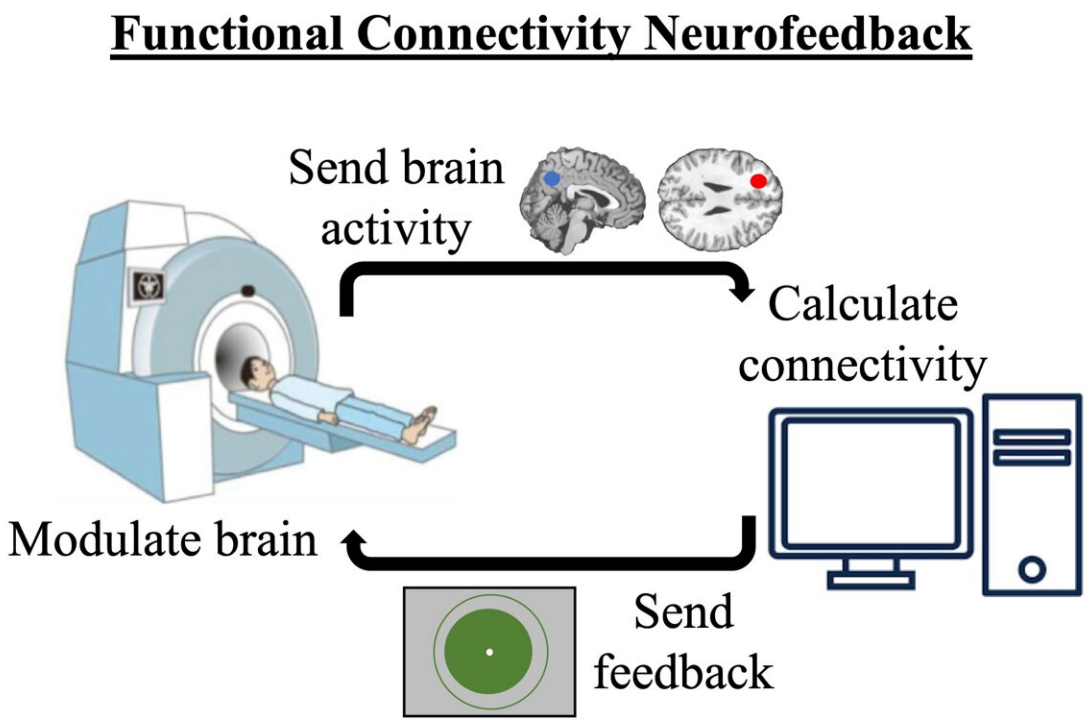
Personalized brain-training approach goes after one of depression's hardest-to-break loops

April 29 2026, by Ingrid Fadelli



Functional connectivity neurofeedback forms a closed loop between the participant's brain and the computer, so that they provide feedback to one another. Seeing visual feedback about their own brain activity allows participants to gain control over it. Credit: Taylor et al.

Depression is a debilitating mental health disorder characterized by persistent low mood, a loss of interest in everyday activities, repetitive negative thinking and possible changes in appetite and/or sleeping patterns. While there are several available treatments for depression, including various medications and psychotherapeutic approaches, these typically treat all patients similarly, without considering differences in the symptoms they are experiencing.

Researchers at the Advanced Telecommunications Research (ATR) Institute International in Kyoto and Kyoto University recently carried out a study investigating the potential of a technique called functional connectivity neurofeedback for the targeted treatment of specific depressive symptoms. Their findings, published in *Translational Psychiatry*, suggest that this technique can reduce rumination, the repetitive negative thinking associated with depression.

"Our recent paper was a multi-institute collaboration that came about with a lot of careful thought from scientists and medical doctors at varying stages of our careers," Jessie Elizabeth Taylor, first author of the paper, told Science X. "The primary goals were to test the feasibility and effectiveness of functional connectivity neurofeedback for treating psychiatric symptoms, and to find the optimal parameters under which it may do so."

The first author, Jessica Taylor, about to run a pilot subject in her functional connectivity neurofeedback paradigm. Credit: Taylor et al.

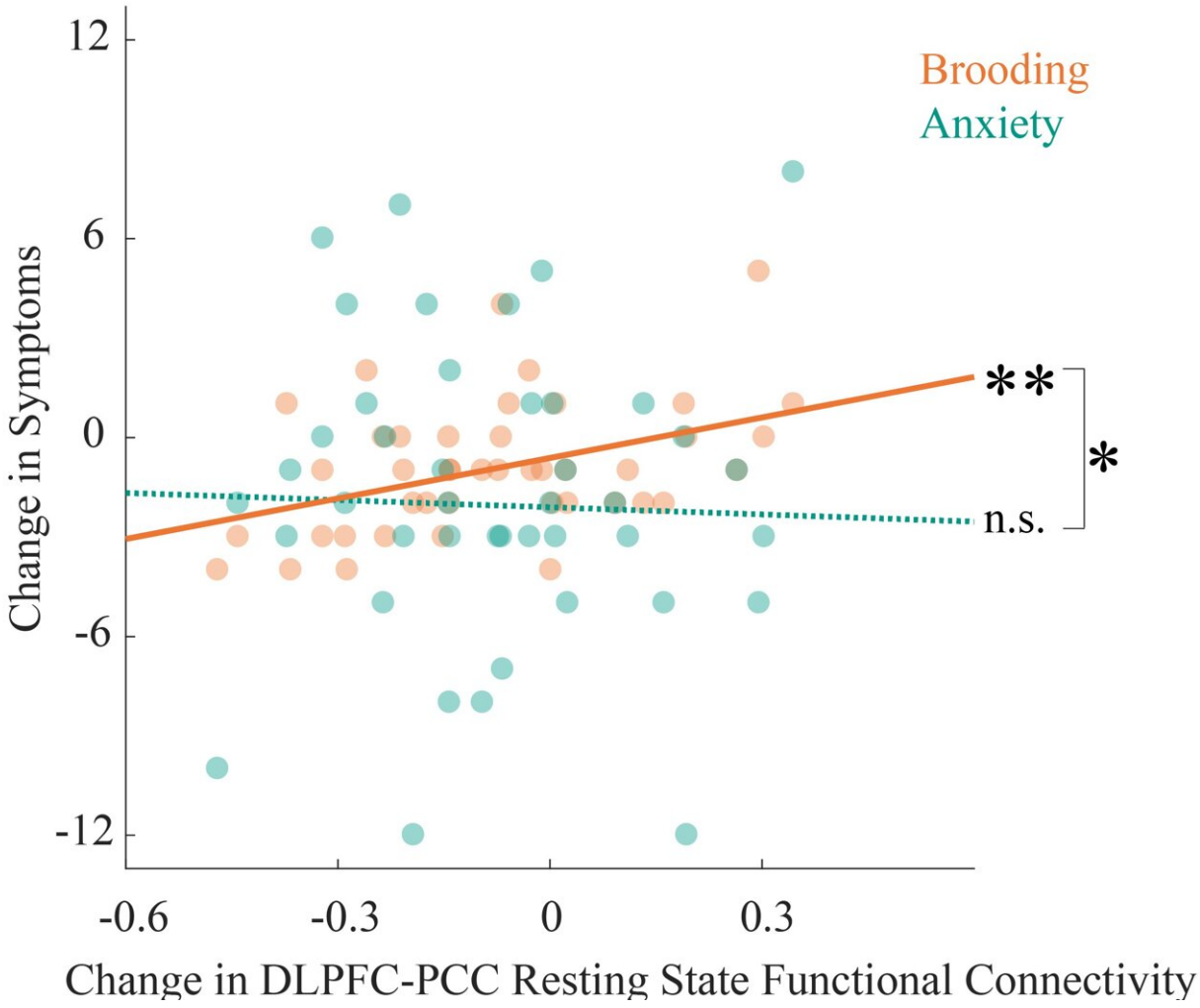
Rewiring the brains of patients with depression

To conduct their experiments, Taylor and her colleagues recruited 68 adults who were experiencing symptoms of depression. Each participant was asked to visit the laboratory for 6 to 8 days, to take part in functional magnetic resonance imaging (fMRI) sessions, complete screenings and attend clinical interviews.

FMRI is a noninvasive neuroimaging technique that monitors brain

activity by measuring changes in blood oxygenation and flow across different brain regions. Over the course of their experiments, the researchers scanned the participants' brains with fMRI for over 700 hours.

"There was a lot to be arranged with scheduling participants, experimenters, MRI techs, and the scanner," said Taylor. "We found that people with depressive symptoms (understandably) often need to reschedule or stop partway through an experiment. We are very grateful to the participants—and to the staff who helped us with all the scheduling—that we were able to make it work. When the participants came in, the main thing they did was the neurofeedback itself."



Graph summarizing the team's results. As participants' dorsolateral prefrontal cortex-posterior cingulate cortex (DLPFC-PCC) resting state functional connectivity became more healthy-like from before- to after- FCNef, related symptoms (rumination) reduced. The same was not seen for unrelated (anxiety) symptoms, which highlights the precision of this effect. Credit: Taylor et al.

During neurofeedback sessions, participants were asked to lie down in an MRI scanner and complete what appeared to be a computer game presented on a screen in front of them. Essentially, the experimenters

asked them, "Try to use your brain to make the green circle on the screen bigger."

"Their brain scans were being sent to our computer in the control room in real-time," explained Taylor. "When their brain activity was looking 'healthier' (more like the brain activity of a healthy control than that of a person with depression), then our computer program presented them with a larger green circle. By trying different strategies and seeing what worked for them to make the green circle larger, they were thereby able to learn how to make their brain activity 'healthier.'"

A key objective of the team's study was to assess the potential of fMRI neurofeedback for the targeted treatment of specific psychiatric symptoms. Their neurofeedback sessions thus specifically targeted the connectivity between the left dorsolateral prefrontal cortex and the left pre-cuneus/posterior cingulate cortex. The connection between these two brain regions was previously found to be associated with a specific symptom of depression: rumination.

"Indeed, as this connection normalized with functional connectivity neurofeedback, rumination symptoms were found to decrease," said Taylor.

"Anxiety symptoms, on the other hand, which also started out as higher than typically seen in healthy people, did not decrease as the targeted connection normalized. Because anxiety symptoms are thought to arise from different neural mechanisms, this highlights the precision of our technique: rumination is what we targeted, and rumination is what decreased as the targeted brain activity became 'healthier.'"

Towards the precision treatment of mental health disorders

Overall, the results of this study highlight the potential of functional connectivity neurofeedback for the precision treatment of some psychiatric symptoms, particularly rumination. Future studies could try to use the same approach to modify brain connectivity patterns associated with different symptoms of depression or with the symptoms of other mental health disorders.

"Current first-line treatment is rather homogenous, but different patients (even with the same clinical diagnosis) often present with different symptoms with different underlying neural mechanisms," said Taylor. "It is not surprising, therefore, that treatment response is often underwhelming. The ability to tailor treatment to the individual holds great potential for improving treatment response rates and improving individual patients' quality of life beyond what might be achievable with current first line practice."

Taylor completed this recent study while she was working at the ATR institute in Kyoto. She has since moved to Duke University in North Carolina, where she is conducting further research assessing the potential of fMRI neurofeedback within a lab led by Dr. Alison Adcock.

"In the lab led by the wonderful Dr. Adcock, they have been working on real-time neurofeedback to activate the Ventral Tegmental Area of the midbrain and the substantia nigra, primary sources of dopamine in the brain," added Taylor. "Their technique works well, with people reliably being able to activate this. Our future plans are to run this in a sample of people with ADHD. People with ADHD are usually prescribed drugs that increase dopamine signaling in the brain. We are hoping to use real-time neurofeedback to mimic this."

The objective of the ongoing studies by Dr. Adcock and Taylor are to use fMRI neurofeedback to gradually train people with ADHD to increase dopamine in their midbrain at will. This could help them to

better cope with the disorder, without having to rely on stimulants or other ADHD medications.

More information: JE Taylor et al, Paving the way for precision treatment of psychiatric symptoms with functional connectivity neurofeedback, *Translational Psychiatry* (2026). DOI: 10.1038/s41398-026-04040-3.