

# Domains of generality

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## Abstract

We argue that general intelligence, as presented in the target article, generates multiple distinct and non-equivalent characterisations. Clarifying this central concept is necessary for assessing Burkart et al.'s proposal that the cultural intelligence hypothesis is the best explanation for the evolution of general intelligence. We assess this claim by considering two characterisations of general intelligence presented in the article.

## Commentary

Recent studies suggest that general intelligence is not limited to humans, but can be identified in a number of nonhuman species. Such studies provoke the question: How does general intelligence evolve? Burkart et al. argue that the cultural intelligence hypothesis is the best explanation for the evolution of human and animal general intelligence. According to this hypothesis, the access to socially maintained knowledge generates selection pressures for increased reliance upon domain general capacities. In order to assess the cultural intelligence hypothesis, one must have a good grasp of what is meant by general intelligence. The authors are quick to note that this is a tricky concept to pin down. Defining general intelligence in terms of specific measures of intelligence

like problem solving and learning is problematic insofar as these skills can result from adaptive domain-specific modules. The authors thus characterise general intelligence as a domain-general ability best understood in contrast to the properties of domain-specific modules (sect. 1.2.1, para. 5, 6). There are many ways to make this contrast, however. As a result, the authors characterise domain-generality in a variety of ways: as phenotypic plasticity, as being non-modular in structure, as requiring learning or other processes of “ontogenetic construction” or canalisation, as involving reasoning, or as involving belief or belief-like states. The fact that domain-generality can be understood in many distinct and non-equivalent ways is worrisome insofar as different conceptualisations of domain-generality are likely to require distinct evolutionary narratives.

To take one example, domain-generality can be purchased quite cheaply if it is understood as mere phenotypic plasticity. Peter Godfrey-Smith (1996), for instance, makes a convincing case that phenotypic plasticity is selected for in heterogeneous environments – a scenario one expects to be common. To the extent that this is the case, phenotypic plasticity will be a widespread adaptive solution, seen quite deep in evolutionary history (Godfrey-Smith’s central example of *Bryozoan*, sometimes known as ‘sea-moss’, behaviour makes this point clear). One does not need to invoke the cultural intelligence hypothesis in order to purchase such flexibility.

Elsewhere, the authors characterise domain-generality as involving reasoning and belief or belief-like states. The idea here is that domain-generality can be conceptualised as the ability to use a variety of distal cues to generate mental representations, which in turn can

be used to produce adaptive behaviour (sect. 1.1.2, para. 4). Of course, mental representations can be understood more or less restrictively. In some extenuated way, simple neuronal systems like those of *Caenorhabditis elegans* “represent” or register their local environment. However, it seems clear that the authors are interested in representations in a richer sense, in line with what Kim Sterelny (2003) called “de-coupled representations.” These are representational states with the function of tracking features of the environment, but which are not tightly coupled to specific types of response. Such representations identify what Sterelny called “action targets” which can be acted on in a variety of different ways to satisfy goals.

De-coupled representations are an interesting evolutionary phenomenon, and one that the cultural intelligence hypothesis may get some explanatory purchase upon. De-coupled representations are the kind of psychological structure one would expect of creatures who need to rationalise and predict the thoughts of conspecifics, as well as weigh the complex tradeoffs involved in acquiring knowledge from multiple sources. However, even here we urge caution. The coleoid cephalopods (cuttlefish, squid, and octopuses) seem to display de-coupled intelligent behaviour, particularly those of the order *Octopoda*. Octopuses display sophisticated cognitive capacities including problem solving, individual recognition, and perhaps imitation (Godfrey-Smith 2013; Mather & Kuba 2013; Roth 2013). Nonetheless, octopuses are not social, often interacting with conspecifics only during mating (Roth 2013). The existence of cephalopod intelligence may thus pose a counterexample to the cultural intelligence hypothesis even when general intelligence is understood in the restricted sense of involving de-coupled representations.

The authors might respond by arguing that the evolutionary phenomenon they are attempting to describe is not merely the existence and amplification of one of the above features of domain-general cognition, but how a conglomerate of such properties came about and increased in sophistication. This conglomerate might include flexible reasoning and learning generated by de-coupled representations, in turn underpinned by the contents of an increasingly large brain. If this conglomerate really is what the authors mean by domain-generality, however, then they need to do more in order to motivate it. Recent work on grackles and New Caledonian crows, for example, shows that behavioural flexibility occurs independently of innovativeness, problem-solving ability, problem-solving speed, and brain size (Logan et al. 2014; Logan 2016a; 2016b). Given that purported features of domain-general intelligence do not always co-occur, further justification is required to ground claims that “general intelligence” is a unitary explanandum.

We suggest that the consequences of this analysis are twofold. First, we urge the authors to be clearer about the terms they use, and to operationalise them when possible. Second, the arguments presented here suggest that the cultural intelligence hypothesis may be insufficient for explaining the evolution of general intelligence, understood as involving the evolution of de-coupled representational states. Although this hypothesis may capture some directional effects in some clades, more needs to be done in order to show that it is the best explanation for the evolution of general intelligence in all clades.

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