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Ability to estimate quantity increases in first 30 years of life

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One of the basic elements of cognition—the ability to estimate quantities—grows more precise across the first 30 years or more of a person's life, according to researchers supported by the National Institutes of Health.

This intuitive grasp of numbers, also called an approximate number sense, or ANS, is tied to concrete math skills at every stage of life, the researchers found.

Previously, the researchers have reported that ninth graders with a math disability were more likely to have an imprecise number sense. They also have found a correlation between an inherent grasp of quantity and such basic number skills as counting among children as young as 3 years old.

The new finding that the ANS grows sharper from birth through a person's childhood, teens, and twenties also suggests the possibility that environmental factors, such as education, may influence the strength of the ANS and that education could help improve it. Because ANS proficiency is linked to math ability, instruction to improve the ANS might be used to prevent the development of math learning disability or help remediate this disability, the researchers said.

"People who struggle with a math learning disability may also struggle with day-to-day tasks such as estimating a bill or judging calories as part of a diet," said Kathy Mann Koepke, Ph.D., of the Child Development and Behavior Branch of the Eunice Kennedy Shriver National Institute

of Child Health and Human Development (NICHD), the NIH institute that supported the study. "Research shows that differences in math ability in school can have a large impact on later health, as well as income, over a lifetime."

First author Justin Halberda, Ph.D., of Johns Hopkins University, Baltimore, conducted the research with Hopkins colleagues Ryan Ly and Daniel Q. Naiman, Ph.D., Jeremy B. Wilmer, Ph.D., of Wellesley College in Wellesley, Mass., and Laura Germine, Ph.D., of Harvard University, Cambridge, Mass.

Their findings were published online in the *Proceedings of the National Academy of Sciences.*

People use an intuitive number sense to estimate and compare quantities in everyday life as well as in the classroom. For example, people use this sense when judging which line to enter at the grocery story. In human beings, this sense is present from birth. Studies have shown that many animals also have an innate ability to estimate quantities.

To collect information about the functioning of the ANS, the researchers posted a 10-minute test on their website, www.panamath.org. During the testing, visitors to the site were shown varying quantities of blue and yellow dots and each time were asked to estimate whether they saw more blue or more yellow dots.

Each person also filled out a brief questionnaire answering questions about his or her own mathematical ability, performance in science and language classes, and level of computer skill. More than 10,000 people from around the world took the test and the researchers catalogued their scores by age.

The study authors noted that recruiting study volunteers on the Web

allowed them to recruit a larger and more diverse group of participants than would have been possible in a conventional laboratory setting. They cited several studies which compared Web based sampling to a number of different types of other study sampling methods and found comparable results.

The researchers found a pattern showing that, for people 15 to 30 years of age, older persons typically had better ANS ability, suggesting that ANS improves over time with development and/or experience, up until about 30 years of age. However, a greater number of participants over the age of 60 had a less precise number system. This was a general trend over a large population, with a high degree of individual variation suggesting ANS ability might fade over time in some, but not all people. The researchers also found that a more precise number sense corresponded with participants' self-rating of their math ability, controlling for age, science, language, and computer skills.

"We saw people in their 70s with scores as precise as the best-performing 30-year-olds," said Halberda. "At the same time, 1 adult in 8 had an ANS score that was less precise than a typical 11-year-old child."

The researchers said that educational efforts to improve number sense might help people across a wide range of ages.

"It appears that there is a large window of opportunity to intervene," said Halberda. "A precise ANS may be the foundation on which we build formal mathematical skills, and if that's true, early help for children at risk for math disability could have a big, lifelong impact. However, these results suggest that we might help adults too, by trying to refine their ANS."

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