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Commentary

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Drawing lessons from "CRISPR/Cas as a minimal cognitive system": a commentary on Yakura

Fred Keijzer

Abstract

Hidetaka Yakura provides an interesting contribution to the discussion on minimal cognition. He develops the idea that the CRISPR/Cas immune system, as present in many bacteria and archaea, can itself be cast as a minimal cognitive system.

Keywords

minimal cognition, CRISPR/Cas, immune system

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Hidetaka Yakura (2019) provides an interesting contribution to the discussion on minimal cognition. He develops the idea that the CRISPR/Cas immune system, as present in many bacteria and archaea, can itself be cast as a minimal cognitive system: immune systems exhibit fundamental cognitive features such as recognition, information integration, responses to external threats, and memory. In addition, he extrapolates from here to the cognitive importance of all immunological systems. In this way, Yakura presents a convincing case of minimal cognition that exhibits interesting features that further extend an already wide range of cases currently defended as examples of (minimal) cognition. This list now contains organisms such as bacteria, slime molds, plants, and a broad range of animals as clear cases (Barrett, 2011; Godfrey-Smith, 2016; Lyon, 2015) and also other biological processes such as development, regeneration, and physiological functions (Baluška & Levin, 2016; Keijzer, 2017). Yakura's discussion of immune systems nicely fits into this pattern.

Having said this, it is less clear how this proposal impinges on the general issue of formulating minimal conditions for cognition. Ideally, this would consist of clear, necessary, and sufficient conditions for designating a system as cognitive. Yakura claims that existing proposals are diverse, each making sense in their respective contexts, but none of them being able to provide a widely shared consensus view. As a remedy, he posits that the (bacterial) immune system provides a more generally useful alternative as it "serves as a more universal and fundamental cognitive system in living beings" such that for cognitive capacities, it is "obligatory to adopt a biochemical definition."

Concerning this last point—formulating minimal conditions for cognition—Yakura overstates his case. First, while accepting that immune systems suffice as cases of cognitive systems, making their presence a requirement for minimal cognition is no improvement when it comes to demarcating minimal cognition. A reason for considering immune systems as cases of cognition does itself derive from the use of what Lyon (2015) calls a cognitive toolbox: a diverse set of criteria such as the presence of sensing/perception, valence, behavior, memory, learning, and various others that provide useful indicators to signal the presence of cognitively relevant phenomena. Importantly, the cognitive features that Yakura mentions to characterize an immune system and claim its cognitive status clearly fit in this toolbox list. At this point, it rather seems that Yakura provides support for the toolbox list as a useful and pragmatic way to demarcate cognitive phenomena: the immune system case provides a new "minimal" example of cognition but not a criterion.

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Second, defining (minimal) cognition in biochemical terms rather than using something such as Lyon's toolbox seems to contradict Yakura's own critique of the use of structurally based interpretations of cognition. Yakura questions taking the brain as a structural requirement for cognition, a situation that he compares to the initial problem in immunology of accepting a CRSPR/Cas-based immune system that worked without the seemingly necessary ingredients of lymphocytes and antibodies. This critique is valid enough, but it becomes problematical to align this with a subsequent "biochemical definition" of minimal cognition. Thus, while Yakura stresses the importance of a functional interpretation of immune systems, he still returns to a definition of cognition that highlights a structural view of the immune system. It is unclear how he would avoid the very problems he signals when it comes to taking brains as a requirement for cognition.

This last critical point should be placed in context however. Yakura's somewhat equivocal treatment of functional and structural interpretations of cognition touches on a key issue concerning the demarcation of cognition. On one hand, one could argue that a functional reading of minimal cognition suffices and that the structural aspects—the material system itself—are not by themselves necessary, as long as a functionality is maintained that fulfills the toolbox criteria. On the other hand, this is not a direction that gives sufficient credit to the CRISPR/Cas case and the lessons that can be learned from this example.

Immune systems, nervous systems, developmental systems, and other similar cases do not lie around on the ground to be found by an attentive human being who looks down at the right spot. They are components of various organisms for which they perform a broad range of functions, functions that depend on and make sense in this organismal context and that can be presumed to be deeply entangled with this context in, up till now, unknown ways. Some of these functions, and probably much more than we are currently aware of, fulfill the toolbox criteria that make it plausible to designate them as cognitive in some new way.

However, discovering these functions as well as deciphering how they are performed derives from a study of the organisms in which they occur and where they are relevant. Yakura's CRISPR/Cas example is a case in point. It was the study of bacteria that provided this exciting new case of (minimal) cognition, like other examples that are now explicated in a wide array of living systems (Baluška & Levin, 2016; Keijzer, 2017; Lyon, 2015). In all these instances, living systems provide the structural—material—basis where phenomena occur that can be studied empirically and sometimes be deemed (minimally) cognitive.

Looking at cognitive functions in a more abstract way easily leads to an interpretation of cognition that is only loosely connected to life. A general lesson to be drawn from the CRISPR/Cas case, as well as other such examples, is that the relation between life and cognition is actually a very close one. The point here is not to argue that the notions of cognition (or mind) and life must be joined in an intrinsic conceptual way, as for example is done in parts of the enactivist literature (e.g. Thompson, 2007). Instead, the claim is simply that living systems provide the natural material examples that exhibit cognitive phenomena, often in ways that we are little aware of as yet. Thus, instead of setting abstract cognitive functions center stage, a better way to understand the broad variety of cognitive phenomena is by studying the living systems that exhibit them.

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