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Autism: New iSTART Model Of Brain Sheds Light On Triggers

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Approximately 1.5 million children and adults in the U.S. have autism and it is estimated to be the fastest growing developmental disability with a 10 - 17 percent increase each year. While much is known about the symptoms of autism, the exact cause of the condition is not yet defined.

A new model of the brain developed by Dr. Stephen Grossberg, professor and chairman of the Department of Cognitive and Neural Systems at Boston University, and Dr. Don Seidman, a pediatrician with the DuPage Medical Group in Elmhurst, IL, sheds light on the triggers of behaviors commonly associated with autism. The paper, "Neural Dynamics of Autistic Behaviors: Cognitive, Emotional, and Timing Substrates," appears in the July issue of the journal Psychological Review, published by the American Psychological Association.

"Autism involves multiple genes and correspondingly, people with autism are known to have multiple cognitive, emotional, and motor symptoms - such as impaired development of speech and difficulty expressing emotions," said Dr. Grossberg. "The iSTART model describes the various brain mechanisms that underlie autism and how they may give rise to the symptoms of the condition."

iSTART, which stands for Imbalanced Spectrally Timed Adaptive Resonance Theory, is derived from the earlier START model developed by Grossberg to explain how the brain controls normal behaviors. The new model describes how brain mechanisms that control normal emotional, timing, and motor processes may become imbalanced and lead to symptoms of autism. START and its imbalanced version iSTART are a combination of three models, each one of which tries to explain fundamental issues about human learning and behavior.

The first, called Adaptive Resonance Theory, or ART, proposes how the brain learns to recognize objects and events. Recognition is accomplished through interactions between perceptually-driven inputs and learned expectations. Inputs attempt to match expectations which helps prompt the brain to anticipate input/expectation patterns.

"When a match occurs, the system locks into a resonant state that drives how we learn to recognize things; hence the term adaptive resonance," explained Grossberg.

The degree of match that is required for resonance to occur is set by a vigilance parameter which controls whether a particular learned representation will be concrete or abstract. Low vigilance allows for learning of broad abstract recognition categories, such as a category that is activated by any face; high vigilance forces the learning of specific concrete categories, such as a category that is activated by a particular view of a familiar friend's face. iSTART proposes that individuals with autism have their vigilance fixed at such a high setting that their learned representations are very concrete, or hyperspecific.

"Hypervigilance leads to hyperspecific learning which perpetuates a multitude of problems with learning, cognition, and attention," said Grossberg.

The second model, called the Cognitive-Emotional-Motor, or CogEM, model, extends ART to the learning of cognitive-emotional associations, or associations that link objects and events in the world to feelings and emotions that give these objects and events value. Under normal circumstances, arousal of the circuits in the brain that control emotion are set at an intermediate level. Either under-arousal or over-arousal of these circuits can cause abnormal emotional reactions and problems with cognitive-emotional learning.

"If the emotional center is over-aroused, the threshold to activate a reaction is abnormally low, but the intensity of the emotion is abnormally small," said Grossberg. "In contrast, if the emotional circuits are under-aroused, the threshold for activating an emotion is abnormally high, but when this threshold is exceeded, the emotional response can be over reactive. The iSTART model proposes that individuals with autism experience under-aroused emotional depression which helps explain symptoms like reduced emotional expression as well as emotional outbursts."

The third model, called the Spectral Timing model, clarifies how the brain adaptively times responses in order to acquire rewards and other goals. iSTART shows how individuals with autism experience failures of adaptive timing that lead to the premature release of behaviors which are then unrewarded.

"iSTART depicts how autistic symptoms may arise from breakdowns in normal brain processes, notably a combination of under-stimulated emotional depression in the amygdala and related brain regions, learning of hyperspecific recognition categories in the temporal and prefrontal cortices, and breakdowns of adaptively timed attention and motor circuits in the hippocampal system and cerebellum," said Grossberg. "The model clarifies how malfunctions in these mechanisms can, though a system-wide vicious circle, cause and maintain problems with them all."

According to the researchers, iSTART is a breakthrough in the understanding of the many factors that contribute to autism and provides a unifying perspective that connects autistic symptoms to brain mechanisms that have no obvious connection to the condition.

"This approach should make it easier for scientists studying normal behavior to connect their work to autism research," said Grossberg. "iSTART opens up a wide range of possible new experiments to evaluate autistic behaviors and further test and develop the model."

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More information about iSTART and its component models can be found at http://www.cns.bu.edu/Profiles/Grossberg.

Founded in 1839, Boston University is an internationally recognized institution of higher education and research. With more than 30,000 students, it is the fourth largest independent university in the United States. BU contains 17 colleges and schools along with a number of multi-disciplinary centers and institutes which are central to the school's research and teaching mission.

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