Cogitating monkeys can calculate statistics

Rhesus monkeys turn out to be pretty good statisticians, a study reveals.

They can accurately assess which of two behaviours is more likely to bring them a reward by summing together a series of probabilistic clues. And their reasoning is reflected in the firing rate of individual neurons in their brain.

Tianming Yang and Michael Shadlen at the Howard Hughes Medical Institute and the University of Washington in Seattle, US, tested the reasoning of two rhesus macaques by showing them a series of abstract shapes on a video screen.

Each shape corresponded to a different probability that a drink reward would be associated with a red instead of a green target.

In each trial, the monkey saw a sequence of 4 of 10 possible shapes then, had to choose which target to look at. The probability that the red target would give the reward was the sum of the probabilities for each of the four shapes; otherwise, the green target yielded the drink.

High-risk project

After several weeks of training on thousands of trials per day - clearly, the monkeys are no Einsteins - both macaques learned to match their choices closely to the actual probabilities revealed by the shapes they saw, choosing the correct target more than 75% of the time.

This is the first time monkeys have been shown to make such subtle probabilistic inferences.

"When we started this, we thought it was a high-risk project," says Shadlen. "When we had monkeys doing it, I was pretty shocked."

Computing neurons

The researchers also used electrodes in the brain to record the activity of 64 neurons in the lateral intraparietal area - a region on the side of the brain that is involved in attention and visual processing.

They found that the neurons responded to the first shape by firing at a rate proportional to the probability suggested by that shape. As each successive shape was shown, the firing rate changed to match the probability determined by all the shapes seen so far.

"We're seeing neurons that are making computations," says Shadlen. In particular, the neurons appeared to be computing the log likelihood ratio of red versus green rewards - exactly the sort of computation a statistician might do.

"We're exposing the basic elements, the fundamental biology of higher cognition," says Shadlen. Further work should allow the researchers to begin to understand the decision-making process in more detail.

Reference: Nature (DOI: 10.1038/nature05852)
Humble fruit fly can make its own decisions
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Weblinks
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