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Research shows how sensory-deprived brain compensates

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Whiskers provide a mouse with essential information to negotiate a burrow or detect movement that could signal a predator's presence. These stiff hairs relay sensory input to the brain, which shapes neuronal activity. In a first, studies of this system by Carnegie Mellon scientists show just how well a mouse brain can compensate when limited to sensing the world through one whisker. Published April 4 in the *Journal of Neuroscience*, the results should help shape future studies of sensory deprivation that results from stroke or traumatic brain injury, say the authors.

"Our findings are the first to show this degree of brain adaptability in a setting with significantly limited sensory input," said Alison Barth, assistant professor of biological sciences and a member of the Center for the Neural Basis of Cognition (CNBC). "This finding tells us that brain function is plastic, or reparable, when a sense like touch has been profoundly diminished. Plasticity is an important indicator that the brain is reorganizing to compensate for an injury or deficit."

For a decade, neuroscientists have known that the brain can increase its plasticity, or adapt, in response to injury that limits bodily motion. This latest study is the first to show such an impressive enhancement of brain activity in an animal with sensory loss. Losing sight, hearing, taste, smell or touch are common disabling side effects of traumatic brain injury and stroke.

In her study, Barth recorded brain activity in mice with various degrees of whisker removal. As a first step in her research, Barth removed all but one whisker and recorded neural activity in a brain region located on the opposite side of the animal. (Flicking a whisker on one side of a mouse stimulates a part of the brain on the animal's opposite side). Over the course of a week, Barth found that one whisker could not only stimulate a predicted cluster of neurons inside the brain; it could also activate nearby neurons. While some degree of plasticity would be expected, the growth of brain activity seen in the experiments was striking, Barth says.

"What this tells us is that the parts of the brain processing sensory information are extremely adaptive and can strengthen in the presence of limited sensory input," Barth said.

In another experiment, Barth found something more surprising — a single-whiskered mouse was more likely to generate new brain activity than a mouse with a whisker on one side of its head and a full complement of whiskers on the other side.

"These findings show us that a fully functioning set of whiskers on one side of the body dramatically inhibits the ability of a single whisker to remodel the brain," said Barth. "This finding suggests that we could boost the brain's plasticity if we 'turn off' sensory input from the opposite side of the body."

Hypothetically, in a clinical setting, doctors could temporarily remove a patient's ability to see, hear, smell or touch on one side of the body to force the same sense on the other side of the body to expand its activity within the brain, thereby remodeling it to perceive a limited sensation much better.

This kind of "forced use" therapy is already applied in the clinic for patients with motor deficits. For example, a patient who suffers a brain injury is made to use a poorly performing arm with the expectation that the brain may be plastic enough to assist that arm in recovering motion.

"We think that our well-designed model is extremely good for future in-depth studies of brain plasticity in response to changes in how an animal senses its environment. Ultimately, we want to understand at the molecular level the dynamic between sensory use and neural plasticity," Barth said.

Source: Carnegie Mellon University

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