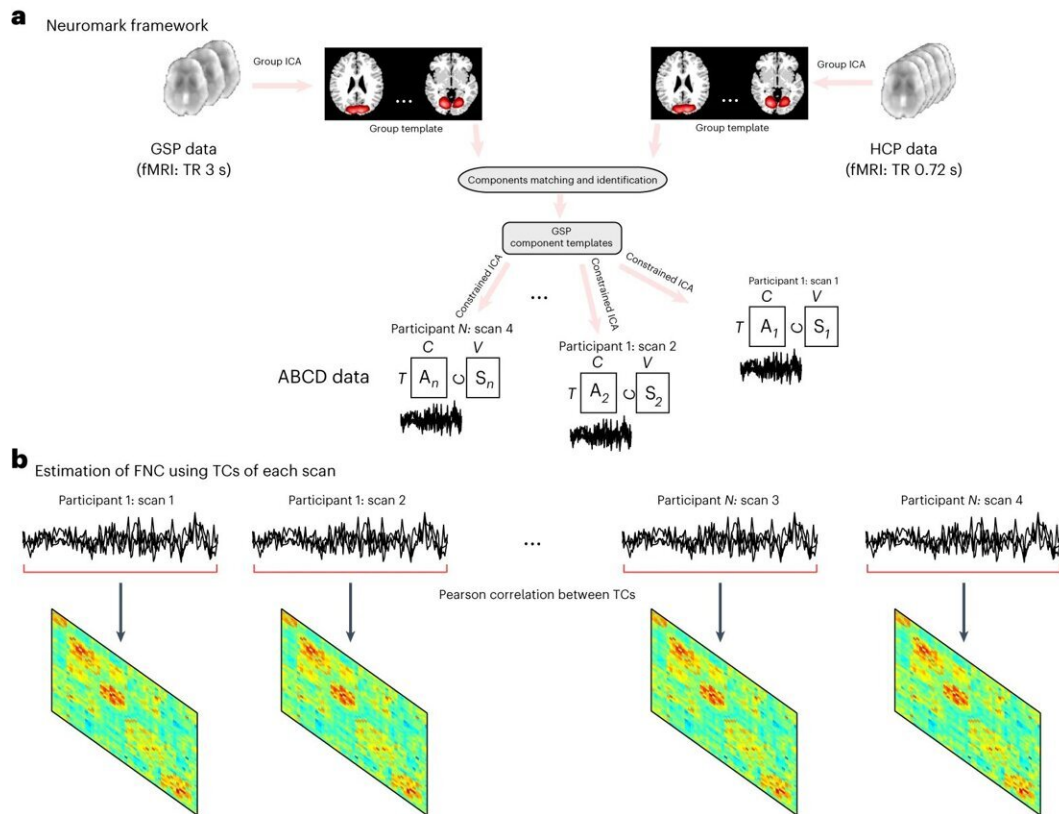# Connectivity scans could serve as brain 'blueprints' for adolescents, researchers find

November 7 2023, by Noelle Toumey Reetz

The flowchart of the FNC analysis to investigate cross-scan FNC. **a**, Neuromark framework extracts robust functional components from the ABCD data. Component templates are identified using two independent data with different repetition time (TR). **b**, FNC is estimated using the TCs of components from each scan. **c**, Cross-scan FNC similarity is measured by the correlation between FNC from different scans. **d**, Individual identification is performed on the basis of the cross-scan FNC similarity. **e**, Association analysis between FNC stability (intra-participant FNC similarity) and individuals' behavior via the LMM.

Researchers with the Translational Research in Neuroimaging and Data Science (TReNDs) Center at Georgia State have identified important new methods for accurately identifying possible biomarkers in adolescent brains that can reliably predict cognitive developments and psychiatric issues.

A new study, published in *Nature Mental Health*, represents the first large-scale analysis of its kind in which researchers analyzed functional network connectivity (FNC) across scans and identified associations with a diverse range of health measures in children. Researchers believe that inferences about early cognitive and psychiatric behaviors in children may be made using these intra-subject variabilities as a useful biomarker.

Researchers studied four scans from more than 9,000 subjects ages 9 to 11.

Neuroscientist, Distinguished University Professor and head of the TReNDS Center at Georgia State Vince Calhoun worked with the research team to develop the study. He said the research demonstrates that, independent of brain growth and development, a child's FNC is robust and stable with high similarity across scans and can serve as a fingerprint to identify an individual child from a large group.

"This study is quite exciting as it shows the promise of using advanced machine learning to identify brain patterns which might help us intervene early in children who are most at risk for cognitive or psychiatric problems," said Calhoun, who is the senior author of the study.

Researchers say that brain [functional connectivity](#) derived from [functional magnetic resonance](#) imaging (fMRI) is commonly used as a potential blueprint for adults. But they believe that intra-subject variation of FNC can carry biologically meaningful information, especially during adolescence, which is a time of significant change in the brain.

Principal investigator Zening Fu said the study demonstrates that functional connectivity variability can predict a wide range of children's behavior, including cognition, mental health and sleep conditions.

"Most previous fMRI studies believe that resting-state functional connectivity can provide a fingerprint of an individual, and that variability in connectivity is due to noise or other confounding effects," said Fu. "However, we found that the variations of individualized FNC across scans are notable and convey psychological and physiological information underlying distinct behavioral phenotypes in children. Multivariate methods could help to capture much larger effects between FNC stability and children's behavior."

The research team was able to predict with surprising accuracy a number of conditions or outcomes, including cognitive performance and psychiatric problems. Researchers were also able to predict sleep conditions and screen usage based on FNC stability. Additionally, they were able to identify brain-behavior correlations with parent psychopathology and prenatal exposure to marijuana and other drugs.

Fu explained how they are able to read the results and, in many cases, predict outcomes in children based on the scans over time.

"FNC stability in our present work is defined as the variability or changes in the resting-state functional connectivity across scans (measurements)," Fu said.

"That is, if a subject has been collected using resting-state fMRI scans multiple times, the functional connectivity estimated using each fMRI scan should be different, even if they are from the same subject. Such difference or variability is not trivial, but biologically meaningful. Subjects with larger FNC variability (smaller stability) might tend to have lower cognitive performance and more mental health problems."

In a second study, published in *Biological Psychiatry*, research conducted at the TReNDS Center and led by Weizheng Yan finds that functional network connectivity, which steadily reconfigures over time, potentially contains abundant information to assess psychiatric risks. Yan is a former postdoctoral research associate with the TReNDS Center now working with the National Institutes of Health.

As part of the study, researchers developed a brain-wide risk score (BRS), a novel FNC-based metric that contrasts the relative distances of an individual's FNC to that of psychiatric disorders versus healthy control references.

The research team discovered that the BRS revealed a distinct, repeatable gradient of FNC patterns for each psychiatric disorder in over 8,000 unaffected teenagers, ranging from low to high risk. The BRS could also identify people with early psychosis from healthy controls and predict psychosis scores.

To generate group-level disorder and healthy control references, researchers used a large brain imaging dataset containing more than 5,000 individuals diagnosed with schizophrenia, autism spectrum, major depressive and bipolar disorders, and their corresponding healthy controls.

The findings show that the BRS could be a new image-based tool for assessing psychiatric vulnerability over time and in unaffected

individuals, and could also serve as a potential biomarker, facilitating early screening and monitoring interventions.

Both studies used a multimodal database known as the [Adolescent Brain Cognitive Development](#) (ABCD) Study. The dataset contains a wide range of measurements of mental health, cognition and other health-related factors that have been found to be helpful in examining the connection between teenage behaviors and [brain](#) function.

More information: Zening Fu et al, Functional connectivity uniqueness and variability? Linkages with cognitive and psychiatric problems in children, *Nature Mental Health* (2023). [DOI: 10.1038/s44220-023-00151-8](#)

Weizheng Yan et al, A brain-wide risk score for psychiatric disorder evaluated in a large adolescent population reveals increased divergence among higher-risk groups relative to controls, *Biological Psychiatry* (2023). [DOI: 10.1016/j.biopsych.2023.09.017](#)

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