Researchers reveal how the brain processes important information

April 2 2009

Researchers at UT Southwestern Medical Center have shed light on how the neurotransmitter dopamine helps brain cells process important information.

Researchers found in a study of mouse cells that this neurotransmitter, one of the molecules used by nerve cells to communicate with one another, causes certain brain cells to become more flexible and changes brain-cell circuitry to process important information differently than mundane information.

"This can help one remember a new, important episode as distinct from any other episode, such as remembering where you parked your car today versus yesterday," said Dr. Robert Greene, professor of psychiatry at UT Southwestern and senior author of the study published in the March 11 issue of the Journal of Neuroscience.

"If we can one day manipulate the way that salient information is processed, we might be able to not only improve learning, but also improve the learning needed to extinguish severe fear responsiveness, such as when a soldier can't forget emotional war memories associated with post-traumatic stress disorder," he said.

Dr. Greene said the research also could have implications for addictions and schizophrenia, because those conditions are associated with alterations in dopamine in the brain.

Researchers have known that dopamine is released in the brain in association with experiencing "important" events and remembering salient acts, such as learning to avoid a hot stove or that a good grade is rewarded. The current research focused on how dopamine operates on the cells associated with this type of memory formation.

Dr. Greene, director of the National Clozapine Coordinating Center at the Dallas Veterans Affairs Medical Center, and his research team isolated slices of the hippocampus region of the animals' brains and then electrically stimulated the cells. To simulate what happens in the brain in response to a memory-worthy event, they then exposed the cells to a selective dopamine-like neurotransmitter agent and repeated the stimulation. By comparing the effects of the stimulation with and without the dopamine agent, they could identify changes in NMDA receptor responses. NMDA receptors are proteins that mediate synaptic plasticity when activated.

"The NMDA responses changed to increase the cells' plasticity, and we think that this facilitates learning and memory," Dr. Greene said.

In addition, the changes in NMDA responses to dopamine agents changed the functional circuitry of the cells. These changes made the cells more responsive to electrical impulses coming from an indirect route through three processing "stations" before they reached the output region of the hippocampus. Without the presence of dopamine, Dr. Greene said, the cells tend to respond instead to impulses traveling by a route that is more direct and requires less processing. Information sent by this direct route may reflect what is already known and is less likely to change the animal's behavior.

"While the current study involved isolated mouse brain tissue containing the memory circuits, the human brain likely works the same way," Dr. Greene said. "You don't want to have interference from yesterday. You need to know where you parked your car today, and dopamine may help to ensure that information from today will be remembered as distinct from yesterday."

The researchers next will study how dopamine modulation affects learning and memory-related behavior and will investigate further exactly how dopamine acts on cells and their circuits.

Source: UT Southwestern Medical Center (news : web)