

Magnetic Resonance Imaging of Tinnitus-Related Brain Changes in Humans and Rats

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Tinnitus is one of the most common ailments of the auditory system with often debilitating consequences, yet little is known about its mechanisms of origin. Although tinnitus often begins with a peripheral hearing loss from loud noise exposure, trauma, or age-related sensorineural changes, several lines of evidence suggest that central factors play an important role as well. We propose a two-pronged approach towards understanding the brain changes in tinnitus. The common methodology of both specific aims is magnetic resonance imaging (MRI). One aim will be pursued in human tinnitus patients, the other in a rat model of tinnitus. In the human studies, we will first perform detailed audiological screening of patients to characterize their hearing loss and then carry out quantitative tinnitus matching (pitch, bandwidth, spectral composition, loudness). Using high-field (3-Tesla) functional MRI we will generate high-resolution tonotopic maps of central auditory structures, with particular emphasis on auditory cortex and thalamus. This approach will allow us to determine the amount of central reorganization compared to individually paired controls with normal hearing. Preliminary studies have pointed to the nucleus accumbens (NAc) region as a possible structure crucially involved in gating the tinnitus sensation via thalamus, so we will include the NAc and associated paralimbic areas in our fMRI analysis. In addition, we will use high-resolution structural analysis with voxel-based morphometry (VBM) to assess the predicted volume changes in this region and will correlate these changes with scores on anxiety, depression and insomnia from standard tinnitus questionnaires. The same analyses will be performed in patients with hearing loss but no tinnitus. In our animal studies, we will generate artificial tinnitus by exposing rats to loud noise and behaviorally verify the presence of tinnitus. Each animal will then be scanned with fMRI in a high-field (7-Tesla) scanner that is able to display functional activation of auditory cortex at high resolution. Magnetic resonance spectroscopy (MRS) will be used to estimate neurotransmitter concentrations in the NAc. Finally, every animal will undergo neurophysiological recording with single-unit or optical methods in auditory cortex and thalamus as well as histochemical processing of the NAc region.

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