Crows able to understand the concept of recursion

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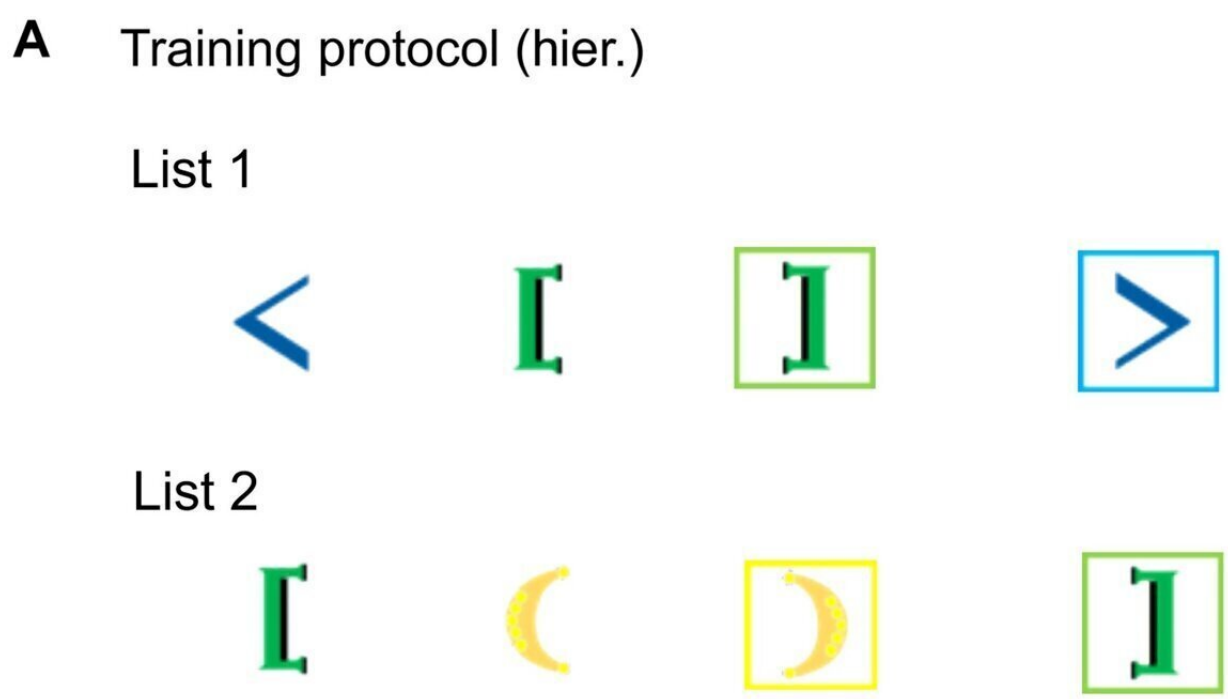

Hierarchical ordering of bracket stimuli. (A) Following identical procedures of experiment 1, two new training lists were presented until criterion was reached. Again, transfer trials were introduced that consisted of one unique pair of brackets from each of the training lists. (B) Valid center-embedded responses with the two pairs can be ordered in two different ways. In experiment 1, there was no difference in the order. In this experiment, test pairs were composed of the outer pair from list 1 and the inner pair from list 2. The crows vastly preferred responding in an outside-to-in pair manner when producing center-

embedded sequences. Credit: *Science Advances* (2022). DOI: 10.1126/sciadv.abq3356

Researchers at the University of Tübingen have found via experimentation that crows are capable of understanding the concept of recursion. In their paper published in the journal *Science Advances*, Diana Liao, Katharina Brecht, Melissa Johnston and Andreas Nieder describe experiments they conducted with crows and what they learned.

For many years, scientists believed that humans were the only animals capable of understanding the concept of recursion, in which meaningful structures are embedded in other structures. An example would be "The rat the cat chased ran." In this example, the words "the cat chased" are embedded in another sentence. But two years ago, a team of researchers conducted experiments that showed that some kinds of monkeys are able to understand the idea of recursion on a par with three- to four-year-old human children.

In this new effort, the research team conducted similar experiments with crows that show that they, too, have the cognitive ability to understand recursion.

The experiments by both teams involved training test subjects to choose bracket pairs in a sentence made of symbols—choosing the parentheses in the sentence {()}, for example. Once the crows got the idea, the researchers then created longer sentences to see if the test subjects could still pick out the ones that were embedded. As with the monkeys, the researchers found that the test subjects could pick out the embedded characters in numbers that were greater than chance would allow.

The researchers on this new effort, noting a problem with the prior

testing done with the monkeys, added more complexity to make sure that the test subjects were not simply memorizing the order in which the symbols were shown. They added another character, allowing for sentences such as {[()]}. Doing so did not slow the crows; they were just as proficient as they had been with the original character set. The researchers noticed something else—the crows were able to pick out the embedded characters without the extra training needed by most of the monkeys.

More information: Diana A. Liao et al, Recursive sequence generation in crows, *Science Advances* (2022). DOI: 10.1126/sciadv.abq3356