Intelligent brains take longer to solve difficult problems, shows simulation study

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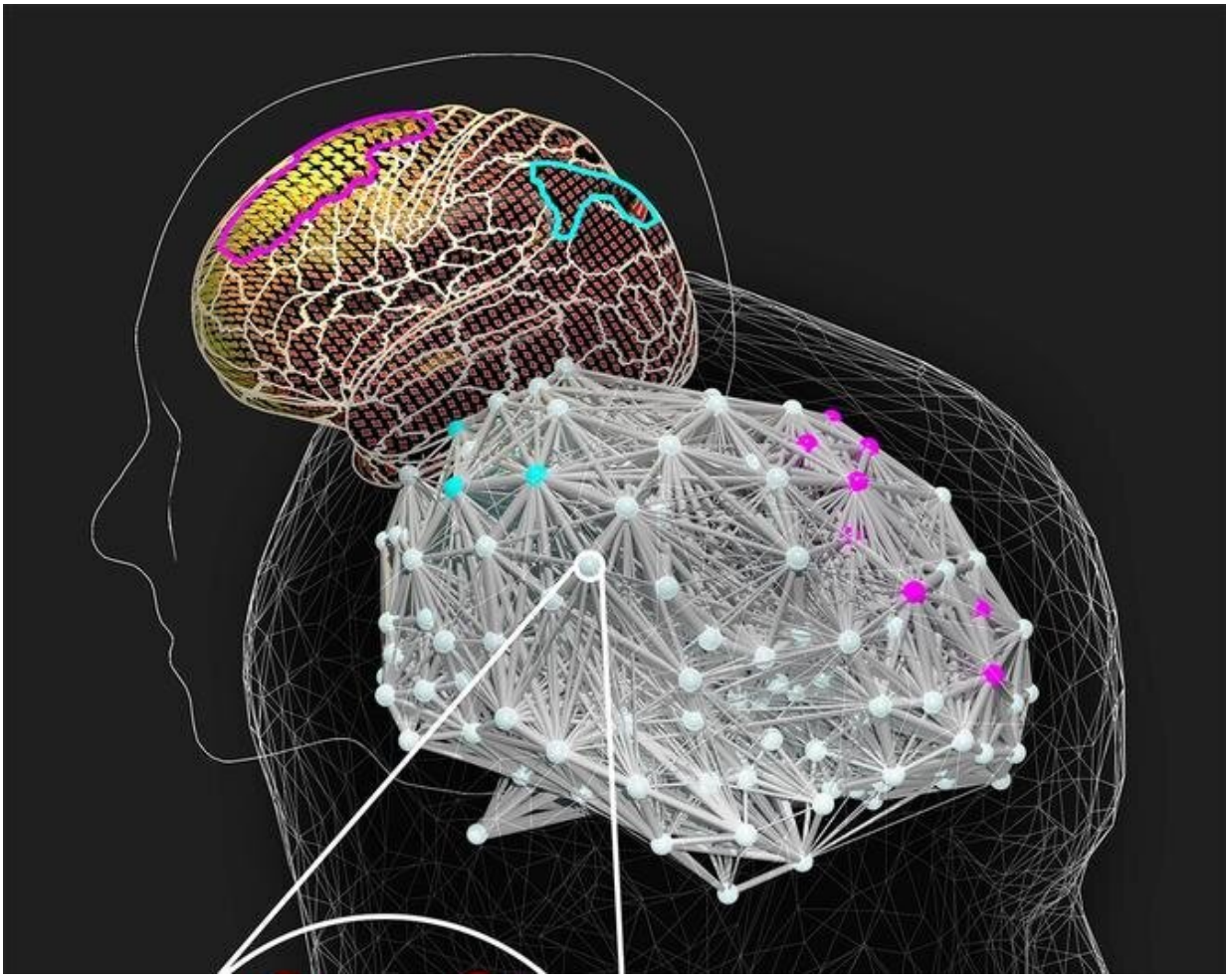


Credit: BIH/Petra Ritter

Do intelligent people think faster? Researchers at the BIH and Charité—Universitätsmedizin Berlin, together with a colleague from Barcelona, made the surprising finding that participants with higher intelligence scores were only quicker when tackling simple tasks, while they took longer to solve difficult problems than subjects with lower IQ scores.

In personalized brain simulations of the 650 participants, the researchers could determine that brains with reduced synchrony between brain areas literally "jump to conclusions" when making decisions, rather than waiting until upstream brain regions could complete the processing steps needed to solve the problem.

In fact, the brain models for higher score participants also needed more time to solve challenging tasks but made fewer errors. The scientists have now published their findings in the journal *Nature Communications*.

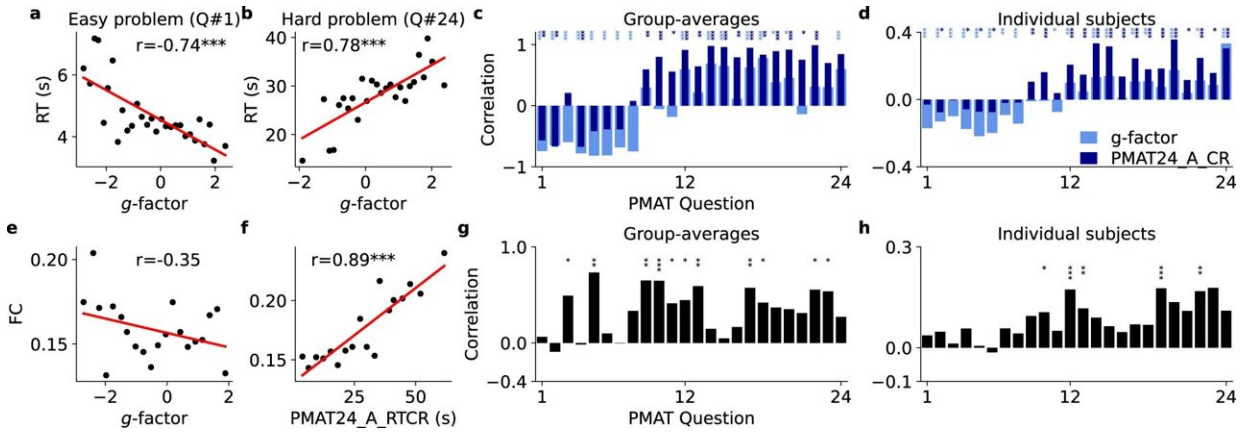
There are 100 billion or so neurons in the human brain. Each one of them is connected to an estimated 1,000 neighboring or distant neurons. This unfathomable network is the key to the brain's amazing capabilities, but it is also what makes it so difficult to understand how the brain works.

Prof. Petra Ritter, head of the Brain Simulation Section at the Berlin Institute of Health at Charité (BIH) and at the Department of Neurology and Experimental Neurology of Charité—Universitätsmedizin Berlin, simulates the human brain using computers. "We want to understand how the brain's decision-making processes work and why different people make different decisions," she says, describing the current project.

Personalized brain models

To simulate the mechanisms of the human brain, Ritter and her team use digital data from brain scans like magnetic resonance imaging (MRI) as well as mathematical models based on theoretical knowledge about biological processes. This initially results in a "general" human brain model. The scientists then refine this model using data from individual people, thus creating "personalized brain models."

For the present study, the scientists worked with data from 650 participants of the Human Connectome Project, a U.S. initiative that has been studying neural connections in the human brain since September 2010. "It's the right excitation-inhibition balance of neurons that influences decision-making and more or less enables a person to solve problems," explains Ritter. Her team knew how participants fared on extensive cognitive tests and what their IQ scores were.



Correlations between intelligence, RTs and FC. **a**, **b** Group-average *g*-factor (30 groups, based on g-factor, $N = 650$ subjects) versus RT for correct responses in PMAT questions #1 (very easy, p=4.0×10−6p=4.0×10−6p=4.0\times {10}^{-6}) and #24 (very hard, p=3.0×10−6p=3.0×10−6p=3.0\times {10}^{-6}). **c**, **d** Group-average and subject-level correlations between *g*/PMAT24_A_CR and the RT for correct responses in each individual PMAT question. Subjects with higher *g* /PMAT24_A_CR were quicker to correctly answer easy questions, but they took more time to correctly answer hard questions (questions sorted according to

increasing difficulty; sign of correlation flips at question #9). **e** Group-average *g* -factor versus mean FC (20 groups, based on *g*-**f**actor, $N = 650$ subjects, p=0.13p=0.13p=0.13). **f** Group-average PMAT24_A_RTCR versus mean FC (20 groups, based on PMAT24_A_RTCR, $N = 650$ subjects, p=6.9×10−7p=6.9×10−7p=6.9\times {10}^{-7}). **g**, **h** Group-average (20 groups, based on PMAT24_A_RTCR) and subject-level correlations between mean FC and RT for correct responses in each PMAT question. Subjects that took more time to correctly answer test questions had a higher FC, independent of whether the question was easy or hard. *P* values of two-sided Pearson's correlation test: *p