

AUTHOR'S RESPONSE

A Tale of Two Comparative Psychologies: Reply to Commentaries

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Animal metacognition is a growing area in comparative psychology that raises questions about the evolutionary emergence of reflective mind and self-awareness. Theoretical discussions are constructive as this area develops. We thank the editor for arranging this dialogue and the commentators for contributing to it. The dialogue reveals the strong consensus that one must look beyond associationism to understand animal metacognition. The target article and the commentaries focused on cognitive process and representation, and on detailed cognitive analyses of metacognitive phenomena. Accordingly, this theoretical dialogue presents the possible outline of a new phase of animal-metacognition research.

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Animal metacognition is a growing area in comparative psychology. It raises important questions about the forms of self-knowledge, the emergence of reflective mind in the vertebrates, and the evolution of humans' cognitive system. Theoretical dialogues are very constructive as this area develops. We will go right to the interesting issues raised by the commentators in their contributions to this dialogue.

Le Pelley

The crux of Le Pelley's (2014, pp. 132–134) commentary came in his definition of associative learning. He said: "an animal is in state X; it performs response Y and is rewarded. When that animal finds itself in state X in future, it will—other things being equal—perform response Y. This is the essence of associative learning" (p. 133).

This definition reinforces powerfully the target article's message. The definition is vague, monolithic, and all-inclusive. It

makes no psychological distinctions. It leaves the construct *associative* empty and uninformative.

Cognitive psychologists understand that there are different memory systems (episodic, semantic), different categorization systems (explicit, implicit), different levels of behavioral knowledge (declarative, procedural), and different levels of awareness. In our view, it would be a regressive mistake for comparative psychology to forego these sharp analytic tools for making psychological differentiations. If we do, our sense of animal minds will be impoverished. We will be unable to analyze distinctions among species, to develop animal models for important human capacities like metacognition, or to understand human origins and the evolutionary emergence of those capacities.

We tried in our target article to illustrate this progressive brand of comparative psychology. We described how concurrent working-memory loads selectively eliminate animals' uncertainty responses while sparing their primary perceptual responses. This finding points to the executive nature of uncertainty responses. It dissociates them from associative processes. It grants macaques the beginnings of executive cognition, an important theoretical statement. These insights are invisible if everything is crushed into the rubric associative. It was disappointing to see this illustration not even mentioned by Le Pelley (2014).

Our target article was not an attack on associative learning. If these phenomena are given disciplined definitions regarding stimuli, rewards, and so forth, they have had and will always have an important place in comparative psychology. A principled and delimited associative theory is not vacuous, to use Le Pelley's (2014) term. But a casual, kitchen-sink associationism is the duller tool in the psychologist's kit. To be fair, we believe that many

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comparative psychologists have given up this casual associationism to seek sharper analytic tools.

Le Pelley's (2014) commentary embodies a related problem. He reifies his formal models and parameters, mistaking them for an explanation. The target article discussed the interesting dissociation that macaques make uncertainty responses but capuchins hardly do so (even when the associative stakes rise dramatically so that every error potentially costs capuchins 30 food rewards). In contrast, capuchins make primary perceptual responses at very high levels when a perceptual response replaces the uncertainty response in a closely matched task.

Le Pelley's (2014) view is that macaques and capuchins, respectively, would have an uncertainty-response parameter value of (e.g.) 5.1482 and 0.0017. He says: "an associative model can be parameterized such that it rarely, if ever, chooses the *uncertain* response" (p. 133). Likewise, capuchins in the perceptual and uncertainty tasks, respectively, would switch from having parameter values of (e.g.) 7.1362 to 0.0384.

Our view is that parameter values explain nothing. The statement—macaques are 5.1482—explains nothing. To the contrary, these dissociations cry out for serious psychological analyses of why uncertainty and perceptual responses are so psychologically different, and of why macaques' and capuchins' minds are differentially open to uncertainty. A parameter value can't be that explanation. Comparative psychology must develop beyond the idea that a model explains. A model is math awaiting a psychological explanation.

Carruthers

Carruthers (2014, pp. 138–139) endorsed our evaluation of "associationist explanations of the primate metacognition data." He agreed that "an obsessive focus on associationist accounts of animal behavior impedes progress in comparative psychology and obstructs attempts to understand animal precursors and homologies of components of human cognition" (p. 138). He noted that we provided "strong support for executively controlled processes in nonhuman primates" (p. 138).

Having reinforced us positively, Carruthers (2014) struck. Though acknowledging that primates' executive uncertainty processes are metacognitive in a sense, he proposed that the construct metacognition be dropped in favor of a strict dichotomy between executive and metarepresentational processes. He and others urgently want to know whether other species have full-fledged metarepresentational cognition. Here are our reflections on that dichotomous program.

Strict dichotomies can create artificial distance and separation. They do not foster the study of continuities and emergence. Yet comparative psychologists urgently want to trace the evolution, the continuity, of metacognition.

Our view is that executive uncertainty responses are metacognitive. Carruthers (2014) agrees with a qualification. They meet the operational definition of metacognition in the human literature. Accordingly, we would meet Carruthers half way. We would say that metacognition has different facets, monitoring, control, executive functioning, explicitness, possible consciousness, and possible self-awareness or metarepresentation. This grants the comparative psychologist the search for varieties of the metacognitive experience. But it also lets one wonder whether macaques have the

self-imbued facet of metacognition, which they may not. Of course this facets analysis only becomes possible once one drops the ardent associationist framework, which is why Carruthers and we agree strongly on this point.

Exploring that self-imbued facet of metacognition is going to be difficult. In several places, Carruthers (2014) used humans' verbal reports and introspections to justify a metarepresentational interpretation. This is unacceptable in the cross-species study of metacognition, because it prejudices the issue. We will all need to collaboratively find those tasks and data profiles that plausibly show metarepresentation but do not depend on post hoc verbal justifications. We appreciated the idea that some human populations might dissociate executive-attentional uncertainty and metarepresentation. There might be productive lines of research stemming from that idea.

We should warn philosophers that their view of the natural world may not be accurate. There is a view that self-imbued metacognition is the last mental sophistication, probably humanly unique, maybe language borne, and so forth. Somehow, after primates thrived for tens of millions of years without it, it popped on in humans. Why that facet? Why only humans? What was the value added? Why was it last? Traits in evolution do not usually pop on suddenly. This idea may not make functional, structural, or evolutionary brain sense, as we show now.

Humans' executive-attentional system is closely allied to our hypothesis-testing abilities, our declarative cognition, our explicit consciousnesses, and our self-awareness. Carruthers (2014) acknowledges these entanglements when he discusses how working memory and attentional systems broadcast their cognitive contents to brain systems globally. Therefore, another plausible possibility is that this explicit cognitive system, including forms of self-awareness, is integral, not separable, and that it emerged integrally and gradually through primate evolution. That is, it may not be that the executive-attentional uncertainty system evolved in mindless, unconscious, selfless, automaton fashion, and then selfness dropped in. Everything may have been coming along together. In that case, researchers will have to reckon with the possibility that macaques are showing primitive forms of metacognition and primitive forms of metarepresentation, too.

Basile and Hampton

Basile and Hampton (2014, pp. 135–137) concluded that we "persuasively identify the problems with current associative models" (p. 135). They agreed that "comparative studies of executive control in nonhumans are important and will inform our understanding of both human cognition and the evolution of cognition" (p. 135). They agreed that "the associative models proposed by Le Pelley (2012) and Jozefowicz et al. (2009) do not currently explain the breadth of nonhuman metacognitive performance" (p. 135). This dialogue has clearly revealed the consensus that one must look beyond associationism to understand animal metacognition.

However, Basile and Hampton (2014) do accuse us of treating animal metacognition too intuitively/impressionistically. We acknowledge their point without acknowledging that our treatment of animal metacognition is like appreciating a flower. Pressing for intuition is to help our field gain theoretical distance from associationism. It is our way of suggesting that animal uncertainty is likely isomorphic with human uncertainty, sharing some (but not

necessarily all!) processing machinery with human metacognition. Intuition is the opening statement in a conversation that produces careful cognitive analyses. That stance has been a useful counter to the associative stance that has the problem that it tries to end the conversation.

We endorse the goal to explore the information-processing mechanisms of animal metacognition so that our description is as concrete and specific as possible. Basile and Hampton (2014) offer a useful perspective drawn from older ideas of stimulus control in discriminative responding. But here they intend that research can measure animals' sensitivity to internal psychological signals, such as memory, in the same way as external signals, like light or tone. These are the psychological signals that are potentially important to metacognition. Then the question is whether animals can sense those signals, with implications for research paradigms that can establish this fact.

Thus, Basile and Hampton (2014) focus on metacognitive contents, proposing a horizontal empirical survey of animal metacognition across its possible cues and signals. In contrast, our recent research has instantiated a vertical, cognitive-levels empirical program that considers whether metacognitive signals are implicit-procedural, executive-attentional, or even declaratively conscious. Both these complementary research approaches seem productive ways to cover the theoretical and empirical terrain of animal metacognition.

We note that philosophers also want close cognitive analyses of the sense of self and self-awareness. Therefore, one could issue the Carruthers (2014) challenge to Basile and Hampton (2014). That challenge would be to design experiments that catch animals in the

act of psychophysically sensing and monitoring the internal signals of selfness. We think that our field should not conclude too quickly that this question is unanswerable and to be avoided.

In summary, this theoretical dialogue presents the possible outline of a new phase of animal-metacognition research. The target article and the commentaries focused on cognitive process and representation, on detailed cognitive analyses of metacognitive phenomena, and on prescriptions for research that cross-cuts metacognitive cues horizontally and metacognitive levels vertically. We are glad to be working in this intriguing area with our distinguished colleagues Le Pelley, Carruthers, Basile, and Hampton, and we look forward to more opportunities for dialogue in the future. We add that this field is still developing and still open to other colleagues with interest. There is a lot of work to be done.

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