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Study shows certain brain waves aren't just background noise

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Even when at rest, the brain is never truly quiet.

New research in mice sheds light on the seemingly random brain signals that hum in the background of brains. These signals might help the brain switch between states of inattention or disengagement and states of optimal performance, UO researchers reported Oct. 14 in the journal *Neuron*.

Neuroscientists have been studying an oscillating background wave called the alpha rhythm in the human brain for decades. This signal appears to reflect whether a person is engaged and attentive or not, but the neurobiological basis for the signal isn't fully understood.

"Brain states have big effects on how you can think and perform," said UO neuroscientist and Presidential Chair David McCormick, who led the new study with postdoctoral researcher Dennis Nestvogel.

If the brain is idling in background mode, it's processing information less efficiently, making it harder to do something that requires deep focus. On the other hand, if the brain is too amped up, it might not perform at its best either. Understanding how these brain states are regulated, and how the brain can switch between them, might help scientists learn more about focus, attention and engagement.

In their study, McCormick and Nestvogel looked at a background firing pattern in mice brains that is similar to the human alpha rhythm. By recording animals' neural activity while they explored, the researchers could link the patterns of brain waves to behavior. They watched the rhythm appear when the mice were relaxing, then disappear when the animals were moving around or twitching their noses and whiskers.

That pattern of neural firing in an at-rest brain comes from a communication volley between two different brain regions, the thalamus and the cortex, the pair showed.

"We've known the thalamus is important for sleep," Nestvogel said. "But not much is known about how the thalamus may control moment-to-moment changes in waking states."

The thalamus is like a switchboard in the brain: It takes in signals from many different brain regions, and routes them out again. The particular neurons at play here "can send two different types of signals: They can rhythmically discharge in a resting hum, or they can switch to information-transmitting mode," McCormick said. And mice could switch between those two states within milliseconds, the team noticed.

When the researchers silenced activity from the thalamus, the cortex couldn't switch into the more attentive, information-sending state. Instead, the background signals were reminiscent of the patterns seen when mice are drowsy or sleeping.

Going forward, McCormick and Nestvogel hope to learn more about the origins of these background rhythms in the brain and better understand how they affect performance. Ultimately, knowing how these brain circuits work help might lead to better treatments for ADHD and other disorders that affect attention and focus.

"In the past, people thought that most of the spontaneous rhythms in the awake brain constitute random noise," Nestvogel said. "We still don't fully know their purpose, but we can now better predict these signals and see their effects on information processing and behavior."

More information: Dennis B. Nestvogel et al, Visual thalamocortical mechanisms of waking state-dependent activity and alpha oscillations, *Neuron* (2021). DOI: 10.1016/j.neuron.2021.10.005

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