ECOLOGY AND BEHAVIOR

Shaping of Hooks in New Caledonian Crows

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Many animals use tools, but their understanding of physical forces or causal relations is unclear (*1*, *2*). Primates are considered the most versatile and complex tool users, but observations of New Caledonian crows (*Corvus moneduloides*) (*3–5*) raise the possibility that these birds may rival nonhuman primates in tool-related cognitive capabilities.

We report here an experiment inspired by the observation that a captive female spontaneously bent a piece of straight wire into a hook and successfully used it to lift a bucket containing food from a vertical pipe (Fig. 1A). This occurred on the fifth trial of an experiment in which the crows had to choose between a hooked and a straight wire and only after the hooked wire had been removed by the other subject (a male). The animals had prior experience with the apparatus, but their only previous experience with pliant material was 1 hour of free manipulation with flexible pipe-cleaners a year before this experiment, and they were not familiar with wire (*6*).

To investigate the importance of this observation, we conducted several new trials in which we placed a single straight piece of garden wire (0.8 mm in diameter, 90 mm long) on top of the tube and did not intervene until either of the birds obtained the food (a valid trial) or dropped the wire irretrievably into the tube (an invalid trial).

Out of 10 valid trials (interspersed with seven invalid ones), the female bent the wire and used it to retrieve the food nine times, and the male retrieved the food once with the straight wire (*7*). To bend the wire, she first wedged one end of it in sticky tape (available around the bottom of the tube and the side of the plastic tray containing the apparatus) or held it in her feet at a location 3 m from the food, where there was no tape. She then pulled the other end orthogonally with her beak (see Movie S1), resulting in a bend with an angle of 74 ± 30° (mean ± SE) (see Fig. 1B for individual tool shapes). She started to bend the wire 35 ± 8 s after the start of each trial and used the resulting hook 6 ± 2 s later. In all cases but one, she tried with the straight wire (for 15 ± 4 s) before starting to make the hook. In all valid trials, the birds retrieved the food within 2 min.

Thus, at least one of our birds is capable of novel tool modification for a specific task. In the wild, New Caledonian crows make at least two sorts of hook tools using distinct techniques (*3*, *4*), but the method used by our female crow is different from those previously reported and would be unlikely to be effective with natural materials. She had little exposure to and no prior training with pliant material, and we have never observed her to perform similar actions with either pliant or nonpliant objects. The behavior probably has a developmental history that includes experience with objects in their environment (just as infant humans learn about ev-

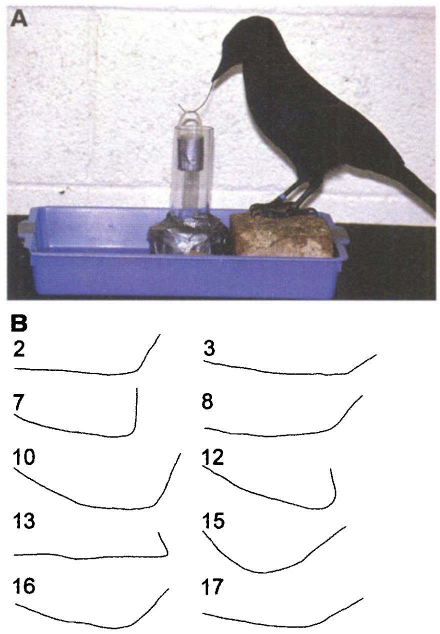

Fig. 1. Bending wire into hooks by a captive New Caledonian crow. **(A)** The female New Caledonian crow extracting the bucket containing meat using a piece of wire she had just bent. This is a photo taken after the experiment was completed, but the hook and posture depicted are typical of experimental trials. **(B)** Outline tracings of all the bent wires, with the end inserted into the tube facing right. Numbers refer to trial number. The wire bent in trial 8 was not successfully used to retrieve the bucket (it was dropped into the tube). Because of experimenter error, the wire in trial 10 was 2 cm longer than the wire in the other trials. Scale bar, 5 cm.

eryday physics from their manipulative experience), but she had no model to imitate and, to our knowledge, no opportunity for hook-making to emerge by chance shaping or reinforcement of randomly generated behavior. She had seen and used supplied wire hooks before but had not seen the process of bending.

Purposeful modification of objects by animals for use as tools, without extensive prior experience, is almost unknown. In experiments by Povinelli [experiments 24 to 26 in (*2*)], chimpanzees (*Pan troglodytes*) repeatedly failed to unbend piping and insert it through a hole to obtain an apple, unless they received explicit coaching. Further experiments [exp. 27 in (*2*)] (*8*) have shown a similar lack of deliberate, specific tool modification in primates. There are, however, numerous suggestive field observations (*9*) and one report of a male capuchin monkey (*Cebus apella*) unbending a piece of wire to obtain honey (*10*).

Our finding, in a species so distantly related to humans and lacking symbolic language, raises numerous questions about the kinds of understanding of "folk physics" and causality available to nonhumans, the conditions for these abilities to evolve, and their associated neural adaptations. Comparisons between New Caledonian crows and their relatives, as well as between other cognitively exceptional birds and their relatives (*11*), offer a unique natural experiment to examine hypotheses about the ecological and neural preconditions for complex cognition to evolve. It is not yet known if New Caledonian crows are also exceptional in cognitively demanding tasks not involving tools.

References and Notes

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6. The female subject was wild-caught as a juvenile in March 2000 and has been in our laboratory ever since. The male subject was in a zoo in New Caledonia for over 10 years until he was moved to our laboratory, also in March 2000 (it is not known when or how he was caught). See (*5*) for further details of subjects, history, and housing conditions.
7. The male rarely attempted this task and never bent the wire. He observed the female bending the wire and stole the food from her in three trials. The birds are tested together because they are highly social and, when separated, are less motivated to participate in experiments.
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12. We thank D. Wilson for technical assistance, the Wissenschaftskolleg zu Berlin for a research fellowship to A.K., and Joan Silk for comments on the manuscript. The work was funded by a grant from the Leverhulme Trust to A.K. and a scholarship from the Wellcome Trust to A.A.S.W.

Supporting Online Material

www.sciencemag.org/cgi/content/full/297/5583/981/DC1

Movie S1

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