Study finds brain markers of numeric, verbal and spatial reasoning abilities

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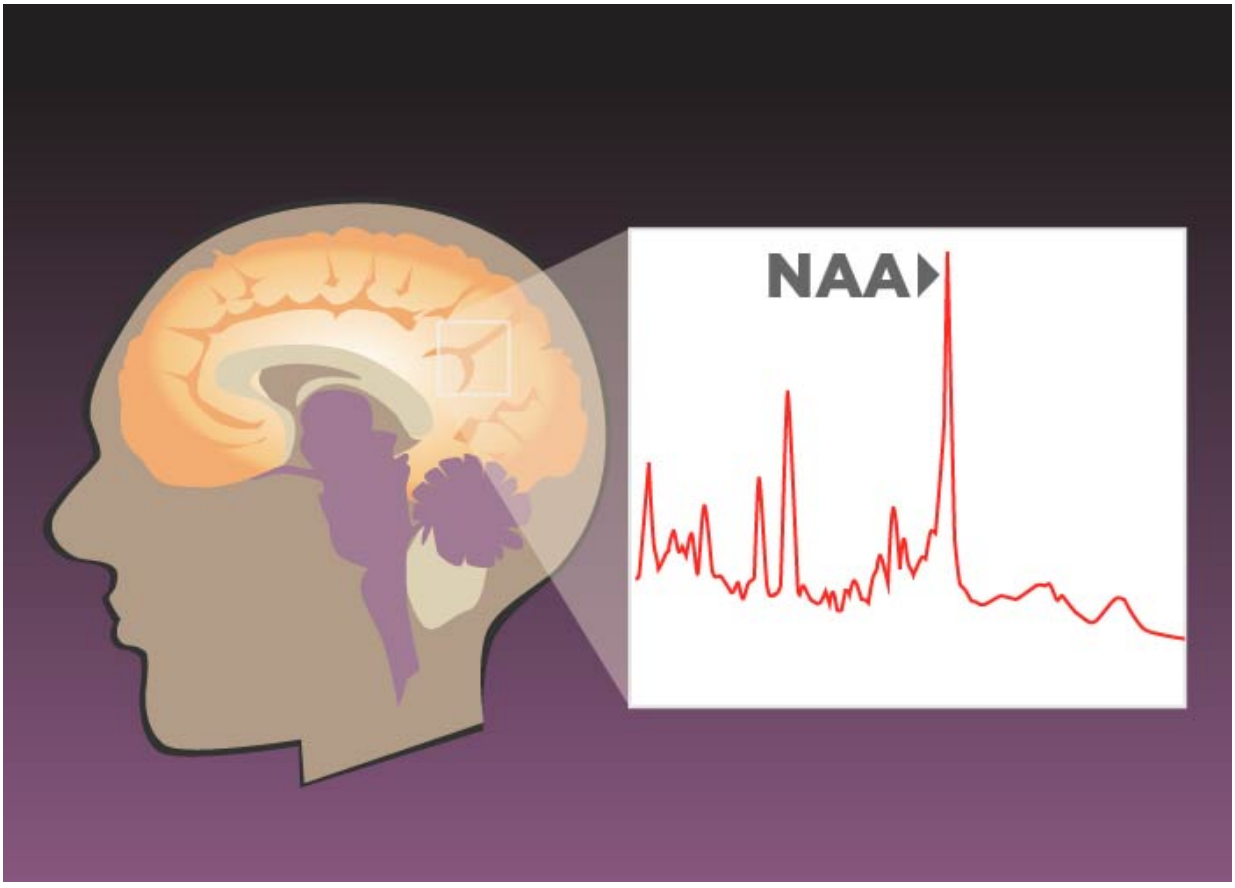


A new study found that higher concentrations of NAA (N-acetyl aspartate) in the medial parietal and posterior cingulate cortices of the brain were associated with better performance on verbal and spatial tests. NAA is a byproduct of glucose metabolism and an indicator of brain health. Credit: Julie McMahon and Erick Paul

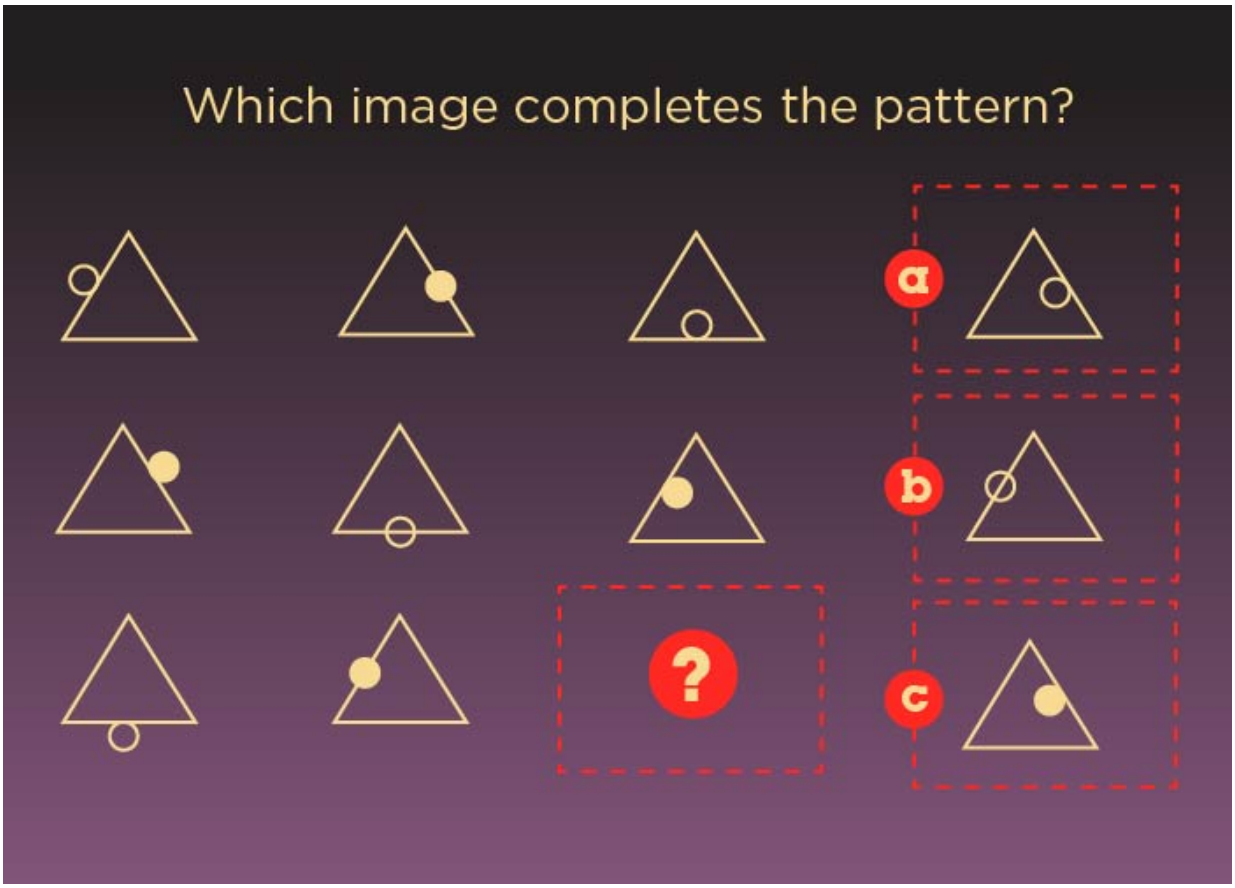
A new study begins to clarify how brain structure and chemistry give rise to specific aspects of "fluid intelligence," the ability to adapt to new situations and solve problems one has never encountered before.

The study, reported in the journal *NeuroImage*, links higher concentrations of a marker of energy production in the brain with an improved ability to solve verbal and spatial problems. It also finds an association between brain size and number-related problem-solving.

The analysis involved 211 research subjects, making it the largest study to date linking brain chemistry and intelligence in living humans, said University of Illinois postdoctoral researcher Erick Paul, who led the work with research scientist Ryan Larsen and Illinois neuroscience professor Aron Barbey. The work was conducted in the Decision Neuroscience Laboratory at the Beckman Institute for Advanced Science and Technology. More studies will be needed to confirm and extend the findings, the researchers said.

"In our data, we observed two facets of fluid intelligence - one that involves quantitative or numeric reasoning, and another that involves verbal or spatial reasoning," Paul said. "A similar separation of reasoning abilities has been demonstrated in previous studies."

The researchers conducted magnetic resonance spectroscopy to analyze brain concentrations of a compound called NAA (N-acetyl aspartate), a byproduct of glucose metabolism and a marker of energy production. They measured brain volume in all subjects using magnetic resonance imaging.



The study tested participants' performance on a number of intelligence tests, with questions, similar to this one, testing subjects' spatial reasoning. Credit: Ryan Larsen and Julie McMahon

"We found that the quantitative reasoning component of intelligence correlated with brain volume, but not with the concentration of NAA in the brain," Paul said. "And the verbal and spatial components of intelligence correlated with NAA, but not with brain volume."

The team observed the same basic relationships when analyzing males and females separately.

The findings add to the evidence that fluid intelligence involves distinct

yet interrelated processes in the brain, Paul said.

"Surely there are many things about the brain that determine a person's intelligence, and the goal is to try to tease apart that puzzle," he said. "These two brain biomarkers, brain volume and NAA, are each giving us independent information about fluid intelligence. There are different properties of the brain that we can measure, and these different properties go with these different facets of fluid intelligence."

"Our findings contribute to a growing body of evidence to suggest that intelligence reflects multiple levels of organization in the brain - spanning neuroanatomy, for example brain size, and neurophysiology, such as brain metabolism - and that specific properties of the brain provide a powerful lens to investigate and understand the nature of specific intellectual abilities," Barbey said.

More information: Erick J. Paul et al, Dissociable brain biomarkers of fluid intelligence, *NeuroImage* (2016). DOI: 10.1016/j.neuroimage.2016.05.037

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