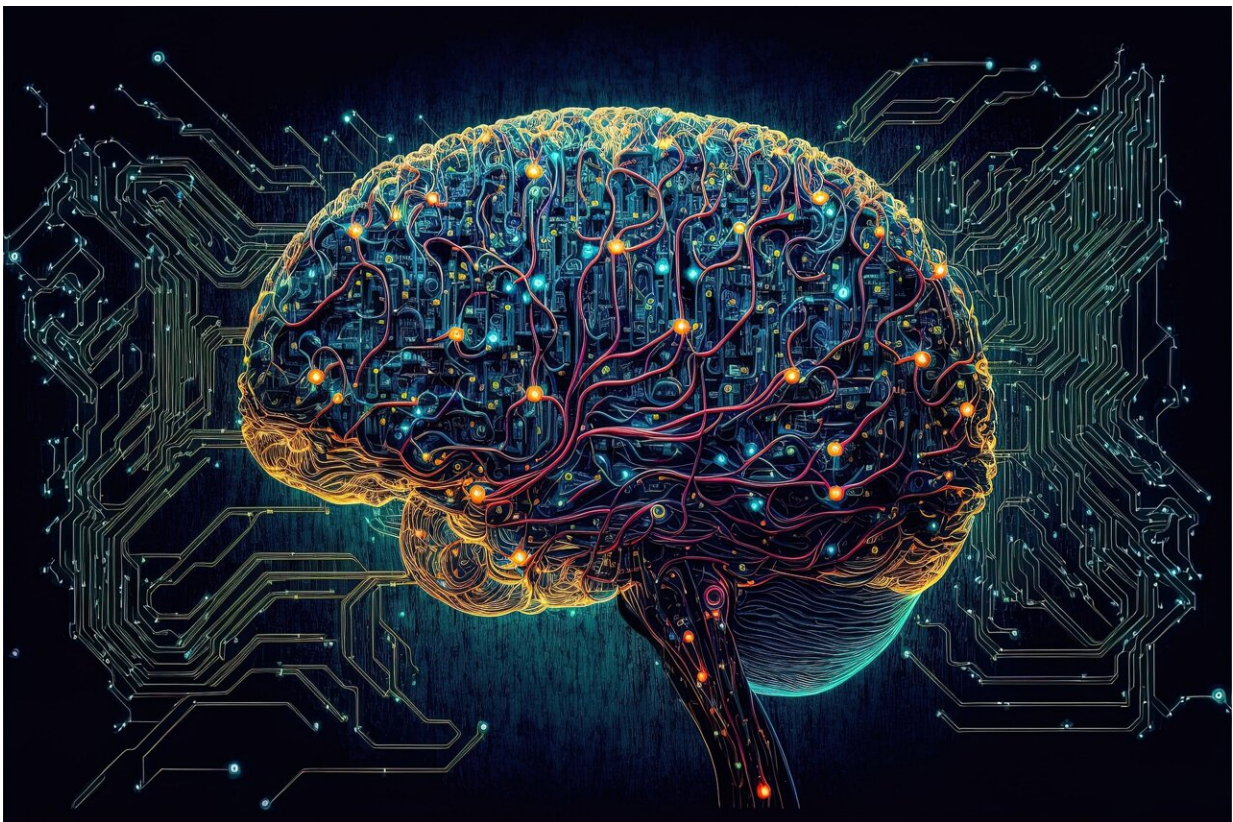


How the brain structure that produces norepinephrine also helps control visual attention

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The locus coeruleus (LC) is a small region of the brainstem that produces norepinephrine, a chemical with powerful effects on arousal

and wakefulness which plays an important role in the body's response to stress or panic. Now, research from the University of Chicago shows it plays a specific role in visual sensory processing as well.

In a study, titled "[Locus coeruleus norepinephrine selectively controls visual attention](#)" and published in *Neuron*, neuroscientists [artificially increased neuronal activity](#) in the LC by briefly shining light on genetically modified neurons. They saw that this manipulation selectively enhanced performance in non-human primates performing a visual attention task, underscoring the crucial role that attention plays in sensory perception.

"We want to understand what changes in your brain when you pay attention to something in the environment, because attention greatly affects your ability to discern stimuli," said John Maunsell, Ph.D., the Albert D. Lasker Distinguished Service Professor of Neurobiology and Director of the Neuroscience Institute at the University of Chicago, and co-author of the study.

"Now we have found a brain structure that has strong signals related to whether the subjects are paying attention to a stimulus or not, and we see big differences in how its neurons respond depending on where that attention is directed."

Maunsell and co-author Supriya Ghosh, Ph.D., a postdoctoral researcher, focus their studies on how neurons in different areas of the brain change to represent sensory input when a subject is paying attention to a stimulus or not. For example, activity of neurons in the [cerebral cortex](#) may increase by 10–25% when a subject pays attention to the stimuli those neurons represent.

Previous research has shown that LC activation, coupled with its ensuing norepinephrine production, might improve performance on tasks that

require attention to discern between visual stimuli.

Ghosh, who specializes in subcortical brain structures, suggested that the LC might be a good candidate to study for these effects. The team trained two monkeys to perform a visual task in which they paid attention to the left or right side of a screen. First, a sample image would appear on both sides of the screen.

Next, after a delay, a test image would appear on one side of the screen. The monkey would report if that image was oriented differently than the sample shown earlier on that side of the screen by moving its eyes to one of two targets. The researchers recorded neuron activity in the LC during the task and saw that activity increased greatly—and only—when the animal attended to the image that appeared on the side of the screen monitored by those neurons.

To see if there was a [causal relationship](#) between this increased activity and performance, they also used a method called optogenetics to increase activity in the LC while the animals were performing the task. Optogenetics allows researchers to selectively control the activity of norepinephrine-expressing cells via light.

First, they introduce a [genetic modification](#) that causes neurons to produce a light-sensitive protein called opsin, the same type of protein that photoreceptors in the eye use to detect light. When they shine a special light on these neurons, the opsin causes the neurons to fire.

Optogenetically boosting the responses of the neurons drastically improved the animals' ability to differentiate the shapes on the corresponding half of the screen, without affecting motor processing.

"This kind of artificial enhancement of that activity did not interfere with other cognitive factors either, such as motor actions or decision-

related activities," Ghosh said. "So, it could selectively contribute to the perceptual sensitivity in a very precise way."

Distinguishing the effects of attention from other factors, like decision-making or motor movements, is crucial, Ghosh said. Those processes take place in other parts of the brain, and can contribute to performance independently. Understanding how a relatively small brain structure like the LC impacts such an important function as attention is also one step toward solving the overall puzzle of the brain.

"Every time we get more information about the likely contribution of a given brain structure, or how broad the range of functions of a given structure might be, that gives us much more power to understand the relationships among them," Maunsell said. "No one part of the brain does interesting behaviors by itself."

More information: Locus coeruleus norepinephrine contributes to visual spatial attention by selectively enhancing perceptual sensitivity, *Neuron* (2024). [DOI: 10.1016/j.neuron.2024.04.001](https://doi.org/10.1016/j.neuron.2024.04.001).
[www.cell.com/neuron/fulltext/S0896-6273\(24\)00239-3](https://www.cell.com/neuron/fulltext/S0896-6273(24)00239-3)

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