Scientists Learn How Brain 'Boots up' to Process Sensory Info

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The same chemical in the body that is targeted by the drug Viagra also helps our brains “boot up” in the morning so we can process sights, sound, touch and other sensory information. The discovery could lead to a better understanding of major brain disorders, according to researchers from Wake Forest University School of Medicine.

“We’ve learned new information about how our brains process sensory information, which may help increase our understanding of what goes awry in conditions such as schizophrenia, attention deficit disorder and epilepsy,” said Dwayne Godwin, Ph.D., associate professor of neurobiology and anatomy and senior author of the study, reported on-line this week in the journal Neuroscience.

Through studying ferrets, the researchers set out to understand the role of nitric oxide, a small gaseous molecule with big roles in health. The drug Viagra acts by slowing down the breakdown of nitric oxide in the penis, leading to increased blood flow. The heart drug nitroglycerin is converted to nitric oxide by the body and widens blood vessels, easing the pain of angina.

In the brain, small puffs of the gas are naturally released during the day by the brainstem, where it affects another region called the thalamus, but scientists knew little about its role.

Nitric oxide is released during awareness, or aroused states of the brain. In the animal studies, Godwin and colleagues found something surprising

about how it enhances the flow of sensory information from the eyes to the brain to process vision.

“Just as a computer must boot up its operating system before running involved applications like spreadsheets, nitric oxide released as the brain wakes up may set the stage for more complex brain operations by enhancing information at the earliest processing steps,” said Godwin.

Sensory information from the eyes, skin or ears goes first to the thalamus, which acts like a gateway and either allows the information to flow on to the cortex, the thinking part of the brain, or stops it. Scientists knew that the thalamus sends information to the cortex, but did not know that nitric oxide affects how the cortex communicates back.

“What we have shown is that nitric oxide released into the thalamus enhances communication between the thalamus and cortex. This is a whole new understanding of how the brain communicates,” said Godwin.

He explained that the cortex receives visual information from the thalamus that is basically just a small part of an image, analogous to a pixel in a photograph. The cortex then builds up a more complex representation, which it then feeds back to the thalamus to select the information that it needs to complete or organize the picture. Nitric oxide enhances this feedback effect.

This discovery was made by isolating inputs to the thalamus into two groups: inputs from the eyes; and a second group of feedback inputs from the cortex. What they found about nitric oxide’s role was surprising.

“We expected to find that signals from the eye would be boosted by nitric oxide,” said Godwin. “Instead, we found that nitric oxide reduced signals from the eyes, and enhanced the feedback from the cortex. The

tiny molecule appears to allow the cortex to exert more control on how much information it receives from the thalamus."

Godwin said it is likely that our other senses work the same way.

"This showed us something important about how the brain communicates with itself – it is a more cooperative and flexible relationship than we imagined," he said. "It is commonly thought that vision flows from the eye to the cortex through a straight line. Now we know that vision and other senses are more like a loop whose strength may wax and wane with the arousal of our brain."

Godwin said the finding has implications for human health because it increases understanding of brain communication in normal cognitive processing. "This study shows a unique role for nitric oxide. It may help us to someday understand what goes wrong in diseases that affect cognitive processing, such as attention deficit disorder or schizophrenia, and it adds to our fundamental understanding of how we perceive the world around us."

Source: Wake Forest University Baptist Medical Center