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Where to draw the line on metacognition: A taxonomy of metacognitive cues

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### Abstract

This response to commentaries describes four kinds of cues that could guide metacognitive judgments. The cues are classified based on two factors: whether they are direct assessments of the information being judged (direct) or involve drawing inferences from other information (inferential), and whether they are observable to outsiders (public) or not (private). There is a consensus that using private-direct cues requires metacognition and public-direct cues does not. I argue that private-inferential cues like familiarity qualify as metacognitive because they are internal cognitive states, but public-inferential cues like reaction time do not qualify because they are behaviors, not cognitions. Contemplating this framework can inspire a healthy skepticism about what it is, exactly, that makes metacognition different from other situations in which animals respond based on complex cues.

Where to draw the line on metacognition: A taxonomy of metacognitive cues

Judgments do not generally occur unprompted. They are elicited by cues, and metacognitive judgments are no exception. It is important to understand these cues because whether or not a response qualifies as metacognitive depends, at least in part, on what kind of cue elicited it.

In the target article I distinguished between two types of metacognitive cues: direct access cues and inferential cues. The commentaries revealed that a more fine-grained taxonomy of cues might be useful. In this article I describe four types of cues that guide metacognitive judgments. This new taxonomy maintains the direct-versus-inferential distinction but also includes a distinction between private cues, which are observable only by the organism making the judgment, and public cues, which can be observed by outsiders as well (see Table 1).

Two of the cue-types in Table 1 are non-controversial: Private-direct cues entail metacognition and public-direct cues do not. When drawing a line on metacognition, the difficult question is, does either type of inferential cue qualify as metacognitive? I discuss this question next.

### **Do judgments based on private-inferential cues qualify as metacognitive?**

A sense of familiarity with a stimulus is a private-inferential cue for three reasons: It is an internal, private state; it is a cognitive cue (i.e., it is the outcome of a cognitive process), and it is inferential in the sense that it is not direct in the way recognition memory strength would be. If metacognition is defined as monitoring internal cognitive states, then responding based on a sense of familiarity seems to qualify as metacognitive.

Non-cognitive internal cues, such as hunger, can also guide behavior and judgments (Bolles & Petrinovich, 1954). These cues do not seem to qualify as metacognitive because they are not cognitive cues. Whether “meta-emotional” judgments, for lack of a better term—for example, judgments that are made based on how frightened, hungry, angry, or excited an animal finds itself to be—deserve the same special status that metacognitive judgments currently enjoy is a question worth asking (but not one that I will attempt to answer here).

Beran and Smith (2014) rightly point out that it is important to interpret findings skeptically, and to be proud of “the 100-year-old burden (or gift!) of a deeply conservative interpretative stance toward animal behavior.” At first blush, the most conservative way of defining metacognition would seem to be to decide that private-inferential cues do not qualify. But it is one thing to be vigilant about looking for external cues that might be guiding behavior; it is another to allow for the possibility that barring external cues, internal cognitive states must be the guides. These two views are not incompatible. Thus, on further examination, perhaps a conservative interpretation of behavior allows for private-inferential cues to be defined as metacognitive.

Moreover, as Beran and Smith point out, it is important to take cognitive mechanisms seriously, and investigate metacognitive cues, when examining metacognition. Smith, Coutinho, Church, and Beran (2013) examined the effect of a concurrent working memory load on metacognitive performance. They found that increasing load affected metacognitive judgments more than it affected a functionally similar response pattern, suggesting that cognitive theories of executive function might be important in understanding animal metacognition.

In short, I would argue that making a judgment based on private-inferential cues qualifies as metacognitive for two reasons. First, doing so involves monitoring internal cognitive states. Second, it is not clear that private-direct cues like memory strength, which everyone considers metacognitive, deserve a special status compared to private-inferential cues.

### **Do judgments based on public-inferential cues qualify as metacognitive?**

Relatively difficult trials tend to elicit both long response times and uncertainty. Is one's own reaction time in responding to a prompt a valid metacognitive cue? Before addressing this question, there is a larger one: Is it important to distinguish between public and private cues? I would argue that it is not. From the organism's perspective, public and private cues are both observable. Distinguishing between them just because of what outsiders can see seems arbitrary. It focuses on the researcher's perspective rather than the perspective of the organism making the judgment. Thus, being public should not disqualify a cue from being metacognitive (see Hampton, 2005; 2009).

Even if being public is not a disqualifier, however, public-inferential cues might not be metacognitive because, by and large, they are not cognitive cues. In his commentary, Crystal (2014) suggests that reaction time is not a valid metacognitive cue. This is a reasonable position given that reaction time is not necessarily a cognitive state. The same is true of other public-inferential cues. For example, an animal could "notice" that it is going back and forth between two potential response options—wavering—and use this behavior as cue that it should choose an uncertain response. Like reaction time, wavering is not necessarily a cognitive cue. (It might be tempting to consider the uncertainty that led to the wavering as the metacognitive cue, but from the perspective of

the taxonomy provided in this article, uncertainty is not a cue, it arises in response to prior cues.)

In short, public-inferential cues do not seem to qualify as metacognitive. It is not being public that disqualifies them, it is the fact that they are behaviors, not cognitions, and metacognition should involve monitoring cognitions. A cognitive process underlies reaction time, perhaps, and monitoring that process would be metacognitive. But a skeptic would be right to say that an animal has not shown conclusive evidence of metacognition if it might be responding based on reaction time (the target article points out that in human-metacognition research this skepticism neither appropriate or common).

### **Drawing the line**

In the title of his article Crystal (2014) asks “where is the skepticism in animal metacognition?” He highlights Le Pelley’s (2012) reinforcement-learning model of metacognition as an example of well-placed skepticism. In terms of the current framework, his argument is that the field should be vigilant about the influence of public cues—that is, cues that are observable to outsiders. Being public allows cues to be inputs into a model such as Le Pelley’s (2012). This kind of skepticism is valuable (although as I have argued, I do not believe that it is their public-ness that makes public cues problematic). But vigilance about public cues can easily coexist with a belief that private-inferential (and obviously private-direct) cues should be considered metacognitive.

In the target article I asked whether inferential cues should be considered metacognitive. The new taxonomy proposed here further divides inferential cues into two types: public-inferential and private-inferential cues. The question remains, should these

cues be considered metacognitive? Crystal (2014) thinks not. “Because the metacognitive status of certainty judgments in animals is at the center of the dispute in the field, demonstrations of the inferential view would not provide evidence that putative metacognitive cues are indeed based on metacognition.” In other words, inferential judgments are not metacognitive. This is a perfectly reasonable way to define metacognition, especially because reaction time, which Crystal objects to, is an inferential cue based on the definition of inferential cues from the target article. The value of the new taxonomy presented in this article is that it asks a more refined question: should private-inferential cues be considered metacognitive, as I have argued, even though they are inferential?

Crystal (2014) also argues that quantitative models of metacognition will advance the field. Hoffman and Schwartz (2014), by contrast, make the insightful point that the field could also benefit from using more ecologically valid methods. These two suggestions point in opposite directions, because ecological approaches often lead to messier data and less control over the inputs that would need to be modeled. But there is room in the literature for both approaches.

### **Concluding comment**

The taxonomy presented here divides the cues that guide metacognition into four types. Two of these cue-types (the direct cues) are non-controversial. I have argued that private-inferential cues—which are internal cognitive states—qualify as metacognitive, whereas public-inferential cues are not metacognitive if only because they are not traditionally considered cognitive.

Being vigilant about the role public cues play in guiding ostensibly metacognitive judgments is healthy kind of skepticism. Contemplating the framework presented here can produce a deeper level of healthy skepticism though: Even in a best-case scenario, when metacognitive responses are made based on private, internal cognitive cues, how special is that, really? Is a judgment based on an internal cognitive cue more impressive than a judgment based on an internal non-cognitive cue like hunger? Is it more impressive than a judgment based on a complex, difficult to understand external cue? Metacognition may be like a Monet—it looks transcendent from afar, but if you look closely it can become almost ordinary.

## References

- Beran, M. J., & Smith, J. D. (2014). The uncertainty response in animal-metacognition researchers. *Journal of Comparative Psychology*.
- Bolles, R., & Petrinovich, L. (1954). A technique for obtaining rapid drive discrimination in the rat. *Journal of Comparative and Physiological Psychology*, 47(5), 378–380.  
doi:10.1037/h0060058
- Crystal, J. D. (2014). Where is the skepticism in animal metacognition? *Journal of Comparative Psychology*.
- Hampton, R. R. (2005). Can Rhesus monkeys discriminate between remembering and forgetting? In H. S. Terrace & J. Metcalfe (Eds.), *The missing link in cognition: Origins of self-reflective consciousness* (pp. 272-295). New York: Oxford.
- Hampton, R. R. (2009). Multiple demonstrations of metacognition in nonhumans: Converging evidence or multiple mechanisms? *Comparative cognition & behavior reviews*, 4, 17–28.
- Hoffman, M. L., & Schwartz, B. L. (2014). Metacognition does not imply self-reflection, but it does imply function. *Journal of Comparative Psychology*.
- Kornell, N. (2014). Where is the “meta” in animal metacognition? *Journal of Comparative Psychology*.
- Le Pelley, M. E. (2012). Metacognitive monkeys or associative animals? Simple reinforcement learning explains uncertainty in nonhuman animals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 38(3), 686–708.  
doi:10.1037/a0026478

Smith, J. D., Coutinho, M. V. C., Church, B., & Beran, M. J. (2013). Executive-attentional uncertainty responses by rhesus monkeys (*Macaca mulatta*). *Journal of Experimental Psychology: General*, *142*, 458-475.

Table 1

*Four kinds of metacognitive cue*

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**Public cues**

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A public-direct cue is an external stimulus that directly influences certainty judgments.

For example, if an animal indicated that she was highly certain any time a photograph contained mostly red, her certainty judgments would be controlled by color, an external cue. (It is important to distinguish direct relationships like this one from indirect relationships, for example when the red in a particular stimulus makes it seem familiar.) There is wide agreement that public-direct cues do not qualify as metacognitive.

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A public-inferential cue is observable to an outsider but it is not a property of the stimulus being judged. It is a behavior. If an animal's certainty judgments were controlled by its own reaction time, then reaction would be a public-inferential cue.

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**Private cues**

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A private-direct cue is the central topic of a metacognitive judgment. For example, it would be the actual strength of the memory elicited when a stimulus is presented. The consensus is that this type of cue does qualify as metacognitive. Ample research suggests, however, that humans do not (and possibly cannot) access this type of cue when making judgments, and the same is likely true of other animals (see target article).

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A private-inferential cue is not the central topic of the judgment and it is not visible to an outsider. For example, the ease with which information comes to mind, or the sense of familiarity of a picture, are cues that outsiders cannot observe that could control

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certainty judgments. Unlike private-direct cues, it is possible for these cues to produce judgments of high certainty even when actual response accuracy is low.

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