

Scientists can predict intelligence from brain scans

June 29 2018



Credit: Pixabay/CC0

If you've ever lied about your IQ to seem more intelligent, it's time to fess up. Scientists can now tell how smart you are just by looking at a scan of your brain.

Actually, to be more precise, the scientists themselves aren't looking at your brain scan; a machine-learning algorithm they've developed is.

In a new study, researchers from Caltech, Cedars-Sinai Medical Center, and the University of Salerno show that their new computing tool can predict a person's [intelligence](#) from [functional magnetic resonance](#) imaging (fMRI) scans of their resting state brain activity. Functional MRI develops a map of brain activity by detecting changes in blood flow to specific brain regions. In other words, an individual's intelligence can be gleaned from patterns of activity in their brain when they're not doing or thinking anything in particular—no math problems, no vocabulary quizzes, no puzzles.

"We found if we just have people lie in the scanner and do nothing while we measure the pattern of activity in their brain, we can use the data to predict their intelligence," says Ralph Adolphs (Ph.D. '92), Bren Professor of Psychology, Neuroscience, and Biology, and director and Allen V. C. Davis and Lenabelle Davis Leadership Chair of the Caltech Brain Imaging Center.

To train their algorithm on the complex patterns of activity in the human brain, Adolphs and his team used data collected by the Human Connectome Project (HCP), a scientific endeavor funded by the National Institutes of Health (NIH) that seeks to improve understanding of the many connections in the [human brain](#). Adolphs and his colleagues

downloaded the [brain scans](#) and intelligence scores from almost 900 individuals who had participated in the HCP, fed these into their algorithm, and set it to work.

After processing the data, the team's algorithm was able to predict intelligence at statistically significant levels across these 900 subjects, says Julien Dubois (Ph.D. '13), a postdoctoral fellow at Cedars-Sinai Medical Center. But there is a lot of room for improvement, he adds. The scans are coarse and noisy measures of what is actually happening in the brain, and a lot of potentially useful information is still being discarded.

"The information that we derive from the brain measurements can be used to account for about 20 percent of the variance in intelligence we observed in our subjects," Dubois says. "We are doing very well, but we are still quite far from being able to match the results of hour-long intelligence tests, like the Wechsler Adult Intelligence Scale,"

Dubois also points out a sort of philosophical conundrum inherent in the work. "Since the algorithm is trained on intelligence scores to begin with, how do we know that the [intelligence scores](#) are correct?" The researchers addressed this issue by extracting a more precise estimate of intelligence across 10 different cognitive tasks that the subjects had taken, not only from an IQ test.

In predicting intelligence from brain scans, the algorithm is doing something that humans cannot, because even an experienced neuroscientist cannot look at a brain scan and tell how intelligent a person is.

"If trained properly, these algorithms can answer questions as complex as the one we are trying to answer here. They are very powerful, but if you actually ask, 'How do they learn? How do they do these things?'

These are difficult questions to answer," says co-author Paola Galdi, previously a Ph.D. student at the University of Salerno and now a [postdoctoral fellow](#) at the University of Edinburgh.

The study was conducted as part of an ongoing quest to build a diagnostic tool that can tell a great deal about a person's mind from their brain scans. Adolphs and his colleagues say that they would like to one day see MRIs work as well for diagnosing conditions like autism, schizophrenia, and anxiety as they currently do for finding tumors, aneurisms, or liver disease.

"Functional MRI has not yet delivered on its promise as a diagnostic tool. We, and many others, are actively working to change this," says Dubois. "The availability of large data sets that can be mined by scientists around the world is making this possible."

Intelligence was chosen as one of the first test beds for the technology because research has shown that it's very stable over time. That is, a person's IQ score will not vary much over a period of weeks, months, or years.

The researchers also conducted a parallel study, using the same test population and approach, that attempted to predict personality traits from fMRI brain scans. An individual's personality, Adolphs says, is at least as stable as intelligence over a long period of time. The personality test they used divides personality into five scales:

1. Openness to experience: Preference for new experiences and ideas vs. preference for routine and predictability
2. Conscientiousness: Self-discipline and thoughtfulness vs. spontaneity and flexibility
3. Extraversion: Sociability and talkativeness vs. shyness and reservation

4. Agreeableness: Friendliness and helpfulness vs. antagonism and argumentativeness
5. Neuroticism: Confidence and predisposition to positive emotions vs. nervousness and predisposition to negative emotions

However, it has turned out to be much more difficult to predict personality using the method the team used for predicting intelligence. But this is not surprising, says Dubois.

"The personality scores in the database are just from short, self-report questionnaires," he says. "That's not going to be a very accurate measure of personality to begin with, so it is no wonder we cannot predict it well from the MRI data."

Adolphs and Dubois say they are now teaming up with colleagues from different fields, including Caltech philosophy professor Frederick Eberhardt, to follow up on their findings.

Papers describing the two studies, titled "Resting-state functional brain connectivity best predicts the personality dimension of openness to experience," and "A distributed [brain](#) network predicts general intelligence from resting-state human neuroimaging data," are available online through bioRxiv; their publication in, respectively, *Personality Neuroscience* and *Philosophical Transactions of the Royal Society*, is pending.

More information: Julien Dubois et al. Resting-state functional brain connectivity best predicts the personality dimension of openness to experience, (2017). [DOI: 10.1101/215129](https://doi.org/10.1101/215129)

Julien C Dubois et al. A distributed brain network predicts general intelligence from resting-state human neuroimaging data, (2018). [DOI: 10.1101/257865](https://doi.org/10.1101/257865)

Provided by California Institute of Technology

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