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Humans have innate grasp of probability

Study of indigenous Maya people finds probabilistic reasoning does not depend on formal education.

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A Q'eqchi' Maya woman from San Pedro, Guatemala, with her grandchild.

People overrate the chances of dying in a plane crash and guess incorrectly at the odds that a coin toss will yield 'heads' after a string of several 'tails'. Yet humans have an innate sense of chance, a study of indigenous Maya people suggests. Adults in Guatemala who have never learned a formal number system or a written language did as well as formally educated adults and children at estimating the probability of chance events¹, the researchers found.

Children are born with a sense of number, and the roots of our mathematical abilities seem to exist in monkeys, chickens and even salamanders. But evidence has suggested that the ability to assess the chances of a future event is not as innate.

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In a 1972 study, Daniel Kahneman, a psychologist at Princeton University in New Jersey, and the late psychologist Amos Tversky found that educated adults incorrectly judged the sequence of coin tosses 'heads-heads-heads-tails-tails-tails' as less probable than 'heads-tails-heads-tails-tails-heads'². (Any such sequence has the same exact probability, 1/64, of occurring.) Other researchers have pointed to the fact that the mathematics of probability were not worked out until the seventeenth century to argue that probabilistic reasoning is not innate and relies on formal education.

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More recent research has pointed to a primitive sense of probability. In a study published in December 2013 and titled "Apes are intuitive statisticians", researchers found that chimpanzees, gorillas and other great apes made decisions on the basis of the chances of receiving a preferred treat such as a banana over a less-coveted carrot³.

Vittorio Girotto, a cognitive scientist at the University IUAV of Venice, Italy, and his colleagues have found in past work that young children have some grasp of probability, albeit with limits⁴. For instance, 12-month-old babies shown three yellow balls and one blue ball being put into a container expressed surprise when a blue ball emerged. Yet 3- and 4-year-olds answer at random when asked which colour will be pulled from the container, and older children who passed that task struggled at more complicated tests of probabilistic reasoning.

Running the numbers

To further probe humans' innate sense of probability, Girotto's IUAV colleague Laura Fontanari travelled to rural Guatemala to work with adults from the indigenous Kaqchikel and K'iche people who had not been formally educated in language or maths. In a series of tests of probabilistic reasoning, the adults performed just as well as Maya schoolchildren and Italian adults.

The tests involved picking the colour of a chip drawn at random from a pool of several. If the pool contained three blue chips and one yellow chip, for example, most of participants guessed that the chip chosen at random would be blue.

The Maya adults also updated their predictions with new information. In a test in which a pot contained four square-shaped chips (all of them red) and four circular chips (one red, three green), they determined that a red chip of any shape was most likely to be drawn. But when the researchers told them that a circular chip would be drawn, the volunteers updated their decisions and picked green.

In a third test, participants were shown a collection of differently-coloured tokens and asked to bet on whether two tokens chosen at random would be the same colour. Schoolchildren under 6 tend struggle with such combinatorial probabilities. But Mayan adults and 9-year-olds and Italian adults all performed better than chance. The results were published on 3 November in *Proceedings of the National Academy of*

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Giroto says that people's problems estimating probabilities may have to do with how uncertainty is expressed. Tasks that people struggle with, such as those presented by Kahneman and Tversky, often involved reading about percentages, while Giroto's tests were visual.

"Eventually we will have a map of boundaries between the tasks that untrained people or other animals can perform and those they fail," says Kahneman. "The present study is very useful in allowing us to colour one segment of that large map — but we should not draw overly general conclusions from it."

Giroto also distinguishes between innate ability and advanced understanding. "The fact that we discovered this intuition in infants and in preliterate adults does not mean that this form of reasoning is flawless," he says.

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References

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