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Parallel overinterpretation of behavior of apes and corvids

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Summary:

The report by Kabadayi and Osvath (2017) does not demonstrate planning in ravens. The behavior of corvids and apes is fascinating and will be best appreciated through well-designed experiments that explicitly test alternative explanations, and that are interpreted without unjustified anthropomorphic embellishment.

Corvids and apes are widely believed to be especially intelligent species, particularly for apparent flexibility in cognition. While bats may be extraordinarily capable in processing complex acoustic stimuli, chickadees may have remarkable spatial memory, and rats may be exceptionally good at discriminating safe from dangerous food, these animals are not often described as highly flexible in use of these capacities. In the anthropocentric search for intelligences that appear "human-like," the ability to apply cognitive abilities across domains and in novel situations is justifiably a standard criterion. So the comparative study of the flexibility of cognition, difficult as that may be to define, is of potential importance.

A recent report in *Science* described a set of experiments with ravens (*Corvus corax*) interpreted as measuring flexible planning (Kabadayi & Osvath, 2017). The authors conclude that ravens plan flexibly for opportunities to collect food rewards 15 minutes and 17 hours in the future and that this capacity in ravens parallels that in apes. The authors suggest that these abilities likely evolved independently in apes and corvids because it seems unlikely that planning would have existed in a common ancestor that lived over 300 million years ago. If true, these conclusions about planning in ravens and apes would justify new efforts to understand the selection pressures for the evolution of planning and the conditions under which apes and corvids plan. Unfortunately, the studies in both ravens and apes shared by Osvath and colleagues fall short of demonstrating planning or justifying the focus on these taxa to understand the evolution of planning. Additional studies would be needed to justify the inference that subjects were planning.

Prior to the experiments described, ravens were trained to exchange plastic bottle tops for food, and to use "tools" – rocks that had to be dropped down a chute - to earn food rewards. These behaviors are, in themselves, quite interesting and unusual. How the birds learned them is worthy of study. That these behaviors do not appear to be common in the wild, if they occur at all, is critical to Kabadayi and Osvath because they argue that "unnatural" behaviors are more likely to demonstrate cognitive flexibility. They additionally argue that

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these behaviors demonstrate cognitive flexibility because the exchange task is “social” and the task involving the rocks is “physical.” But do these tasks actually involve specialized “social” and “physical” cognitive processes? Do birds think they are bartering in one case and using a tool in another, or do they perceive both tasks as requiring that they place an object in a particular location to get a food reward?

There is an additional concern with the presentation of this work. The study is, in fact, not about the exchange task or the tool-use task at all. It is about planning. The extent to which these studies fail to demonstrate planning is likely underestimated by many readers because attention is directed away from planning *per se* and toward these captivating “bartering” and “tool-use” behaviors.

Ravens were trained to pick up bottle tops and rocks and deposit them with an experimenter (exchange) or in a chute (tool-use) to collect food. Once they reliably performed these actions, ravens were tested with presentation of these objects displayed among a set of perceptually distinct distractors. Picking up or manipulating the distractor objects had never been associated with food reward. In the case of the tool-use task the birds were given additional experience teaching them that the distractor objects could not be used to earn a food reward. Thus, the birds were presented with sets consisting of one object that was associated with food rewards, and other objects that had either not been associated with reward, or had been associated with the absence of reward. The measure of planning was whether birds selected the objects that had been previously associated with reward, avoiding non-rewarded distractors. It should not be surprising that the birds tended to select the object that had been associated with reward.

The authors claimed that the selection of objects reflected planning because, in the test phase, the items could not be used to earn food rewards until 15 minutes or 17 hours had elapsed. Unfortunately, no evidence was presented to demonstrate that the birds actually represented the fact that reward would be delayed or that the birds picked the item with a future use in mind. Quite to the contrary, it is not evident that the birds could have known that a delay would follow, or how long that delay would be. In the absence of these critical tests, it is more likely that the birds were attracted to the trained objects because the objects were associated with reward. What were the ravens doing that is different from a rat approaching and contacting a lever that had been previously associated with the delivery of rewards? A mechanistic analysis is required to find out, one that considers reasonable alternative explanations and evaluates them experimentally. We need to be especially careful to apply these standards when working with alluring animals like corvids and apes that may elicit our uncritical anthropomorphism.

To test whether birds were planning, as in thinking about the future use of the items in 15 minutes or 17 hours, the experimenters would need to include control conditions that test whether birds choose the bottle caps and stones only when they have a plan for using them. For example, birds should not select these objects when they know there will be no future opportunity to use them (see for an example, Bourjade, Call, Pele, Maumy, & Dufour, 2014). Alternatively, a condition could be arranged in which birds choose between the bottle tops and the rocks under conditions in which they are informed that only one or the other would be useful in the future. Parallel concerns may be raised about the report of planning in apes presented by Osvath and Persson (2013).

All memory is "for the future." It evolved to allow past experience to adaptively shape future behavior. Memory of the location of cached food in a chickadee exists to guide the bird to this food source in the future, not so that it can reminisce about a seed well-cached! The mental representation a rat has of lever presses resulting in food allows it to press the lever in appropriate circumstances in the future. Devaluation, selective satiation, and other manipulations prove that many animals often remember quite precisely what reward they have received in the past for a particular response (Shettleworth, 2010). Many nonhumans therefore *expect* specific events, such as delivery of particular rewards, to occur in the very proximate future. Memories are also necessary for longer term planning. But the fact that memory controls selection of a bottle cap, combined with the fact that the bottle cap can be exchanged for food the next day if an experimenter so decides, does not necessitate the conclusion that selection of the bottle cap is part of a 17 hour plan. The bottle cap may elicit a memory of food, and that may make the bottle cap attractive. That does not constitute a plan.

Planning evolved from precursors. We should expect to see aspects of many types of cognition distributed among extant species. It is therefore appropriate to look for comparative evidence of planning, of language, of episodic memory and other fascinating forms of cognition. Comparative studies of cognition promise to help us understand why cognition takes the forms it does and thereby to better understand our human place in the evolutionary landscape. At times we will be humbled by the astounding capacities of other species. At other times we will certainly see that we excel cognitively in ways no other animal on the planet does. For our understanding to be meaningful, we need to ensure that our scientific methods are rigorous and based in a mechanistic analysis of behavior that explicitly hypothesizes and evaluates alternative explanations. When we leap to embrace superficial similarities among species, without adequate experimentally rigorous analysis, we may foist our cognitive preconceptions on other species. Analyses that definitively elucidate the processes that account for behavior, and that identify the diversity in cognition, are needed to advance our understanding of the evolution of cognition.

Ravens may indeed make plans that involve cognitive representation of future events. Alternatively, there may be other cognitive mechanisms that prepare them for the future. Designing and executing appropriately controlled experiments that disentangle these alternatives is the challenge, and the reward, of work in comparative cognition.

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