 3 » First, the inseparability of imagination from perception. This is probably an easy(-ier?) move for "dream" scientists, and still a key milestone yet to reach for most cognitive scientists, in general, and for neuroscientists in particular. Both scientific realism and Western philosophy are so pervasive in every step of the scientific method that it has become difficult to unlearn the most basic assumptions we taught ourselves for years. For a modern, Western, not-so-computationalist cognitive scientist who might be open to "a new way of thinking," it is one thing to agree that perception is an active and engaged process, maybe even discarding some Cartesian concepts. It is an entirely different affair, however, to grasp the ensuing consequence: not only is the perception-action loop constitutive of the agent-world relationship, but it is also a core *mechanism* whereby the agent is to the world ("être au monde" à la Maurice Merleau-Ponty), perpetually creating itself and creating the world at the same time, quite literally.

« 4 » In dream science, imagination is a necessary requirement, but for our young cognitive scientist it might still be unclear why this is relevant to the realm of processes that occur in awake time – and it is! Imagination is a self-imposed bias onto one's perception; self-imposed by an act of volition, or as a side effect of psycho-physiological dynamics. The theatrical and performative cast imbued in dreams, as emphasized by Solomonova and Sha, is also present in awake time, and, I posit, constitutive of every single cognitive processes. For instance, in grasping (to take a striking example), the embodied interaction of the hand with the warm cup of tea is not driven by the empty exploration of space through limited sensory input. It is driven by the imagination of what the evolving relationship of the hand with the world should be like, in light of pre-

vious such interactions. It is the anticipation of sensorimotor contingencies, as the result of repeated training of interaction. The consequence is simple, fingers do not follow a carefully crafted plan, they move in synergy, continually adjusting their being-to-the-world to what the world feels like. Of importance, this conceptualization is not related to "action-oriented predictive processing" or derivatives (Clark 2015). Unlike most predictive coding frameworks, enaction focuses on the interaction of both top-down and bottom-up processing, and does not imply the creation and maintenance of a complete model of the world (Roesch, Nasuto & Bishop 2012).

« 5 » Second, a direct consequence of that realisation relates to the decision about what comes first, subjectivity in the lived experience or the perception-action loop. Emphasising the role of performative perception for identity and sense-making, Solomonova and Sha cast a vote in favour of the primacy of subjectivity. This move has practical consequences for the way that our cognitive scientist would go about empirically studying the mechanisms of their desired object of interest. Solomonova and Sha thus formulate provisions for dream scientists, in a discussion of first-, second- and third-person data. Again, because of the nature of the beast, it makes sense that a dream scientist would seek to emphasise the role of first-person data, putting all three kinds of data at level, more than a cognitive scientist working on grasping, say. As presciently devised in the enaction research programme, focusing solely on third-person data – as is mostly the case in cognitive science and neuroscience – is a mistake. This mistake, in my opinion, has been responsible for driving the field to attractor points, which now yield distorted theoretical perspectives.

« 6 » Most of modern knowledge about the brain comes from third-person data, such as electroencephalography (EEG) and functional magnetic resonance imaging measuring blood oxygenation level-dependent responses (fMRI-BOLD). A typical experiment using fMRI-BOLD, to take just one example, yields colourful blobs typically opposed to other parts of the neural tissue in black. The analysis of this data is readily interpreted in terms of modules and representations; i.e., what shows up in black means it is not being used, therefore it is not doing anything meaningful for that particular task that elicited the colourful blobs. Taking this third-person data at face value for understanding the way the brain works is a mistake.

« 7 » I am not, of course, implying that the whole of the data in cognitive neuroscience is wrong and should be thrown out with the bathwater. I do think, however, that its interpretation is misconstrued at times. The measured change of electrical and electrophysiological correlates can under-represent the complexity of the biological processes at play, and may in fact be dependent on the implementation of the measuring device itself and ensuing analytical practices. For instance, if the hemodynamic response function, representing the BOLD signal, is believed to span over 20 seconds (Logothetis et al. 2001), the sampling of this signal is typically done every 2 to 3 seconds at best – that is 2000× to 3000× the time it takes for one neuron to propagate an action potential. The inability of this technique to account for the minute and continuous variation of the signal is a significant and known limitation of the hardware. Yet a typical statistical analysis will aggregate measures of this signal that tend to be time-locked, artificially segregating physiological variables of interest. By giving such a weight to this kind of data when formulating theories, we have distorted our interpretation by solely focusing on time-locked, localised, linear processes "activated" for a significant amount of time, which must therefore be exchanging information in the form of representations.

« 8 » To conclude: of course, Solomonova and Sha do not propose magic solutions to the challenges of obtaining meaningful third-person data. They do list a number of features that could be extracted from this signal and that could be correlated with first-person data. What shape or form would such analyses take is yet to be defined, but the idea is there. Fully aware of some of the limitations of using first-person data, they also propose strategies to ensure the quality of this data, by training participants or using experts in a given domain. I have no doubt that the work programme proposed by Solomonova and Sha will lead to very interesting insights into that intimate part of our lives, our dreams. I am almost as interested to see more of such applications of the enaction framework.

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Received: 17 February 2016
Accepted: 20 February 2016

Dreaming: Ontological and Methodological Considerations

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> Upshot • This commentary focuses on an ontological claim made by the authors of this target article: that perceiving, imagining and dreaming are inseparable. It explores how best to understand this "inseparability condition." It is shown that the evidence needed to justify a strict reading of the inseparability condition is lacking, while there is room for a more relaxed rendition of the inseparability condition. The inferred lesson is that in developing an enactive neurophenomenology of dreaming, it is a non-trivial task to achieve clarity about the ontology of dreaming, and its relationship to imagining as well as perceiving.

« 1 » Elizaveta Solomonova and Sha Xin Wei aim to champion a phenomenological and enactivist-driven account of dreaming. This focus seems right – especially in the light of recent advances in so-called 4E cognitive science. The authors sketch a view in which a strictly brain-based, neuroscientific framework of dreaming is deemed insufficient. It is argued that our current dream research needs to be properly interpreted through the lens of an enactive neurophe-