EEG markers in early life could help predict and diagnose anxiety

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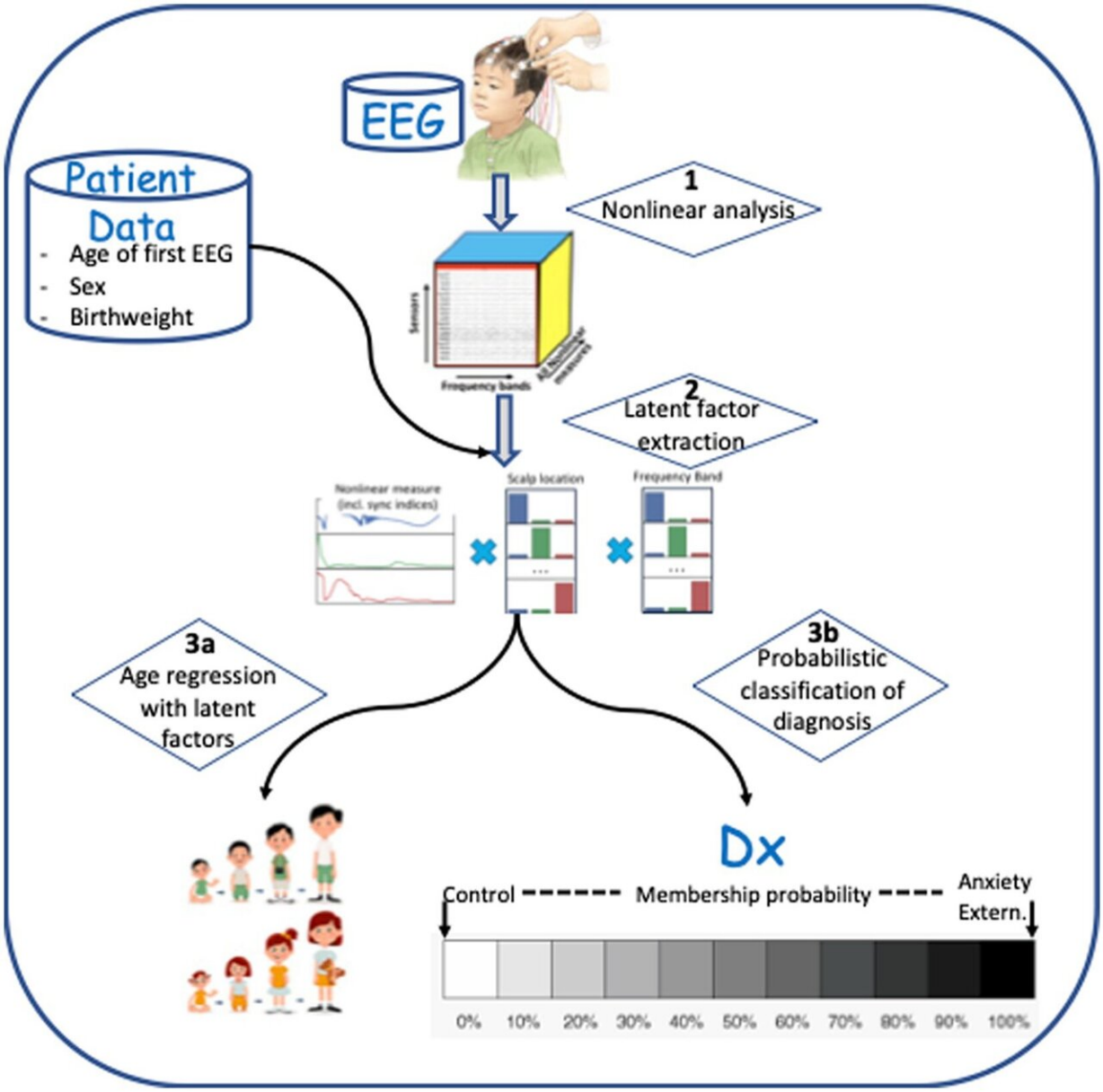

Data processing steps involved in analysis. (1) Multi-frequency decomposition of the signal and computation of nonlinear measures. (2) Latent feature extraction using Supervised Canonical Polyadic (SupCP) algorithm, including EEG measures and covariate data. (3a) Predicting age using regression with latent features. (3b) Classification of anxiety disorder group versus healthy control group, externalizing disorder group versus healthy control group, or anxiety disorder group versus externalizing disorder group. Credit: *Frontiers in Psychiatry* (2023). DOI: 10.3389/fpsyt.2023.1158569

Anxiety disorders are the most common mental health problem among children and adolescents and are a risk factor for adult disorders. Stress is a big factor—at home, at school, and from external factors like COVID-19 and climate change. But some children may be innately more susceptible to anxiety. New research at Boston Children's Hospital suggests a possible way to detect such vulnerability before anxiety becomes apparent clinically.

In a pilot study in *Frontiers in Psychiatry*, Michelle Bosquet Enlow, Ph.D., a clinical psychologist in the department of Psychiatry and Behavioral Sciencs at Boston Children's, and William (Bill) Bosl, Ph.D., in the Computational Health Informatics Program, found telltale markers of anxiety in electroencephalograms (EEGs), even in early childhood.

Bosl is a computational scientist who focuses on clinical neurophysiology and neurodiagnostics. He has developed expertise in analyzing brain "electrodynamics"—not brain waves themselves, but signals and patterns extracted from EEGs that give insights into brain organization and functioning.

"Bill has ways to dig into the EEG data and pull out information you can't see with the human eye," says Bosquet Enlow. "We want to

understand: Is there something we could detect in early development, before behavioral or emotional symptoms emerge, that signals a difference in neural circuitry? And if so, could such differences be targeted through preventative interventions?"

EEG signatures for anxiety?

The study included 150 children enrolled starting in infancy. At age five years, a semi-structured interview with the child's mother assessed the child's psychiatric diagnostic history. The children had EEG recordings in infancy and at ages three, five and seven years.

Bosl and Bosquet Enlow found that EEG signals at age seven most robustly distinguished children with an anxiety disorder from healthy controls. However, there were signals even at three and five years of age. Recordings from two or three time points (excluding infancy) gave much better results than the age seven recordings alone.

"We found that not just a snapshot, but trajectories over time are the most predictive," says Bosquet Enlow. "A single EEG is only telling you what the brain is doing at that moment."

"We're not trying to make a diagnosis, but we're computing risk assessments or probabilities for anxiety, which is more natural and appropriate," says Bosl.

The study also looked at EEG patterns in children with externalizing disorders like ADHD or oppositional defiant disorder. Patterns were distinct from both those in children with anxiety and those in healthy controls. The conditions could be detected as early as ages three and five, especially with two or three recordings rather than a single snapshot.

Future directions

Bosl and Bosquet Enlow are now following the children to age 13, since adolescence is a time of enhanced risk for anxiety. In the future, they hope to:

- Analyze EEG patterns associated with different subtypes of anxiety, such as social anxiety, generalized anxiety, phobias, and separation anxiety. These may have distinct signatures.
- Look at EEG readings taken while showing children an anxiety-provoking stimulus (this study only analyzed resting EEGs).
- Determine how to combine EEG findings with measures like behavioral data, maternal anxiety/depression, and environmental stressors to reliably predict child psychopathology risk as early in development as possible.

"We're still figuring out what other variables to put in the model to make it even more predictive of anxiety," says Bosquet Enlow. "I do think the environment is critical and interacts with what the child's bringing."

Their long-range vision is to bring EEG measurements into routine pediatric check-ups using next-generation portable EEG devices, especially in areas with limited access to mental health professionals.

As for interventions, they could vary depending on the type of anxiety and what Bosquet Enlow and Bosl find to be the most relevant factors in developing anxiety.

"We hope that our work eventually informs more tailored interventions that take into account a given child's specific risk profile," says Bosquet Enlow. "Treatments that are specific to a child's biology and environment may have the greatest success in reducing or preventing symptoms."

More information: William J. Bosl et al, A biomarker discovery framework for childhood anxiety, *Frontiers in Psychiatry* (2023). DOI: 10.3389/fpsyt.2023.1158569