Medical Xpress

Using EEGs to diagnose autism spectrum disorders in infants

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A computational physicist and a cognitive neuroscientist at Children's Hospital Boston have come up with the beginnings of a noninvasive test to evaluate an infant's autism risk. It combines the standard electroencephalogram (EEG), which records electrical activity in the brain, with machine-learning algorithms. In a pilot study, their system had 80 percent accuracy in distinguishing between 9-month-old infants known to be at high risk for autism from controls of the same age.

Although this work, published February 22 in the online open-access journal *BMC Medicine*, requires validation and refinement, it suggests a safe, practical way of identifying infants at high risk for developing autism by capturing very early differences in brain organization and function. This would allow parents to begin behavioral interventions one to two years before autism can be diagnosed through traditional behavioral testing.

"Electrical activity produced by the brain has a lot more information than we realized," says William Bosl, PhD, a neuroinformatics researcher in the Children's Hospital Informatics Program. "Computer algorithms can pick out patterns in those squiggly lines that the eye can't see."

Bosl, Charles A. Nelson, PhD, Research Director of the Developmental Medicine Center at Children's, and colleagues recorded resting EEG signals from 79 babies 6 to 24 months of age participating in a larger study aimed at finding very early risk markers of autism. Forty-six infants had an older sibling with a confirmed diagnosis of an autism spectrum disorder (ASD); the other 33 had no family history of ASDs.

As the babies watched a research assistant blowing bubbles, recordings were made via a hairnet-like cap on their scalps, studded with 64 electrodes. When possible, tests were repeated at 6, 9, 12, 18 and 24 months of age.

Bosl then took the EEG brain-wave readings for each electrode and computed their modified multiscale entropy (mMSE) -- a measure borrowed from chaos theory that quantifies the degree of randomness in a signal, from which characteristics of whatever is producing the signal can be inferred. In this case, patterns in the brain's electrical activity give indirect information about how the brain is wired: the density of neurons in each part of the brain, how connections between them are organized, and the balance of short- and long-distance connections.

The investigators looked at the entropy of each EEG channel, which is believed to contain information about the density of neural connections in the brain region near that electrode.

"Many neuroscientists believe that autism reflects a 'disconnection syndrome,' by which distributed populations of neurons fail to communicate efficiently with one another," explains Nelson. "The current paper supports this hypothesis by suggesting that the brains of infants at high risk for developing autism exhibit different patterns of neural connectivity, though the relationship between entropy and the density of neural arbors remains to be explored." (Neural arbors are projections of neurons that form synapses or connections with other neurons.)

On average, the greatest difference was seen at 9 months of age. The researchers note that at 9 months, babies undergo important changes in their brain function that are critical for the emergence of higher-level social and communication skills -- skills often impaired in ASDs.

For reasons that still need to be explored, there was a gender difference: classification accuracy was greatest for girls at 6 months and remained high for boys at 12 and 18 months.

Overall, however, the distinction between the high-risk group and controls was smaller when infants were tested at 12 to 24 months. The authors speculate that the high-risk group may have a genetic vulnerability to autism that can be influenced and sometimes mitigated by environmental factors.

Bosl hopes to follow the high-risk group over time and compare EEG patterns in those who receive an actual ASD diagnosis and who appear to be developing normally – and then compare both groups to the controls.

"With enough data, I'd like to follow each child's whole trajectory from 6 to 24 months," Bosl adds. "The trend over time may be more important than a value at any particular age."

Although EEG testing for autism risk may seem impractical to implement on a wide scale, it is inexpensive, safe, does not require sedation (unlike MRI), takes only minutes to perform and can be done in a doctor's office. There are already data showing differences in EEG patterns for schizophrenia, major depression and PTSD, Bosl says.

Bosl also has started to collect data from older children 6 to 17 years old, and eventually hopes to have enough subjects to be able to compare EEG patterns for different types of ASDs.

Provided by Children's Hospital Boston