Learning & Behavior (2019) 47:107–108
https://doi.org/10.3758/s13420-018-0342-1

OUTLOOK

Tools of engagement: Information seeking in chimpanzees

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Published online: 15 August 2018

Summary
Two widely studied and impressive cognitive feats in nonhuman animals, metacognition and tool use, both require the cognitive tools of monitoring and controlling knowledge states and adaptive actions toward desirable outcomes. In a recent study, Perdue, Evans, and Beran (*PLoS ONE, 13*(4), e0193229, 2018) found that some chimpanzees used tools to selectively acquire information and make inferences, indicating metacognitive awareness and appropriate use of tools depending on the content of those knowledge states.

Keywords Metacognition · Tool use · Comparative cognition

Metacognition, or thinking about thinking, requires the cognitive tool of monitoring knowledge states. Evidence for metacognition exists in several species with particularly strong evidence coming from apes and old-world monkeys (e.g., Basile, Schroeder, Brown, Templer, & Hampton, 2015; Call, 2010; Marsh & MacDonald, 2012a, 2012b). A few major paradigms exist to address the challenging question of the extent to which nonverbal species can access their cognitive states. Subjects are presented with a primary task, such as a memory test, a psychophysical discrimination, or an apparatus with containers hiding food. In each of these cases, cognitive state varies across trials: memory strength, difficulty of the density discrimination, or knowledge about food location. A secondary task, which allows for the possibility of adaptive metacognitive choices to be made, includes the ability to decline difficult memory tests, placing of "bets" based on recent choices, or seeking information when ignorant. The later paradigm, information seeking, consists of cases in which the subject is, or is not, shown where food is hidden. If subjects know that they know the food's location, then they should not search for more information at other potential hiding locations, but they should search when they are ignorant about food location.

A recent report (Perdue, Evans, & Beran, 2018) described a set of experiments in which chimpanzees were presented with the commonly used information-seeking paradigm to assess metacognition. Another layer of complexity was added to this basic design by requiring the use of a tool to lift the lid to search for the presence or absence of food in five possible hiding locations. After training, and when the effort required to obtain the reward was increased, all three subjects used the tool to search more often when the food was not shown than when it was shown. One chimpanzee transferred appropriate use of the tool to new conditions in which inferences were required to be made and when the quality of food rewards varied. In the final experiment, when foods of different values were hidden, all subjects used the tool adaptively to find the best food item. This work makes a valuable contribution to the field by building on previous work by Call and colleagues and Marsh and MacDonald (Call, 2010; Marsh & MacDonald, 2012a, 2012b) that demonstrates the ability of apes to selectively acquire information with varying levels of effort, qualities of reward, risks of error, and with a required inference by exclusion.

Comparative cognition researchers are, for the most part, in agreement that the worthwhile question in the field of animal metacognition is not *if* but *how* animals demonstrate metacognitive behavior. The how is usually addressed by isolating possible sources of stimulus control that can be either internal or external. Several aspects of the design in this article addressed these important questions; for example, showing chimpanzees empty wells so that they could not be cued directly by the sight of the food and varying the knowledge states of the food locations and values were clever manipulations. That all subjects

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used the tool to search more when the food location was not revealed is consistent with using the presence or absence of knowledge about food location as a discriminative cue to guide searching behavior. However, as the authors note, this behavior in the first experiment is also consistent with the hypothesis that subjects learned two simple rules after experience with differential food reinforcement: see food ➔ point to well for reward; see empty well ➔ obtain tool and search. Such an alternate hypothesis—a generalized search strategy, in which behavior is cued externally by the food itself—was evaluated by showing the chimpanzee all the empty locations so that information about the food's location was gained only indirectly. One of the three chimpanzees, Sherman, made this informational leap by immediately retrieving the food from the correct location without searching first. He used the tool more often when he was shown one empty container than when he was shown four empty containers. In addition to demonstrating tandem tool use and exclusion learning, this behavior indicates metacognitive behavior that was not guided by an externally available source of stimulus control. That the other two chimpanzees did not perform similarly suggests that they could have been using the rule "retrieve the tool when I do not see food." However, in the final experiment, when different qualities of reward were revealed, chimpanzees sometimes continued searching after food had been seen, therefore lending some repudiation of the generalized search strategy hypothesis, which predicts cessation of searching once food is retrieved.

Beyond changing informational contexts of the test itself, tool use presents an additional condition for evaluating metacognitive behavior. This is exciting because tool use might offer a species-relevant methodology for assessing metacognition similar to what natural caching behavior did for the study of episodic memory in food-caching birds, what digging behavior did for examining recognition and temporal order memory in rats, and what lexigrams and pointing behavior did for evaluating spontaneous recall in chimpanzees. Corvids, apes, and other primates are avid tool users, so this method of evaluating the extent to which animals use tools adaptively and in accordance with varying informational contexts could prove invaluable as the aforementioned methodological tools did in those paradigmatic studies. The use of tools could also be important for species that have been problematic to test for metacognitive behavior. For example, capuchin monkeys have shown equivocal evidence for metacognitive behavior in information-seeking tasks, possibly because they almost always search. Adding the tool-use dimension to information-seeking behavior for this naturally tool-using species might result in more selective looking behavior.

This article makes a novel contribution to the field of animal metacognition because animals showed effortful action to obtain the tool from another enclosure and used it flexibly under many different conditions. Importantly, in the final two experiments, the tool functioned not simply as an extension of the subject's hand but required relocation to a different enclosure to retrieve the tool. This required significant behavioral inhibition to forego potential immediate food to obtain the tool, engage in information-seeking behavior with it, and return it to the experimenter when ready to make a choice about food location. While the methodological advance of adding tool use to information-seeking metacognitive paradigms is exciting, more work still needs to be done to determine how tool use informs what we know about the underlying cognitive mechanism guiding metacognitive behavior. At least one chimpanzee demonstrated that metacognitive behavior is flexible by using tools, inference, and exclusion to make adaptive metacognitive decisions. Beyond flexibility, however, future studies should directly examine *how* tool use might elucidate metacognitive reasoning. It is noteworthy that tool use brought the subjects steps—and therefore external cues—away from the apparatus and the tool itself. Could tool use in metacognitive tasks therefore be akin to first, second, and third order theory of mind where each level of abstraction indicates increased reasoning? While this may be the case, it would be a stretch to assume so based on data we have so far. Regardless, it is interesting in itself that the animals combined cognitive skills and that being in the mode of cognitive access to informational contexts might have primed tool-use behavior and vice versa. It would be interesting for future studies to be designed to more directly inform a mechanistic explanation of how the representations for tool use and metacognition might interact.

Overall, this study certainly adds to our knowledge about chimpanzee metacognition in that some apes can monitor knowledge states, use tools, and make inferences at the same time. More importantly, using tool use as a "tool for engagement" with information seeking might leverage the study of metacognition in nonhuman animals in critical ways.

References

Basile, B. M., Schroeder, G. R., Brown, E. K., Templer, V. L., & Hampton, R. R. (2015). Evaluation of seven hypotheses for metamemory performance in rhesus monkeys. *Journal of Experimental Psychology: General, 144*(1), 85–102. https://doi.org/10.1037/xge0000031

Call, J. (2010). Do apes know that they could be wrong? *Animal Cognition, 13*(5), 689–700. https://doi.org/10.1007/s10071-010-0317-x

Marsh, H. L., & MacDonald, S. E. (2012a). Information seeking by orangutans: A generalized search strategy? *Animal Cognition, 15*(3), 293–304. https://doi.org/10.1007/s10071-011-0453-y

Marsh, H. L., & MacDonald, S. E. (2012b). Orangutans (*Pongo abelii*) "play the odds": Information-seeking strategies in relation to cost, risk, and benefit. *Journal of Comparative Psychology, 126*(3), 263–278. https://doi.org/10.1037/a0025906

Perdue, B. M., Evans, T. A., & Beran, M. J. (2018). Chimpanzees show some evidence of selectively acquiring information by using tools, making inferences, and evaluating possible outcomes. *PLoS ONE, 13*(4), e0193229. https://doi.org/10.1371/journal.pone.0193229