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Study details brain pathways linking visual function, running

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A new study by researchers at the University of Oregon published today in the journal *Neuron* describes a brainstem circuit in mice that may help explain how active movement impacts the way the brain processes sensory information.

"Previous studies have examined changes in the visual cortex of mice during running. What was unknown was how do running and vision get linked together in the first place?" said Cristopher Niell, a biology professor in the Institute of Neuroscience and the senior author on the paper "Identification of a Brainstem Circuit Regulating Visual Cortical State in Parallel with Locomotion."

The "aha moment" that inspired the study came five years ago when Niell, as a postdoctoral fellow in Michael Stryker's lab at the University of California, San Francisco, was examining visual perception in mice. He observed that running appeared to be changing how neurons in the brain were firing.

"We found that running turned up the magnitude in the mouse's visual cortex by about two-fold—the signals were basically twice as strong when the mouse was running," Niell said.

This initial finding, demonstrating a mind-body connection in the mouse visual system, was published in *Neuron* in 2010. Following up on this finding, Niell's team sought to identify neural circuits that could link movement and vision together.

The researchers focused on the brain's mesencephalic locomotor region (MLR), which has been shown to mediate running and other forms of activity in many species. They hypothesized that neural pathways originating in the MLR could serve a dual role – sending a signal down to the spinal cord to initiate locomotion, and another up to the cortex to turn up the visual response.

Using optogenetic methods, the team created genetically sensitized neurons in the MLR region of the mouse brain that could be activated by light. The team then recorded the resulting increased visual responses in the cortex. Their results demonstrated that the MLR can indeed lead to both running and increased responsiveness in the cortex, and that these two effects could be dissociated, showing that they are conveyed via separate pathways.

Next, researchers activated the terminals of the neurons' axons in the basal forebrain, a region that sends neuromodulatory projections to the visual cortex. Stimulation here also induced changes in the cortex, but without the intermediary step of running. Interestingly, the basal forebrain is known to use the neuromodulator acetycholine, which is often associated with alertness and attention.

It is unclear whether humans experience heightened visual perception while running, but the study adds to growing evidence that the processes governing active movement and sensory processing in the brain are tightly connected. Similar regions have been targeted in humans for therapeutic deep-brain stimulation to treat motor dysfunction in patients with Parkinson's disease. Activating this circuit might also provide a means to enhance neuroplasticity, the brain's capacity to rewire itself.

Niell's team included Moses Lee, a visiting scholar at the UO and student in the M.D.-Ph.D. program at UC-San Francisco, who served as the lead author on the paper. "While it seems that moving and sensing are two independent processes, a lot of new research suggests that they are deeply coupled," Lee said. "My hope is that our study can help solidify our understanding of how the brain functions differently in 'alert' states."

Provided by University of Oregon

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