Crossmodal plasticity in hearing loss: Visual communication before cochlear implant use does not harm deaf children

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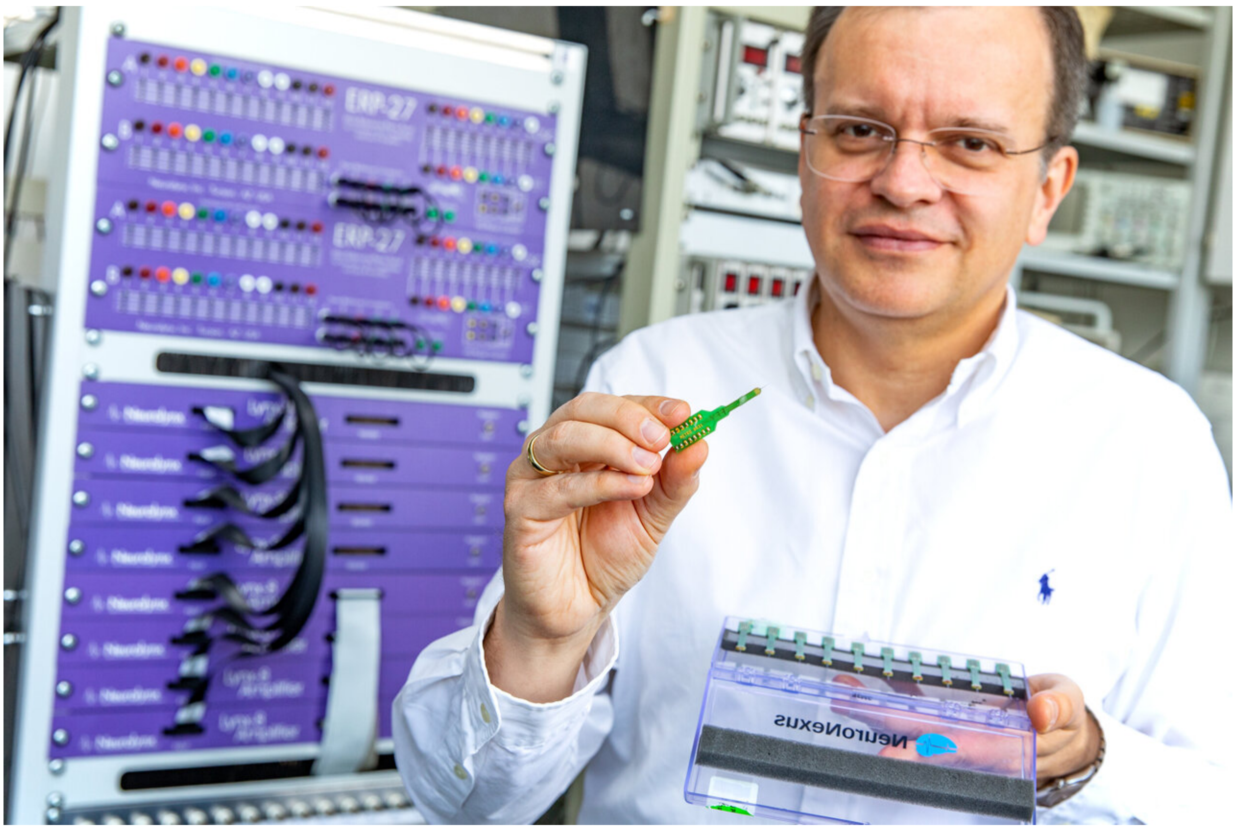

Professor Dr. Andrej Kral with a multi-electrode array in front of an amplifier for brain wave measurement. Credit: Karin Kaiser / MHH

Humans have five senses to perceive their environment: Sight, hearing, touch, smell and taste. If a person loses one of these, the remaining senses partially compensate for the loss. People born deaf then have enhanced visual abilities. "Cross-modal plasticity" is what science calls the brain's ability to turn to another sensory system when one is lost.

Until now, the textbook view has been that a takeover of the auditory system occurs in deafness, with the visual system, for example, irrevocably taking over parts of the auditory cortex. To avoid promoting this effect, some researchers have suggested avoiding communication through gestures or signing with children born deaf before insertion of a hearing prosthesis such as a cochlear implant (CI).

Now, a German-American team of authors led by Professor Dr. Andrej Kral, Scientific Director of the Institute for Audio and Neurotechnology (VIANNA) at Hannover Medical School (MHH), has compared recent data and studies from their own laboratories with others. These data show that crossmodal reorganization changes little in the anatomy of circuits in the brain. The existing networks are just used differently. When hearing is restored, the crossmodal reorganization regresses.

The results have been published in the journal *Trends in Neurosciences*.

Auditory cortex does not become a 'battlefield of the other senses'

During hearing, sound is converted into electrical impulses in the inner ear and transmitted via the auditory nerve through the midbrain and diencephalon to the cerebral cortex. This is where the auditory cortex is located, which is responsible for processing acoustic stimuli. Deaf people use parts of the auditory processing center in the cerebral cortex for visual impressions, such as motion detection.

"Reorganizing the brain is helpful for deaf people to better navigate the environment without an auditory sense," says Professor Kral. "But contrary to earlier assumptions, the neural connections to the auditory sense are not destroyed, so the auditory cortex does not become a battleground between the remaining senses. The existing network is slightly modified and used differently."

This is shown by recent data from animal models as well as from deaf children with hearing loss. Rather, crossmodal reorganization is a dynamic process that makes greater use of already existing nerve connections to other sensory systems, takes place even with mild hearing loss, and regresses after hearing is restored, he says. "Therefore, there is no reason to stop visual communication before inserting a hearing prosthesis," the scientist says. "This is important for the child's development."

Insert hearing prosthesis as early as possible

Nonetheless, rapid insertion of a CI is critical for children born deaf. Hearing loss has extensive negative effects on the hearing system itself that cross-modal reorganization cannot compensate for. "Early therapy with a CI is necessary because in congenital deafness, the hearing system itself cannot develop normally," Professor Kral explains.

"If a child misses out on early hearing experiences, he or she loses many contact points in the auditory cortex and later fails to learn to recognize auditory impressions and speech sounds and to integrate hearing with other sensory perceptions."

Therefore, he said, a hearing prosthesis must be inserted as early as possible, preferably in the first year of life, and at the very latest by age three. "After that, the critical period for hearing therapy is closed."

More information: Andrej Kral et al, Crossmodal plasticity in hearing loss, *Trends in Neurosciences* (2023). DOI: 10.1016/j.tins.2023.02.004

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