

## **Monkey Math Machinery is Like Humans'**

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Monkeys have a semantic perception of numbers that is like humans' and which is independent of language, Duke University cognitive neuroscientists have discovered. They said their findings demonstrate that the neural mechanism underlying numerical perception is evolutionarily primitive.

Jessica Cantlon and Elizabeth Brannon described their findings with macaque monkeys in an article published online the week of Oct. 31, 2005, in the Early Edition of the Proceedings of the National Academies of Science. Cantlon is a graduate student and Brannon is an assistant professor in the Department of Psychological and Brain Sciences, as well as a member of the Center for Cognitive Neuroscience.

In their experiments, the researchers sought to test whether monkeys show a phenomenon known as "semantic congruity" when making numerical comparisons.

"When adult humans compare any two things, such as the size of two animals, and they're asked 'which is smaller, an ant or a rat?' one might think it's the same kind of question as 'which is larger, an ant or a rat?'" said Brannon. "But humans are faster at saying an ant is smaller than saying a rat is larger. By contrast, if the two animals are large, such as a cow or an elephant, they're quicker at saying the elephant is larger than saying the cow is smaller. This 'semantic congruity' holds for all kinds of comparisons, including numbers and distances.

"It would seem that this is entirely a linguistic effect, totally dependent



on language," said Brannon. "But we sought to understand whether monkeys showed this semantic effect, even though they don't have language."

In their experiments, Cantlon and Brannon presented monkeys with two arrays of randomized numbers of dots displayed on a computer touch screen at randomized positions. However, instead of using language to instruct the monkeys to "choose larger" or "choose smaller" the researchers made the background blue if the monkeys were to choose the larger number and red if the smaller number. The monkeys were rewarded with a sip of a sweet drink for correct answers.

"Our results showed a very large semantic congruity effect," said Cantlon. "For example, when the number pair was small, such as two versus three, the monkeys were much faster at choosing the smaller compared to the larger of the pair. We were also impressed at the high level of accuracy the monkeys achieved on this difficult conditional discrimination," she said.

"Clearly, even though their capability has nothing to do with language, it is nevertheless semantic in that the red and blue color cues carry meaning for the monkeys," said Cantlon.

Brannon said the new findings represent further evidence of the fundamental similarity in numerical thinking in human and non-human primates.

Said Brannon "This is another piece of the puzzle showing us that the comparison mechanism that the monkeys use is, as far as we can tell, the same mechanism that humans are using." More broadly, she said, the findings yield insight into the role – or lack of a role – that language plays in the process.



"The ability to use language is obviously one of the major differences in the way humans and animals function in the world," she said. "However, these experiments clearly show that this semantic congruity effect, which we thought was language-dependent, is not."

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Source: Duke University

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