The auditory cortex adapts agilely with concentration

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The birth of sensory perception on the human cerebral cortex is yet to be fully explained. The different areas on the cortex function in cooperation, and no perception is the outcome of only one area working alone. In his doctoral dissertation for the Department of Biomedical Engineering and Computational Science in Aalto University Jaakko Kauramäki shows that the auditory cortex is not left to its own devices.

Kauramäki's dissertation in the field of cognitive neuroscience studied neural top-down processes, that is, the ways the brain as a system handles sounds arriving onto the auditory cortex in the frontal lobes.

Moving from parts towards a whole, bottom-up processes analyse a sound by dissecting it in hierarchical chain reactions from small and sophisticated bits towards a concise auditory sensation.

"The operation of the system as a whole can be affected by focusing on a specific task or sound. In my research I focused precisely on how the top-down effects manifest themselves on the auditory cortex," explains Kauramäki his study.

Right kind of noise promotes concentration and reinforces perception?

Kauramäki studied the auditory cortex in two separate tasks: reactions caused by selective attention during sound recognition and by lipreading.

Kauramäki recorded the electrical and magnetic activity on the cortex using electroencephalography (EEG) and magnetoencephalography (MEG) respectively.

"40 years ago a so-called ‘gain effect’ was formulated: focusing attention enhances responses on the auditory cortex, which means that attention helps to better perceive audio stimuli," tells Kauramäki.

In the attention tests Kauramäki masked the sounds played for the test subjects with different frequencies of noise – and made a discovery. During periods of selective attention, the enhanced responses on the auditory cortex depended on the type of noise used. The frequency content of the noise affected the prominence of the responses. The responses are not only enhanced, but they are feature and task-specific.

"Similar results have not been obtained earlier because the stimuli used in the experiments have been too simple. The noise mask added a combinatory effect that brought the specificity and selectivity of the responses to the fore."

"Focusing attention may then be easier in a rich sound environment. Complete silence is of course an extreme case, but in total silence the auditory cortex begins to create connections out of thin air, to make up sensory perceptions."

"Then again, the more stimuli there are in the environment, the harder it becomes to focus. In attention disorders such as ADHD, precisely the top-down ability to filter sounds may be lacking," suspects Kauramäki.

In the lipreading tasks Kauramäki did not encounter such a dependency on frequency. Instead, lipreading suppressed the auditory cortex’s ability to react. The reason for this is the neural response of the speech production system.

"The suppressing effect is caused by the adaptation of the areas on the auditory cortex that specialise in speech. Suppressing occurs even when the speech is inaudible – the articulatory gestures of the mouth alone activate parts of the auditory cortex."

For Kauramäki the result suggests that the neural responses of the speech production system can reach the auditory cortex and thus reinforce perception.

"In noisy meetings, for example, it pays off to concentrate on the face of whoever is speaking: lipreading helps in the processing. It may suppress the reaction of the auditory cortex, but the big picture becomes clearer."

Provided by Aalto University