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The Curious Incident of the Capuchins

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In the mystery *Silver Blaze*, Sherlock Holmes draws the detective's attention to the curious incident of the dog in the night-time. The detective reminds him that the dog did nothing in the night-time. Holmes replies: That was the curious incident. The incident is an important clue to the mystery's solution.

We draw everyone's attention to the curious incident of the capuchins. Beran et al. (in press) compared capuchins' ability to make a perceptual response to middle stimuli and an uncertainty response to difficult stimuli. Capuchins completed a Sparse-Uncertain-Dense (SUD) task in which any trials of the monkeys' choosing could be declined through an uncertainty response. The uncertainty response let them avoid difficult trials, avoid associated error timeouts, and greatly increase their reward efficiency. They also completed a Sparse-Middle-Dense (SMD) task in which correctly made middle responses to middle stimuli were rewarded. Capuchins used the middle response easily (Figure 1A) but not the uncertainty response (Figure 1B—see also Figure 6, Smith et al., present volume).

That the capuchins showed almost no uncertainty responding in the SUD task yet used the middle response so perfectly in the SMD task is an important clue in developing a psychological theory of animals' uncertainty responding. It points this new field toward the theoretical developments that will make its next phase rich and scientifically productive. This is why.

You can't explain the Middle-Uncertain dissociation by claiming that animals emit the behavior that is associated with the higher payoff. Then, capuchins would certainly have responded Uncertain for difficult stimuli so as to avoid timeouts.

You also can't explain it by having animals respond to minimize the average delay to reinforcement. That delay would have been sharply reduced by adaptively responding Uncertain on difficult trials to avoid the frequent timeouts.

You can't explain it using some overall-reinforcement-rate explanation. Capuchins lost thousands of seconds of time-on-task through penalty timeouts by not responding Uncer-

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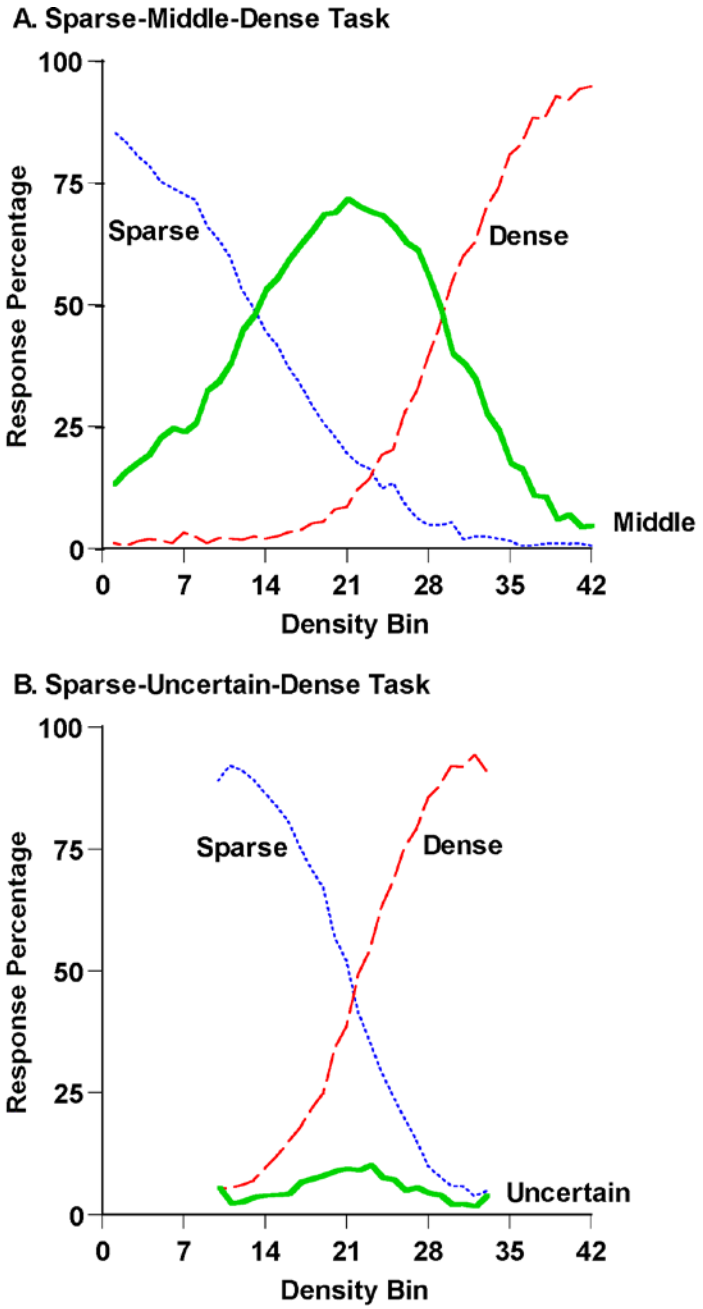

Figure 1. *Mean percentage of sparse responses (blue dotted line), dense responses (red dashed line), and uncertainty or middle responses (green solid line) by capuchin monkeys (Cebus apella) in Beran et al.'s Sparse-Middle-Dense task (A) and Sparse-Uncertain-Dense task (B). The results shown are from Beran et al.'s Experiment 2. The similar results from Beran et al.'s Experiment 1 were shown in Smith et al. (present volume, Figure 6). From "The Psychological Organization of 'Uncertainty' Responses and 'Middle' Responses: A Dissociation in Capuchin Monkeys (Cebus apella)," by M. J. Beran, J. D. Smith, M. V. C. Coutinho, J. J. Couchman, and J. B. Boomer, 2009, Journal of Experimental Psychology: Animal Behavior Processes, in press. Copyright 2009 by the American Psychological Association. Reprinted with permission.*

tain. Indeed, their potential gain from responding Uncertain was greater than their potential gain from responding Middle in the final experiment in Beran et al. (in press).

In fact, you can't explain it using any behavioral economics model. A mathematical model has no way to explain the profound psychological difference between the Middle and Uncertain tasks. Even if very different settings of response-strength, sensitivity, and risk-tolerance parameters could cause the model to fit the data from the SUD and SMD tasks, this would leave unanswered the psychological reason why animals entered a radically different place in parameter space in performing the two tasks. It is important to realize that the mathematics in formal models are psychologically empty and indeterminate.

You can't explain the dissociation using a stimulus-response or response-strength mechanism. The response tendencies for Sparse and Dense would weaken identically going to the middle of the stimulus continuum, so that Middle and Uncertain responses would both have the greater/winning response strength for those middle/uncertain trials.

You can't explain it using an environment-cue interpretation. The cue environments for the two tasks were essentially identical, with exactly the same stimuli and subjective stimulus impressions ideally occasioning the two responses.

You can't explain it with a behavioral-cue interpretation or a response-competition interpretation. The Sparse-Dense conflict/competition would have been identical in the two cases, with the third responses equivalently available as default, avoidance responses.

You can't explain it by claiming that animals carry from task to task an inertial bias to move the joystick down (Crystal & Foote, present volume). That would have led to the same data pattern across tasks, not a qualitative difference, because the middle and uncertainty responses were made in the identical manner. In our view, based on many collective years working with nonhuman primates, this inertial-bias claim carries no weight in any case. This is not what monkeys or apes do, any more than human subjects have a left-response bias in an experiment because they turned left into the parking lot of the psychology building and left off the elevator to come to your office.

Thus, the curious incident of the capuchins is constructive in forcing the field beyond its emphasis on stimuli, reinforcement, conditioning processes, and response-strength gradients. If any of these sufficiently produced the uncertainty data pattern, capuchins would have shown it, because there simply is no way in which the poor-person's chimpanzee is associatively challenged, and because the SUD and SMD tasks were essentially controls for one another.

Then how should we explain the dissociation? Probably capuchins used the Middle response appropriately because it is a perceptual response to a discrete stimulus class—just as the Sparse and Dense responses are. Probably capuchins did not use the Uncertain response because it is not grounded in a discrete stimulus class, because it is not like the Sparse and Dense responses, because it is structurally a second-order response about the judged failure of the primary Sparse-Dense discrimination. One already sees this qualitative task difference empirically in the Middle-Uncertain dissociation. Its explanation lies in the psychological difference between the tasks.

Recent research with macaques reinforces the idea that the uncertainty response plays a distinctive role in psychophysical tasks and deserves a distinctive psychological interpretation. Macaques do not need trial-by-trial reinforcement to make adaptive uncertainty responses (Couchman et al., submitted; Smith et al., 2006) because uncertainty responses are decisional processes that are not dependent on reinforcement history and conditioning feedback. Macaques do not need their uncertainty responses to bring any immediate, tangible reward (Beran et al., 2006, Smith et al., 2006) because uncertainty—definitionally and psychologically—is not a reactive, reward-based phenomenon. Macaques spontaneously respond Uncertain on Trial 1 of new discriminations, but then not on Trial 2 after grasping the discrimination's basis (Washburn et al., 2006). This result highlights the agility and flexibility of uncertainty responses that conditioned responses would never show. Finally, macaques respond uncertain adaptively when facing abstract memory and relational-judgment problems (Hampton, 2001; Kornell et all, 2005; Shields et al., 1997; Smith et al 1998). One sees from this that macaques can make difficulty assessments even about abstract and derived mental representations.

Even the species difference between capuchins and macaques reinforces the distinctive psychological interpretation that uncertainty responses deserve. Hampton (present volume) noted that capuchins seem to be on the outside looking in with regard to tests of animal metacognition (Basile et al., 2009; Call & Carpenter, 2001; Hampton et al., 2004). Despite being equal to or better than macaques at many tasks that allow for associative, learned response patterns, they seem unable to match the macaque in this domain. The obvious implication of these results is that uncertainty responding is not associative, or else the capuchins would show it. This is also the implication from the dissociation shown in Beran et al. (in press).

Thus, many lines of evidence recommend focused research to understand the distinctive psychological role of the uncertainty response in discrimination tasks. In a sense, this was also the recommendation of Josefowiez, Staddon, and Cerutti (present volume) who pointed out that the field could worry less about what is (not) metacognition and focus instead on the processes and representations that allow animals to respond adaptively to uncertainty in the referent tasks.

Their suggestion is important, timely, and paradigm shifting. This approach means letting go the grip of formal mathematics. The mathematics is psychologically silent, and it can block one from thinking psychologically about uncertain situations. It means letting go the grip of stimulus/reinforcement, which are not applicable to recent uncertainty-monitoring findings and which do not explain task and species dissociations. It means focusing on uncertainty monitoring as a controlled process (Shiffrin & Schneider, 1977), an executive process, perhaps a conscious process. If we find the most illuminating psychological level of analysis, there will be many intriguing theoretical questions to consider. In our view, this is the pathway to the strongest theoretical advancement in this area, even though it means that we all will have to wrestle with our higher (cognitive) angels. We are optimistic about continued theoretical progress in this field, given the sharp interest in it and given the insightful comparative scientists exploring it whose work and contributions we admire and respect.

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