MedicalXpress

Study reveals potential role of 'love hormone' oxytocin in brain function

August 4 2013

In a loud, crowded restaurant, having the ability to focus on the people and conversation at your own table is critical. Nerve cells in the brain face similar challenges in separating wanted messages from background chatter. A key element in this process appears to be oxytocin, typically known as the "love hormone" for its role in promoting social and parental bonding.

In a study appearing online August 4 in *Nature*, NYU Langone Medical Center researchers decipher how oxytocin, acting as a neurohormone in the brain, not only reduces background noise, but more importantly, increases the strength of desired signals. These findings may be relevant to autism, which affects one in 88 children in the United States.

"Oxytocin has a remarkable effect on the passage of information through the brain," says Richard W. Tsien, DPhil, the Druckenmiller Professor of Neuroscience and director of the Neuroscience Institute at NYU Langone Medical Center. "It not only quiets background activity, but also increases the accuracy of stimulated impulse firing. Our experiments show how the activity of brain circuits can be sharpened, and hint at how this re-tuning of brain circuits might go awry in conditions like autism."

Children and adults with autism-spectrum disorder (ASD) struggle with recognizing the emotions of others and are easily distracted by extraneous features of their environment. Previous studies have shown that children with autism have lower levels of oxytocin, and mutations in

the oxytocin receptor gene predispose people to autism. Recent brain recordings from people with ASD show impairments in the transmission of even simple sensory signals.

The current study built upon 30-year old results from researchers in Geneva, who showed that oxytocin acted in the hippocampus, a region of the brain involved in memory and cognition. The hormone stimulated nerve cells – called inhibitory interneurons – to release a chemical called GABA. This substance dampens the activity of the adjoining excitatory nerve cells, known as pyramidal cells.

"From the previous findings, we predicted that oxytocin would dampen brain circuits in all ways, quieting both background noise and wanted signals," Dr. Tsien explains. "Instead, we found that oxytocin increased the reliability of stimulated impulses – good for brain function, but quite unexpected."

To resolve this paradox, Dr. Tsien and his Stanford graduate student Scott Owen collaborated with Gord Fishell, PhD, the Julius Raynes Professor of Neuroscience and Physiology at NYU Langone Medical Center, and NYU graduate student Sebnem Tuncdemir. They identified the particular type of inhibitory interneurons responsible for the effects of oxytocin: "fast-spiking" inhibitory interneurons.

The mystery of how oxytocin drives these fast-spiking inhibitory cells to fire, yet also increases signaling to pyramidal neurons, was solved through studies with rodent models. The researchers found that continually activating the fast-spiking inhibitory neurons – good for lowering background noise – also causes their GABA-releasing synapses to fatigue. Accordingly, when a stimulus arrives, the tired synapses release less GABA and excitation of the pyramidal neuron is not dampened as much, so that excitation drives the pyramidal neuron's firing more reliably.

"The stronger signal and muffled background noise arise from the same fundamental action of oxytocin and give two benefits for the price of one," Dr. Fishell explains. "It's too early to say how the lack of oxytocin signaling is involved in the wide diversity of autism-spectrum disorders, and the jury is still out about its possible therapeutic effects. But it is encouraging to find that a naturally occurring neurohormone can enhance brain circuits by dialing up wanted signals while quieting background noise."

More information: Oxytocin enhances hippocampal spike transmission by modulating fast-spiking interneurons, DOI: 10.1038/nature12330

Provided by New York University School of Medicine