

New AI-driven algorithm can detect autism in brain 'fingerprints'

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Stanford researchers have developed an algorithm that may help discern if someone has autism by looking at brain scans. The novel algorithm, driven by recent advances in artificial intelligence (AI), also successfully

predicts the severity of autism symptoms in individual patients. With further honing, the algorithm could lead to earlier diagnoses, more targeted therapies, and broadened understanding of autism's origins in the brain.

The algorithm pores over data gathered through functional magnetic resonance imaging (fMRI) scans. These scans capture patterns of neural activity throughout the brain. By mapping this activity over time in the brain's many regions, the algorithm generates neural activity "fingerprints." Although unique for each individual just like real fingerprints, the brain fingerprints nevertheless share similar features, allowing them to be sorted and classified.

As described in a new study published in *Biological Psychiatry*, the algorithm assessed [brain scans](#) from a sample of approximately 1,100 patients. With 82% accuracy, the algorithm selected out a group of patients whom human clinicians had diagnosed with [autism](#).

"Although autism is one of the most common neurodevelopmental disorders, there is so much about it that we still don't understand," says lead author Kaustubh Supekar, a Stanford clinical assistant professor of psychiatry and behavioral sciences and Stanford HAI affiliate faculty. "In this study, we've shown that our AI-driven brain 'fingerprinting' model could potentially be a powerful new tool in advancing diagnosis and treatment."

Unlike many other diseases, autism lacks objective biomarkers—telltale measurements that reveal a medical condition's presence and sometimes severity—meaning there is no simple test for the disorder. Instead, diagnosis is based on observing patients' behaviors, which are naturally highly variable and thus make diagnosis a challenge. (Common signs of autism include difficulty navigating everyday social interaction, deficits in communicating and learning, and repetitive speech and motions.)

"We need to create objective biomarkers for autism," says Supekar, "and brain fingerprints get us one step closer."

Combining Big Data and XAI

Scientists have long searched for biomarkers via fMRI scans. Yet studies to date with small populations have reported conflicting results, stemming from natural variability in patients' brains and confounded further by differences in fMRI machines and testing methods.

Like many scientific fields, autism research has embraced the [big data](#) approach, Supekar says, where previously unobtainable insights emerge from analyzing large, statistically powerful samples. Supekar's new study is a case in point, pooling brain scans from medical centers worldwide into a mammoth, demographically and geographically diverse dataset.

The next step was to effectively parse and deal with the data complexity and variability. Supekar and colleagues thought a good place to start would be image recognition algorithms, developed by technology companies. These algorithms have grown increasingly sophisticated at handling significant degrees of variability in the images they assess.

For example, Supekar says, imagine an algorithm designed to identify cats and dogs in online images. That algorithm must contend with the animals being photographed from different angles and distances, as well as nimbly account for the ranges of colors and features among breeds.

"For image recognition AI to be successful, it doesn't matter if my 5-year-old took the picture or someone with an award in photography—the algorithm has to work in both cases," says Supekar. "The same kind of heterogeneity you get in pictures of cats and dogs, you get in brain scans, too."

In deriving their image-recognition algorithms, Supekar and colleagues sought to make the [artificial intelligence](#) explainable, or understandable to human researchers. Researchers in recent years have focused on crafting explainable AI, or XAI, in contrast to conventional AI systems that might produce quality results but not in readily apparent ways.

"A challenge has been that AI algorithms can be a 'black box,' where we can't explain where the accuracy of the algorithm comes from," says Supekar.

Taking the cat-versus-dog example model again, researchers would want to know if the algorithm is picking over the animals' facial features or neck sizes, say. For the brain fingerprinting algorithm, Supekar and colleagues fashioned a simple mathematical model that assesses brain regional interactions and interconnectivity. In this manner, the XAI algorithm alit upon three brain regions exhibiting significant differences in interconnectivity in a groupable portion of the dataset.

Lending credibility to the XAI algorithm's findings, those three [brain regions](#) have been previously implicated in autism pathology. The regions are the [posterior cingulate cortex](#) and precuneus, which form part of the default mode network (DMN), notably active during periods of wakeful rest; the dorsolateral and [ventrolateral prefrontal cortex](#), involved in cognitive control; and the superior temporal sulcus, involved in processing the sounds of human voices. In particular, disruptions to the DMN served as strong predictors of autism symptom severity in the studied population.

Earlier the better

While the XAI algorithm performed admirably at this early stage of development, Supekar and colleagues will need to improve its accuracy further still to raise brain fingerprinting to the level of a definitive

biomarker. The researchers intend to explore the [algorithm](#)'s efficacy in sibling studies, where one sibling has autism and the other does not, to hone the ability to detect fine-tuned, yet critical differences between potentially very similar brains.

Supekar envisions brain fingerprinting being used to assess the brains of very young children, perhaps as early as six months or a year old, who are at high risk of developing autism. Earlier diagnosis is critical in achieving better outcomes, with therapies proving more effective when introduced while patients are still toddler-aged versus later in childhood

"We hope that the approach demonstrated in our study could diagnose autism during the window of opportunity when interventions are maximally most effective," says Supekar.

More information: Kaustubh Supekar et al, Robust, Generalizable, and Interpretable Artificial Intelligence–Derived Brain Fingerprints of Autism and Social Communication Symptom Severity, *Biological Psychiatry* (2022). [DOI: 10.1016/j.biopsych.2022.02.005](https://doi.org/10.1016/j.biopsych.2022.02.005)

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