Animal Cognition: Crows Spontaneously Solve a Metatool Task

A recent study found that tool-manufacturing New Caledonian crows spontaneously solved a metatool task in which the birds used a tool to obtain a second, longer tool that could then be used to obtain food that was otherwise out of reach.

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As humans, our technology is pervaded by metatool use, from the construction of stone tools by our Oldowan ancestors of 2.5 million years ago, achieved by knapping one stone onto another, to the most sophisticated computer-controlled milling machines of the 21st century tool maker. But is any other animal capable of using one tool to make or gain another? And if any other species has this ability, to what extent does it require an understanding of the physical principles and causal regularities of how tools work? Chimpanzees can use multiple tools to obtain food in the wild; for example Brewer and McGrew [1] observed chimpanzees on islands in the Gambia River using a chisel bodkin and then a dipstick tool to get honey from a bees' nest, and Matsuzawa [2] observed chimpanzees at Bossou using a wedge stone to prop up a second stone in order to provide a horizontal surface for cracking open nuts. Both of these examples involve the use of two or more tools directly upon the goal.

There are two features of metatool use that make it distinct from multiple tool use. The first is that the object of one of the tools — the metatool — must itself be another tool. The second is that the metatool must be used to gain or modify a second (primary) tool, which is then used to achieve the goal; it is therefore argued that metatool use is more cognitively demanding than multiple tool use because the relationship between a metatool and the goal object (food) is not direct but mediated via the primary tool. I know of little, if any, evidence of such metatool use or modification in the wild in non-human animals, perhaps because in most, if not all cases, the animal can select or manufacture the appropriate length or type of primary tool in the first place and consequently there is no need to use a metatool. In the laboratory, the study of both metatool and multiple tool use has been solely the province of primates (for example [3–6]), ever since Köhler [7] first presented his chimpanzees with a task in which an inaccessible food reward could be reached only by stacking boxes, climbing on top and brandishing a stick.

A paper published recently in *Current Biology* reports a novel and important advance in our understanding of animal cognition: Taylor *et al.* [8] report that the tool-manufacturing New Caledonian crow, the greatest non-primate tool user, is capable of spontaneous metatool use (Figure 1), and that its performance is on a par with apes [3]. It is now 11 years since Hunt [9] discovered that this species of crow manufactures its own tools. Subsequent studies have shown that these crows make a variety of tools which are used for different purposes, some requiring considerable processing from the raw materials [10–12]. Furthermore, crows from different geographical areas have different versions of tool [13], suggesting a level of diversity and flexibility in tool manufacture that may be comparable with the apes. Experiments in the laboratory have also suggested that corvids and apes have comparable abilities in physical cognition (for example [14,15]). Importantly for the present study, these crows have been shown to both select and manufacture a stick tool of sufficient length, which they then use to retrieve otherwise inaccessible food hidden at different depths [16–18].

In their new study, Taylor *et al.* [8] provided the birds with food that was buried in a food well, such that it could only be extracted by using a long stick. The crows also had access to two toolboxes some distance away, one containing a functional tool (the long stick) and one containing a non-functional object (a stone). A short stick that was not long enough to retrieve the food but could be used to access the objects in both toolboxes was placed in front of the toolboxes. To solve the task the crows had to first go to the tool area, 1.75 m away from the food well, select the short stick and use it to retrieve the longer stick from the relevant toolbox, and then go to the food well where the long stick could be used to obtain the food. All seven crows were able to solve the problem eventually. What is most

Figure 1. Metatool used by a New Caledonian crow. (Photo courtesy of Gavin Hunt.)

impressive is that all but one of the crows used the short stick to get (or attempt to get) the long stick on the very first occasion, and four of these six were successful in obtaining the food on that trial. Importantly, the birds had not received any prior experience of using a short stick to retrieve another tool, which is why the authors argue that this metatool use is spontaneous. Of course the birds had received some prior training; they had experience of using the long stick to retrieve food from the food well, and of using a non-functional shorter stick at the food well, and they had experience of withdrawing the long stick from the tool box when it was positioned such that a tool was not required to reach it.

Is this metatool use anything more than the acquisition of a behavioural chain? In the conditioning laboratory, it is well established that rats and pigeons can learn to perform a sequence of responses in order to gain food. For example, the humble lab rat can learn to press a lever in order to make pulling a chain effective in delivering food [19]. This ability is normally explained by the fact that the stimuli associated with performing the terminal response in the behavioural chain become conditioned reinforcers through their association with food, and thereby act to strengthen the initial link in the chain. In applying this argument to the new work of Taylor *et al.* [8], the critical point is whether the primary tool acts as a conditioned reinforcer for the use of the metatool. The crucial observation is that six of the seven crows spontaneously used the short stick to retrieve the longer stick on the very first occasion, which rules out a simple conditioned reinforcement account.

As with most studies of animal cognition it is very difficult to rule out all alternative associative explanations, and whether or not Taylor *et al.* [8] adequately do so here is open to debate. The sceptic might argue that the long stick has become an attractive object through its prior association with food, and that what the crows naturally do is to attempt to retrieve attractive objects that are out of their reach. Nonetheless, this study introduces an interesting example of metatool use, providing a promising and tractable empirical paradigm for investigating the thorny issue of planning and prospective cognition in animals. The authors are also to be congratulated for opening up the whole issue of metatool use beyond the domain of primates, and adding another important strand to the emerging interest in the convergent evolution of intelligence [20].

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Synapse Specificity: Wnts Keep Motor Axons on Target

New studies on the molecular logic of synapse specificity in the fly and worm have brought neurobiologists back to an ancient family of morphogens best known for establishing pattern in the early embryonic nervous system.

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Over many millions of years, nervous systems evolved from simple, distributed networks into intricate, centralized structures that feature highly specific patterns of connectivity and presumably require complex target selection mechanisms. Textbooks are replete with examples of factors that orchestrate the biogenesis and identity of neurons, and molecular