NEWS

Snapshots reveal striking changes in adult brain over time

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Starting in October 2013, **Russell Poldrack** climbed into a functional magnetic resonance imaging (fMRI) machine two to three times a week, a routine he continued for more than a year. Each time, the Stanford University psychology professor lay resting in the claustrophobic bore of the magnet with his eyes closed for 10 minutes.

The resulting images revealed a huge surprise: Instead of seeing subtly different neural portraits, Poldrack and his colleagues found distinctly disparate patterns of activated brain regions depending on the day, even though Poldrack was always resting.

The work has opened scientists' eyes to the possibility that the connections in a person's brain vary significantly over time. The findings, published 5 August in *Neuron*, yield the most detailed depiction of an individual brain to date, says Poldrack[1]. "Until now, no one had looked at how one person's brain organization varies over time."

The study also points to a limitation in the common strategy of **pooling brain images from similar individuals** captured at a single point in time. Researchers use this method to control for variations in brain structure between people when trying to get at group differences — say, between people with and without autism. But the new work indicates that such studies gloss over a second important source of variation: that within an individual.

The findings may help explain why imaging studies designed to look at **connectivity** — the extent to which different brain regions communicate — in autism have generated conflicting results.

"Most studies have relied on comparing a group with autism to a group without autism," says **Gabriel Dichter**, associate professor of psychology and psychiatry at the University of North Carolina at Chapel Hill, who was not involved in the study. But no two people with autism are alike. "Repeatedly scanning one individual with autism could reveal variations in their connectivity that relate to their condition," Dichter says.

Connectivity conundrum:

Over the past five years, the self-imaging method Poldrack used, dubbed **resting-state fMRI**, has become a popular technique for gauging connectivity in the brains of people with autism. By looking for brain areas that activate in synchrony, researchers can infer how much and how often the two regions talk to each other. Researchers talk about this tendency to converse in terms of a connection's 'strength.'

But studies using the technique have yielded **conflicting results**. Some suggest the brains of people with autism are **more strongly connected** than those of controls. Others have found comparatively **weak** connections in people with autism.

In the new study, Poldrack and his colleagues tracked how the strength of connections in Poldrack's brain waxed and waned over time. The connections that changed the most over the year and a half involve regions that control movement and process visual information. Sometimes part of a visual brain region, for example, would activate in tandem with another small section of the brain, indicating a connection between these areas — and sometimes, there was no sign that those regions were communicating.

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For comparison, the researchers created a composite brain made up of resting-state snapshots from 120 healthy college students. They found that connections involving motor and visual regions, which were the most variable in Poldrack's brain, were the most similar among individuals in the composite brain. "That was the really surprising thing," Poldrack says.

Variability among the composite brain individuals was greatest in the frontal and parietal regions of the brain, which control high-level thought, reasoning and executive function.

The findings suggest that day-to-day variations in an individual's brain relate mostly to visual and motor function. And they hint that differences in the frontal and parietal parts of the brain may be what distinguish individuals from one another.

Imaging autism:

The researchers initially speculated that some of the shifts in Poldrack's brain may relate to the fact that he drank coffee on some scan days and not others. Caffeine, they thought, could alter his state of arousal. But when they performed a scaled-down version of the experiment using another team member (with only five hours of imaging), they found a similar degree of variation in the same brain regions.

The study has important implications for autism researchers. **Averaging images across groups of people** with autism — even those who are genetically similar — may mask important differences within an individual over time. It's also possible that people with autism have different thoughts during a 'resting state' than those without the disorder, making any difference in the images simply reflect those thoughts rather than any stable feature of their brains.

"It would be very interesting to track variability in the visual and motor cortex in individuals with autism," says Dichter. Patterns of connectivity within these individuals may reflect underlying links to autism or signal a response to a particular treatment, Dichter says.

The brains of children with autism are constantly evolving, notes **Eric Courchesne**, professor of neurosciences at the University of California, San Diego. Detecting changes in brain connectivity that correlate with improvements in autism symptoms could shed light on the disorder, he says.

Lying still in a scanner two to three times a week over the more than a year is no easy task. But Poldrack and his team say 30 minutes of resting-state fMRI at a few different time points may be sufficient to paint a detailed picture of the brain of an individual with autism.

REFERENCES:

1. Laumann T.O. *et al. Neuron* **87**, 657-670 (2015) **PubMed**