# Brain flexibility may hasten hearing improvements from cochlear implants

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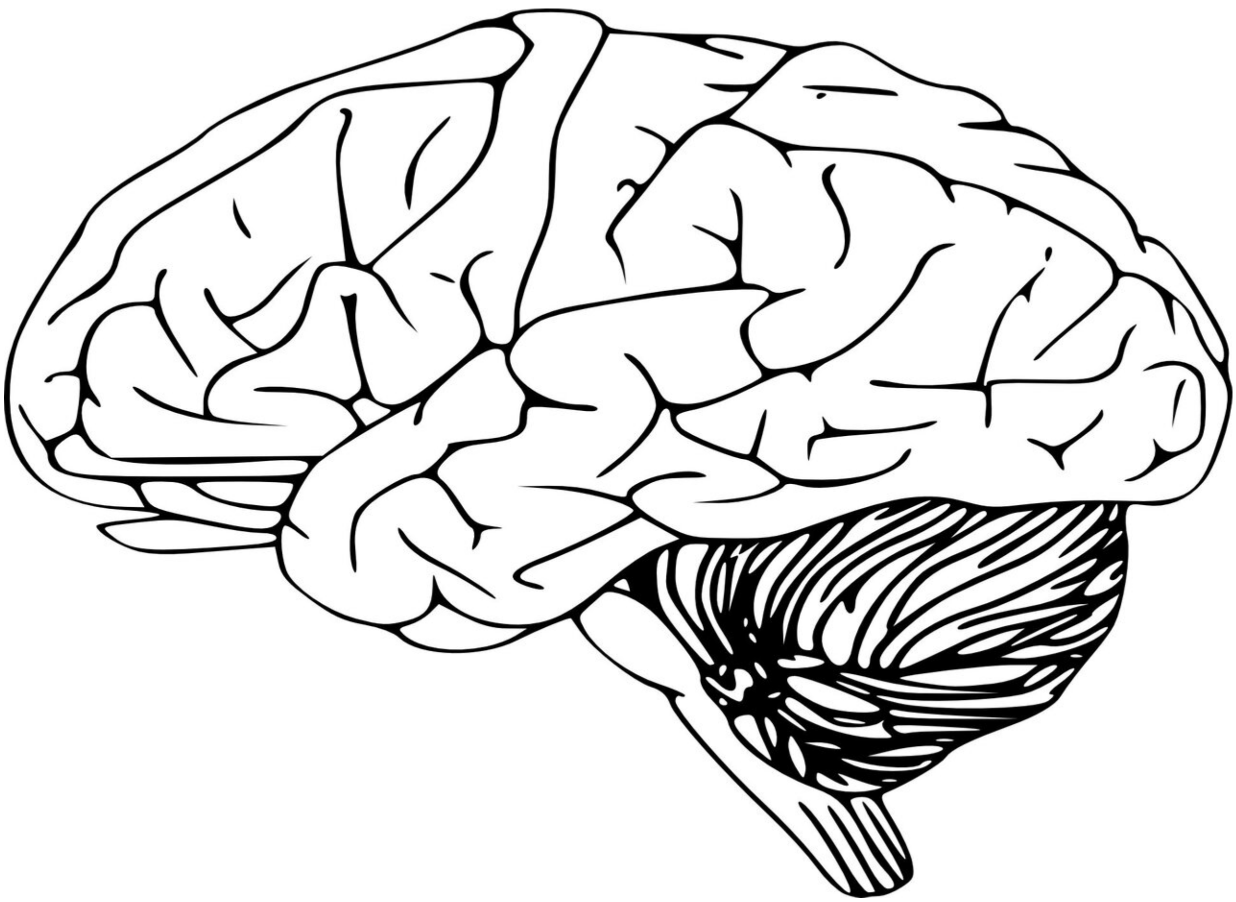

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Kickstarting the brain's natural ability to adjust to new circumstances, or neuroplasticity, improves how effectively a cochlear implant can restore hearing loss, a new study in deaf rats shows. The investigation, researchers say, may help explain the extreme variation in hearing improvements experienced by implant recipients.

Unlike hearing aids, which amplify, balance, and sharpen incoming sound, cochlear implants send electrical signals that represent sounds directly to the brain. Unfortunately, experts say, it can take time to understand the meaning of the signals. Past studies had shown that, while some cochlear implant users understand some speech hours after receiving their device, others required months or years to do so. However, the mechanisms that determine how quickly the brain can adjust to an implant have been unclear.

Led by researchers at NYU Langone Health, the new investigation in rats evaluated whether stimulating the locus coeruleus, a major site of neuroplasticity deep in the brainstem of mammals, improved how quickly they learned to use their devices. It showed that within just three days of receiving their implants, rodents given the extra boost could effectively complete tasks that required accurate hearing. By contrast, those without the stimulation needed up to 16 days to do so.

"Our findings suggest that differences in neuroplasticity, particularly in parts of the brain such as the locus coeruleus, may help explain why some cochlear implant users improve faster than others," says study lead author and neuroscientist Erin Glennon, Ph.D., a medical student at NYU Grossman School of Medicine.

In an earlier investigation, the research team found that electrically stimulating the locus coeruleus in rodents increases neuroplasticity and changes how the brain's hearing system represents sound. However, the new study, publishing online Dec. 21 in the journal *Nature,* is the first to demonstrate that stimulating this brain region hastens hearing among cochlear implant recipients, according to Glennon.

For the investigation, the study authors trained normal hearing rats to press a button after they heard a particular sound and to ignore the button if they heard a different tone. Once deafened, the rats were unable to complete the task. Then they were given cochlear implants and retrained to perform the same challenge by relying on the device.

Among the findings, the study showed that locus coeruleus activity changed dramatically as the rats learned to use their implants. At first, the brain region was most active when the animals received food after hearing the tone and pressing the correct button. As they learned to associate pressing the button with receiving the reward, activity instead peaked when they just heard the tones. Notably, the faster this change occurred, the faster the rats consistently succeeded at the task.

"Our results suggest that improving neuroplasticity in the locus coeruleus may speed up and bolster the effectiveness of cochlear implants," says study co-senior author and neuroscientist Robert Froemke, Ph.D., the Skirball Foundation Professor of Genetics in the Department of Neuroscience and Physiology at NYU Langone.

Froemke says the team next plans to explore ways of stimulating the brain region in humans that do not require invasive surgery. Froemke also serves as a professor in Department of Otolaryngology—Head and Neck Surgery at NYU Langone.

"Since our goal is to activate the locus coeruleus, we need to determine what noninvasive mechanisms may be used to trigger the brain region," says study co-senior author Mario Svirsky, Ph.D. Svirsky is the Noel L. Cohen Professor of Hearing Science in the Department of Otolaryngology—Head and Neck Surgery at NYU Langone.

Svirsky, also a professor in NYU Langone's Department of Neuroscience and Physiology, cautions that the rats' hearing was examined using simple sounds in a straightforward task, while humans need to respond to nuanced speech patterns in noisy environments. Further research, he says, is needed into other brain regions that may be involved.

In addition to Glennon, Froemke, and Svirsky, other NYU study investigators involved in the study were Silvana Valtcheva, Ph.D.; Angela Zhu, MD; and Youssef Wadghiri, Ph.D.

**More information:** Robert Froemke, Locus coeruleus activity improves cochlear implant performance, *Nature* (2022). DOI: 10.1038/s41586-022-05554-8. www.nature.com/articles/s41586-022-05554-8

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