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Scientists Unmask Brain's Hidden Potential

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Description

New findings explaining how the brain compensates for loss of vision also suggest that the brain is much more versatile than previously recognized.

Newswise — Previous research has found that when vision is lost, a person's senses of touch and hearing become enhanced. But exactly how this happens has been unclear.

Now a long-term study from the Berenson-Allen Center for Noninvasive Brain Stimulation at Beth Israel Deaconess Medical Center (BIDMC) demonstrates that sudden and complete loss of vision leads to profound – but rapidly reversible -- changes in the visual cortex. These findings, reported in the August 27 issue of the journal *PLOS One*, not only provide new insights into how the brain compensates for the loss of sight, but also suggest that the brain is more adaptable than originally thought.

"The brain's ability to reorganize itself is much greater than previously believed," explains senior author Alvaro Pascual-Leone, MD, PhD, Director of the Berenson-Allen Center and Professor of Neurology at Harvard Medical School (HMS). "In our studies [in which a group of sighted study subjects were blindfolded for five days], we have shown that even in an adult, the normally developed visual system quickly becomes engaged to process touch in response to complete loss of sight. The speed and dynamic nature of the changes we observed suggest that rather than establishing new nerve connections – which would take a long time – the visual cortex is unveiling abilities that are normally concealed when sight is intact."

Or, as first author Lotfi Merabet, OD, PhD, describes, "In a sense, by masking the eyes, we unmask the brain's compensatory potential."

The scientists had previously shown that study subjects with normal vision who are blindfolded for a five-day period performed better than non-blindfolded control subjects on Braille tests. Subsequent brain scans found that blindfolded subjects also experienced dramatic changes in the brain's visual cortex.

In this study, the authors set out to determine the origins of these outcomes: Were they the result of new nerve connections being developed? Or were latent capabilities in the brain's visual cortex being "unmasked" in response to the loss of sight?

"We recruited 47 subjects to participate in the study," explains Merabet, Assistant Professor of Ophthalmology and Neurology at HMS. "Half of the study participants remained completely blindfolded, 24 hours a day, for a total of five days under the careful watch of the staff of BIDMC's General Clinical Research Center. The other half were only blindfolded for testing, but spent the rest of the day seeing normally. During their stays, both sets of study participants underwent intensive Braille instruction for four to six hours a day from a professional instructor from the Carroll Center for the Blind."

The study participants also underwent serial brain scans (known as fMRI or functional magnetic resonance imaging) at both the beginning and end of the five-day study period.

As predicted, the researchers found that the subjects who were blindfolded were superior at learning Braille than their non-blindfolded counterparts. Furthermore, the brain scans of the blindfolded subjects showed that the brain's visual cortex had become extremely active in response to touch (in contrast to the initial scan in which there was little or no activity). Twenty-four hours after the blindfolds were removed, the subjects were re-scanned, whereby it was discovered that their visual cortices were no longer responsive to tactile stimulation – in other words, reading Braille no longer activated "sight" among the study subjects. Finally, using transcranial magnetic stimulation (TMS) to transiently block the function of the visual cortex, the scientists demonstrated that disruption of the visual cortex impaired tactile function and Braille reading after five days of blindfolding – but not a day after the blindfold was removed and never in the control subjects.

"This extremely rapid adaptation indicates that functions that are normally inhibited in the brain's visual cortex will come to the surface when they are needed," adds Merabet. "We believe that over time, if these adaptive functions are sustained and reinforced, they will eventually lead to permanent structural changes."

"Our brain captures different types of information from the world -- sounds, sights, smells or tactile sensations," adds Pascual-Leone. "The impressions we form require us to merge these various different elements, but science's traditional view of brain function is that it is organized in separate and highly specialized systems."

But, he says, as the results of this research demonstrate, that is not the case.

"Our study shows that these views are incorrect and illustrate the potential for the human brain to rapidly and dynamically reorganize itself," notes Pascual-Leone. "We have shown that even in an adult, the normally developed visual system quickly becomes engaged to process touch in response to complete loss of sight. And we believe that these principles may also apply to other sensory loss, such as deafness or loss of function following brain injury."

In addition to Pascual-Leone and Merabet, study coauthors include BIDMC investigators Roy Hamilton, Gottfried Schlaug, Jascha Swisher, Elaine Kiriakopoulos, Naomi Pitskel, and Thomas Kauffman.

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