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OUTLOOK

Baboon pragmatics: Meta-cognition, meta-communication or something else?

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Summary

Reboul et al. (2022) show that baboons responded faster and more accurately when signs were most informative (i.e., predictive of reward). Because the study did not allow monkeys to directly evaluate a sign's informativeness independently of reward or processing demands, we cannot be certain that the monkeys' responses were primarily guided by meta-cognitive judgments of uncertainty, meta-communicative evaluations of a sign's informativeness, or something else entirely, such as general processing demands.

Any animal that depends on signals emitted by others to find a mate or food or secure shelter, must be sensitive to the informativeness of those signals (i.e., predictive of reward/loss) or the individual emitting them. In fact, the evolution of signs in the living world often reflects an arms race between signalers who want to manipulate or seduce others and receivers who must possess tools to resist being influenced in a manner that diminishes their fitness (Hauser, 1996). The question is whether animals in these circumstances have access to those tools driving their responses to signals. That is, whether they have access to the meaning of signs in their communicative system.[1]

In *Baboon Metaphysics*, Cheney and Seyfarth (2007) provide some examples of baboons in the wild reacting differently to the *same* sign – say a bark – directed toward a low-ranking individual (expected) versus a high-ranking individual (unexpected). These responses suggest that baboons are sensitive to a signs' informativeness vis-à-vis its source. Reboul et al. (2022) build on this line of research and explore whether captive baboons in controlled situations evidence a meta-communicative understanding of a signs' meaningfulness.

[1] That's not to say that all signs can be directly accessed. Humans respond adaptively to many signs of varying informativeness (e.g., olfactory; pheromones) in noisy environments (e.g., perfumes) without any metacommunicative access to them.

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In the first study, baboons were presented with a cue (e.g., circle) that was immediately followed by a choice between, say, a sign matching the cue (i.e., circle) and four squares (i.e., distractors). When the target sign was pressed, baboons received a reward. But, sometimes, there were multiple signs (i.e., duplicate circles) among the distractors, only one of which produced a reward. So, the *more* duplicate signs there were, the *less* informative (or predictive) of reward the sign became. In situations with multiple duplicates, baboons could take a chance and gamble on which of the signs was likely to produce a reward. Alternatively, they could wait (1,000, 1,500, or 2,000 ms) for another cue (i.e., a change of color) that indexed which sign was *the* target sign. When there was just one sign and several distractors, there was no need to wait. Likewise, when there were two signs, the odds of success were fair (1/2 or 50%). However, when there were three (1/3 or 33%) or four duplicate signs (1/4 or 25%) the likelihood of a successful gamble dropped significantly. In these latter situations, one is better off waiting. Baboons performed as expected. They were less likely to gamble – regardless of wait time – when there were three and four duplicate signs relative to conditions with one or no duplicates. Their choice to gamble (and not wait for the indexing cue) corresponded with accuracy, a result that suggests that monkeys understood the reward structure of the task. Namely, that more duplicates were less likely to produce rewards (i.e., low informativeness) than few to no duplicates (i.e., high informativeness).

This result raises the following questions: Were these responses guided primarily by the likelihood of reward, a sign's inherent informativeness, or some combination of the two? To address that question, Experiment 2 introduced two

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new signs (Os vs. Ts) and changed the odds of the rewards associated with their informativeness. Specifically, the most informative condition with no duplicate signs (1/1 or 100%) was eliminated while the less certain reward conditions with one or more duplicates (1/2, 1/3, and 1/4) were preserved. If monkeys gambled and touched one of the duplicate signs (in Experiment 2), they received a reward 70% of the time regardless of how many duplicates there were. If they waited (1,000, 1,500, or 2,000 ms) and touched the highlighted sign, they were guaranteed a reward 100% of the time. This procedure effectively incentivized gambling and disincentivized waiting. The main task seems to be to avoid distractors. Results confirmed that monkeys gambled regardless of whether there were two or four duplicate signs; that is, whether the signs' informativeness was high or low. Gambles also increased as delays increased (1,000 < 1,500 < 2,000ms). These results, together with those of Experiment 1, suggest that monkeys (a) track signs' probability for reward, and (b) are sensitive to delays.

Having extinguished different responses based on a sign's informativeness, Experiment 3 sought to restore this response and answer whether monkeys understood that a sign's informativeness can be independent of reward. To answer that question, Reboul et al. (2022) presented monkeys with two new signs and reintroduced the most informative conditions with no duplicate signs (1/1) along with the less informative conditions with two (1/2), three (1/3), and four (1/4) duplication signs. As in Experiment 2, monkeys did not wait for the indexing cue and gambled in the less informative conditions, which nevertheless guaranteed a reward 70% of the time. Touching distractors was not rewarded. And, in contrast to the two previous experiments, Experiment 3 used only the longest delay period (2,000 ms) in an attempt to increase the association between waiting and the likelihood of success. This manipulation sought to incentivize waiting.

Despite these changes, baboons performed much like they did in Experiment 2. They consistently gambled regardless of the informativeness of the sign. One explanation for this null result is that the incentives for gambling versus waiting were not sufficiently different (70% vs. 100%). In other words, the costs associated with waiting may have been perceived to be greater than not getting a reward following a response. Might a more variable reward structure that ranged randomly between 25% and 50% across the less informative conditions have produced a different result?

What about the reaction time (RT) data? Across all studies RTs increased with decreasing informativeness. As the authors point out, this cannot be explained by tracking reward odds. Recall that in Experiments 2 and 3, informativeness and the likelihood of reward were equalized. This result is significant because RT or waiting are often treated as proxies for "uncertainty" or as requests for additional information. But in Reboul et al. (2022) informativeness was inversely related to the number of signs duplicated. As such, there is no way of knowing whether the longer RTs were controlled by an evaluation of the sign's informativeness or because there were more signs to visually process in the less informative conditions.

Besides decoupling processing demands from judgements of informativeness, future studies might want to adopt a "functional approach" (Hampton et al., 2020) when studying metacommunication in animals and answer the following question: *What can an organism with access to a sign's meaning do relative to one without such access?* As is common in meta-memory research, attempts to answer this question with non-human subjects could involve opportunities to request more information or skip ambiguous trials based on a sign's varying levels of informativeness.

One possible method that might resolve some of these challenges has been pioneered by Basile et al. (2015). What if the central – cueing image – in Experiment 6 was replaced with an indexical sign (arrow, pointed finger, or out-stretched hand) that points to an object associated with a reward later in the trial? This index is most informative when it points directly toward an object and least informative when it points between objects. The size, length, or movement of the arrow can be varied, as can the number of targets, to control for informativeness and processing demands. In these ambiguous situations, would monkeys skip ambiguous trials, request to see the index again, or manipulate the sign to make it more informative (e.g., stop movement or add movement) before proceeding to the test? One might expect a meta-communicative monkey not only to request to see the sign in the most ambiguous situations, but to spend more time studying or manipulating it before taking the test.

In sum, the work by Reboul et al. (2022) point to an exciting avenue of research, one that I hope will inspire more research on the topic. Given the success of metacognition research, applying similar methods to the study of meta-communication might result in equally important insights. Until then, all we can say from the results of Reboul and colleagues is that baboons – like other animals – respond adaptively to a sign's informativeness. But it's unclear if they know why.

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

Cheney, D. L., & Seyfarth, R. M. (2007). *Baboon metaphysics: the evolution of a social mind*. University of Chicago Press.

Hampton, R. R., Engelberg, J. W. M., & Brady, R. J. (2020). Explicit memory and cognition in monkeys. *Neuropsychologia, 138*, 107326. https://doi.org/10.1016/j.neuropsychologia.2019.107326

Hauser, M. D. (1996). *The evolution of communication*. MIT Press.

Reboul, A., Mascaro, O., Claidiere, N., & Fagot, J. (2022). Are monkeys sensitive to informativeness: An experimental study with baboons (Papio papio). *PLoS One, 17*(7), e0270502. https://doi.org/10.1371/journal.pone.0270502