Study shows rhesus monkeys able to add numbers together for a reward

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A rhesus macaque monkey chooses between two letters that represent different sized rewards. Credit: Margaret S. Livingstone

(Phys.org) —A team of researchers working at Harvard Medical School has found that it is possible to teach rhesus monkeys to perform simple addition. In their paper published in *Proceedings of the National Academy of Sciences*, the group describes studies they undertook to teach

lab monkeys to add symbols together in order to receive a reward, the results of which have shown that other primates besides humans are capable of performing simple math.

Scientists know that many animals are capable of making numerical estimates—they can tell if they are being invaded by a few predators or many, for example. They also know that some primates have shown a rudimentary ability to add numbers together—to understand that multiple symbols that hold value hold more when combined, for example. In this new effort, the researchers have found that at least one primate—rhesus monkeys—can actually add values together to form a result which can be used for comparison with another value.

To learn about the monkey's math abilities, the researchers taught several of them to memorize values associated with the digits 0-9, along with 16 letters, and then to assign value to each of them (by giving them a treat if the picked the one with higher value). Then, to find out if they could add, the researchers presented two previously associated characters alongside another single one. To receive a treat a monkey had to add the value of the two symbols then compare the result against the value of the single character and then choose which had the greatest value. The researchers report that the monkeys were able to choose correctly approximately 90 percent of the time.

Of course, the team realized the monkeys may have simply memorized the value of all possible pairings, instead of actually adding, so they introduced a whole new set of characters. Once the monkeys had been trained to associate values with them, they immediately, on their own, applied the math skills they had learned on the first experiment, proving that they were in fact adding the values together to reach a sum, which had a value all its own.

A rhesus macaque monkey is about to touch the symbol 8, worth eight drops of reward, rather than 4, worth four drops of reward. Credit: Margaret S. Livingstone

The researchers noted that that the monkeys did less well when the values of two symbols were closer together, suggesting that at least part of their math skills were based on making estimates—a finding that could prove useful to researchers looking to understand how it is we humans are able to make mathematical calculations.

More information: Symbol addition by monkeys provides evidence for normalized quantity coding, Margaret S. Livingstone, *PNAS*, 2014. DOI: 10.1073/pnas.1404208111

Abstract

Weber's law can be explained either by a compressive scaling of sensory response with stimulus magnitude or by a proportional scaling of response variability. These two mechanisms can be distinguished by asking how quantities are added or subtracted. We trained Rhesus monkeys to associate 26 distinct symbols with 0–25 drops of reward, and then tested how they combine, or add, symbolically represented reward magnitude. We found that they could combine symbolically represented magnitudes, and they transferred this ability to a novel symbol set, indicating that they were performing a calculation, not just memorizing the value of each combination. The way they combined pairs of symbols indicated neither a linear nor a compressed scale, but rather a dynamically shifting, relative scaling.