Insights into how brain compensates for recurring hearing loss point to new glue ear therapies

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Important new insights into how the brain compensates for temporary hearing loss during infancy, such as that commonly experienced by children with glue ear, are revealed in a research study in ferrets. The Wellcome Trust-funded study at the University of Oxford could point to new therapies for glue ear and has implications for the design of hearing aid devices.

Normally, the brain works out where sounds are coming from by relying on information from both ears located on opposite sides of the head, such as differences in volume and time delay in sounds reaching the two ears. The shape of the outer ear also helps us to interpret the location of sounds by filtering sounds from different directions, so-called spectral cues. This ability to identify where sounds are coming from not only helps us locate the path of moving objects, but also to separate different sound sources in noisy environments.

Glue ear, or otitis media, is a relatively common condition caused by a build-up of fluid in the middle ear that causes temporary hearing loss. By age 10, 8 out of 10 children will have experienced one or more episodes of glue ear. It usually resolves itself but more severe cases can require interventions such as the insertion of tubes, commonly known as grommets, to drain the fluid and restore hearing. If the loss of hearing is persistent, however, it can lead to impairments in later life even after normal hearing has returned, such as 'lazy ear', or amblyaudia, which

leaves people struggling to locate sounds or pick out sounds in noisy environments such as classrooms or restaurants.

Researchers at the University of Oxford used removable earplugs to introduce intermittent, temporary hearing loss in one ear in young ferrets , mimicking the effects of glue ear in children. The team then tested their ability to localise sounds as adults and measured activity in the brain to see how the loss of hearing affected their development.

The results show that animals raised with temporary hearing loss were still able to localise sounds accurately while wearing an earplug in one ear. They achieved this by becoming more dependent on the unchanged spectral cues from the outer part of the unaffected ear. When the plug was removed and hearing returned to normal, the animals were just as good at localising sounds as those who had never experienced hearing loss.

Professor Andrew King, a Wellcome Trust Principal Research Fellow at the University of Oxford who led the study, explains: "Our results show that, with experience, the brain is able to shift the strategy it uses to localise sounds depending on the information that is available at the time. During periods of hearing loss in one ear - when the spatial cues provided by comparing the sounds at each ear are compromised - the brain becomes much more reliant on the intact spectral cues that arise from the way sounds are filtered by the outer ear. But when hearing is restored, the brain returns to using information from both ears to work out where sounds are coming from."

The results contrast with previous studies which looked at the effects of enduring hearing loss – rather than recurring hearing loss - on brain development. These earlier studies found that changes in the brain that result from loss of hearing persisted even when normal hearing returned.

The new findings suggest that intermittent experience of normal hearing is important for preserving sensitivity to those cues and could offer new strategies for rehabilitating people who have experienced hearing loss in childhood.

In addition, the finding that spectral cues from the outer ear are an important source of information during periods of hearing loss has important implications for the design of hearing aids, particularly those that sit behind the ear.

"Recurring periods of hearing loss are extremely common during childhood. These findings will help us to find better ways of rehabilitating those affected, which should limit the number who go on to develop more serious hearing problems in later life," adds Professor King.

The study is published today in the journal *Current Biology*.

More information: *Current Biology*, 3 July 2013.

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