Two bionic ears are better than the sum of their parts

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Credit: Tel Aviv University

Cochlear implants—electronic devices surgically implanted in the ear to help provide a sense of sound—have been successfully used since the late 1980's. But questions remain as to whether bilateral cochlear implants, placed in each ear rather than the traditional single-ear implant, are truly able to facilitate binaural hearing. Now, Tel Aviv University researchers have proof that under certain conditions, this practice has the ability to salvage binaural sound processing for the deaf and hard-of-hearing.

According to Dr. Yael Henkin of TAU's Department of Communication Disorders at the Stanley Steyer School of Health Professions and Head

of The Hearing, Speech, and Language Center at Sheba Medical Center, and her colleagues Prof. Minka Hildesheimer, Yifat Yaar-Soffer, and Lihi Givon, the brain unites incoming sound from each ear at the brainstem through what is called "binaural processing." "When we hear with both ears, we have an efficient auditory system," she explains. Binaural processing provides improved ease of listening, sound localization, and the ability to understand speech in noisy surroundings.

In their study, the researchers looked at children who had lost their hearing at a young age and were not born deaf. Those who were provided with bilateral cochlear implants exhibited true binaural processing, similar to that of their normal hearing peers. In contrast, deaf-at-birth children who received their first cochlear implant at young age and their second after long delay, did not exhibit binaural processing.

The research was recently reported in the journal Cochlear Implants International.

Pairing up

More than a matter of symmetry, our two ears function together to create a whole picture of the sound that surrounds us. The integration of information from both ears not only saves neuronal energy, it is the key to different aspects of hearing, such as locating the source of individual sounds and being able to differentiate between different sounds in a noisy room.

Dr. Henkin and her fellow researchers set out to determine if bilateral cochlear implants were able to restore some binaural processing in the brain. Their study included three groups: children who had lost their hearing as toddlers due to illness and received bilateral cochlear implants soon afterwards; children who had been born deaf and received their first implant at around the age of four and a second approximately six

years later; and a control group with normal hearing.

The researchers measured the brainwave P300, associated with auditory discrimination, while participants were asked to listen for the syllables "ta" and "ka" and were told to press a button when they heard the syllable "ta". The sounds were delivered in turn to the left ear, the right ear, and both ears at once. By comparing the P300 brainwaves identified when both ears were stimulated to the sum of brainwaves identified when each ear was stimulated separately a binaural interaction component was identified.

The researchers found a binaural interaction component in participants who had not been born deaf and had received bilateral implants at a young age. This suggested that "auditory experience prior to cochlear implantation is critical for binaural processing," says Dr. Henkin. But in the children who had only one implant for many years, the researchers found no evidence of binaural processing. It appears that the auditory deprivation that results from a long delay between implants may render the system incapable of restoring itself, explain the researchers.

Synchronized technology?

This study adds to the body of literature on how brain function is impacted by both deafness and rehabilitation, says Dr. Henkin. Currently it is not possible to coordinate the operation of separate bilateral implants, but in the future these implants may be designed to synchronize with each other, providing the hearing-impaired patient with the cues required for binaural processing, she says.

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