Medical Xpress

Does a bigger brain make you smarter?

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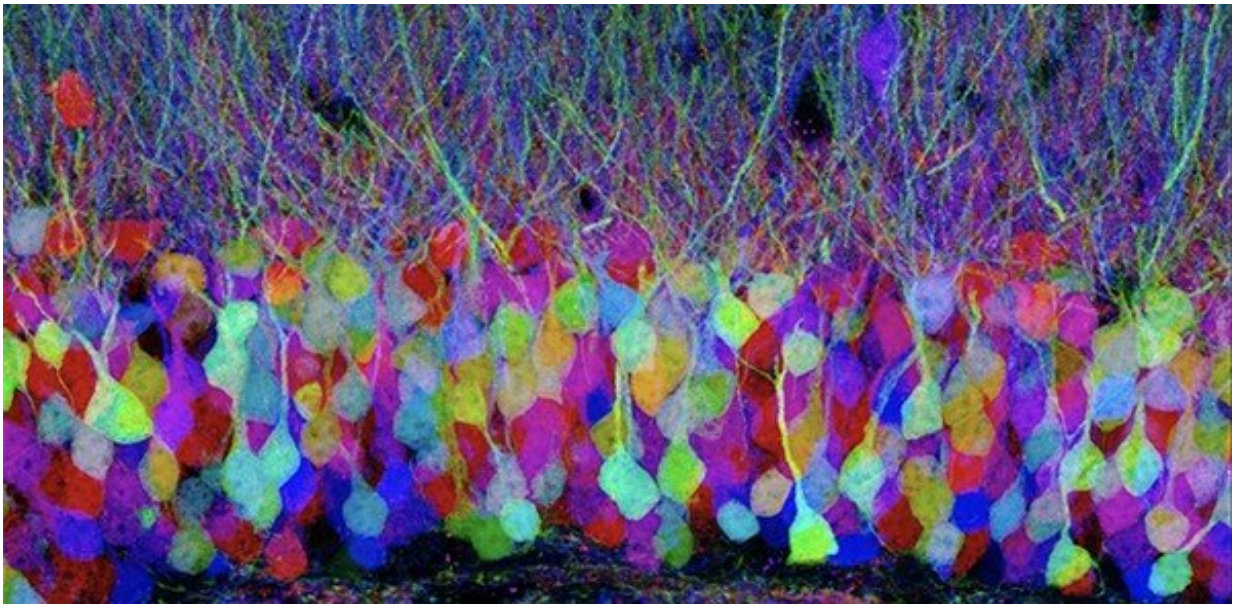

Confocal image of pastel neurons in the hippocampus of a 'Brainbow' mouse brain, with each neuron expressing a distinct colour. Credit: Jean Livet and 2007 Olympus BioScapes Digital Imaging Competition

Increasing the size of neural circuits in the brain can boost learning performance, but this increased connectivity also has the potential to impede learning, new research has revealed.

Cambridge neuroscientists predict that there is an "ideal" brain circuit size suited to carrying out particular tasks. The study, published in the journal *PNAS*, looked at how neural circuits can use additional

connectivity to achieve faster and more precise learning.

The research showed that adding apparently "redundant" neurons (cells that make your brain work) and synaptic connections (that enable information to flow from one neuron to another) to a network is, in fact, a double-edged sword. On the one hand an increase in connectivity can make a task easier to learn. On the other hand, due to inherent noisiness in signal-carrying connections, increased connectivity will eventually hinder both learning and task performance once a circuit exceeds a certain size. These findings suggest a new potential reason why excessive numbers of noisy connections can lead to learning disorders that are associated with brain hyperconnectivity, including some developmental forms of autism.

Dr. Timothy O'Leary, Lecturer in Information Engineering and Medical Neuroscience, who led the study, said: "Our research shows that adding 'spare' or redundant connections to brain circuits can, in fact, boost learning performance. These additional connections—which don't appear strictly necessary for brain function—can make a new task easier to learn.

"However, we found that if each new pathway adds 'noise' to the signal it transmits, the overall gain in learning performance will eventually be lost as a circuit increases in size. We can predict, therefore, that there is a so-called 'sweet spot,' an ideal brain circuit size that suits a particular task. While evidence points to the fact that larger brains tend to be found in species with higher cognitive function and learning ability, brain circuit size may ultimately be constrained by the need to learn efficiently with unreliable synapses. In short, adding neurons and connections to a brain can help learning—up to a point. After that, an increase in size could actually impair learning."

More information: Dhruva Venkita Raman et al. Fundamental bounds

on learning performance in neural circuits, *Proceedings of the National Academy of Sciences* (2019). DOI: 10.1073/pnas.1813416116