Information seeking in rhesus macaques

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Abstract This experiment asked two questions: Can monkeys evaluate their uncertainty in a memory task, and will they request more information when they are uncertain? Two rhesus macaques were trained in a simultaneous chaining task to touch four arbitrarily selected photographs in a fixed order. The task was modified so that if a subject didn't remember the correct order, he could request a "hint" in the form of a flashing border that appeared surrounding the correct item. The hint was available for every item in the sequence. Subjects requested the hint mainly when their accuracy would have been relatively poor without it. This shows that monkeys will seek information when they are uncertain about their memories, an ability similar to metacognitive control in humans.

Introduction Monkeys are able to estimate uncertainty, and escape difficult trials (Hampton, 2001; Shields, Smith, & Washburn, 1997; Smith, Shields, Washburn, & Allendoerfer, 1998). They can also accurately report retrospective confidence judgments, in perceptual as well as memory tasks (Son, Kornell, & Terrace, 2003). These tasks require *metacognition,* the ability to monitor and make judgments about the accuracy of one's memory.

Using a different paradigm, Call (2002) showed that apes will seek more information when they are uncertain how to respond. When food is placed where they can reach it but not see it, they will reach without looking if they saw where the food was placed, but look for it first if they did not.

Here, we asked whether monkeys will seek information when they are uncertain, by giving them the option of requesting hints in a simultaneous chaining task. We predicted that they would take hints on trials on which they did not know the correct response.

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Method

The **subjects** were two male rhesus macaque monkeys, Macduff and Oberon.

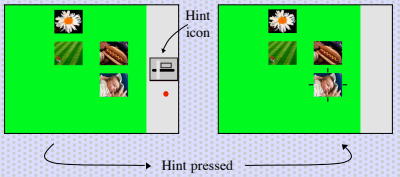
The ***task*** was a modified simultaneous chain on which subjects could obtain hints (see next 3 panels).

Taking hints had a cost: The ***reward*** for trials completed without hints was a mini-M&M; with one or more hints, it was a 190 mg food pellet. A red dot signified that the M&M was available.

Simultaneous chaining To be reinforced, the monkeys had to press four pictures in a fixed order.

No-hint trials On 50% of the trials, the hint was not available.

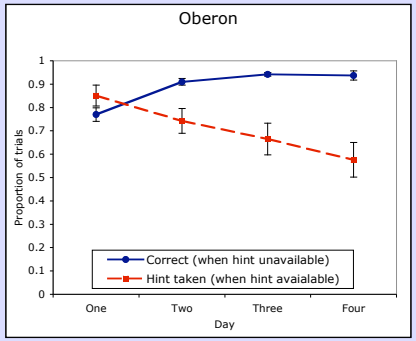
Hint trials On 50% of the trials the hint was available for any or all of the 4 responses.
When the hint icon was pressed, flashing borders appeared around the correct item.

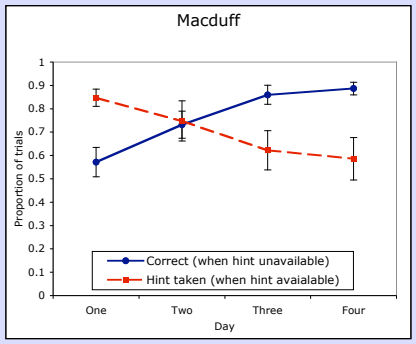


Results

1. Effects of Learning Across Days

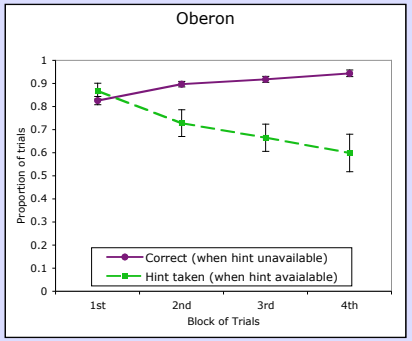
Each list was tested for 4 days. As these figures show, hint taking decreased as accuracy increased across days.

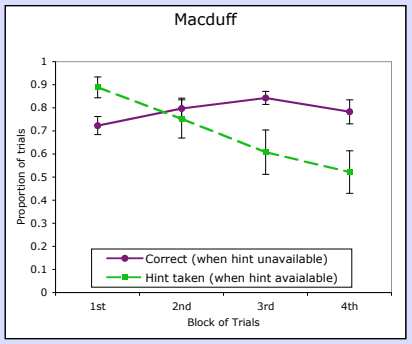




2. Effects of Learning Within Days

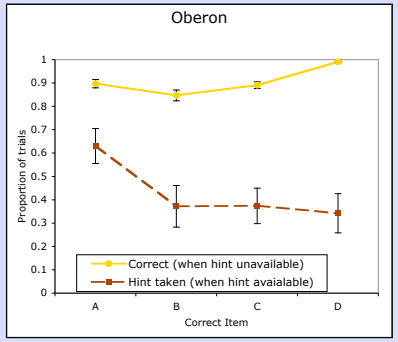
Sessions were divided into 1st, 2nd, 3rd, and 4th quarters. As these figures show, hint taking decreased as accuracy increased within sessions.

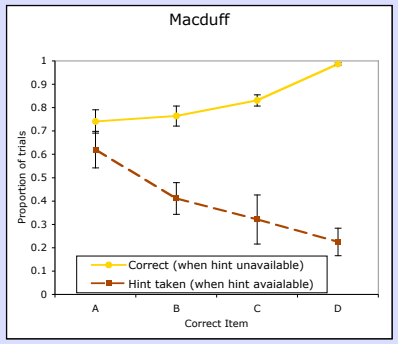




3. Effects of List Item

There were 4 list items, A, B, C, D. As these figures show, hint taking decreased as accuracy increased for successive items.





Results summary Accuracy and hint taking were inversely related. Hint taking decreased as the monkeys learned a list across sessions (Panel 1), and within sessions (Panel 2). Hint taking was also lower for list items the monkeys knew better (Panel 3). The analyses are based on 11 lists for Macduff and 12 lists for Oberon.

Conclusions In this experiment, monkeys sought information in the form of "hints." They did so mainly when their chances of making a correct response without a hint were relatively low. The monkeys seem to have responded to the hint based on their level of certainty about their memories, similar to a human confidence judgment. We therefore consider this a demonstration of metacognitive abilities in monkeys.

Accurate metacognition did not lead directly to more reward in this experiment; instead, it allowed the monkeys to help themselves to answer correctly. More than any previous experiment, this seems to us similar to metacognitive control in humans, the ability to control one's own future behavior (i.e., answer correctly) based on metacognition (i.e., hint taking).

References

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