White Noise Reduces Hearing Damage from Acoustic Trauma in Mice

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In recent years, we have begun to understand that the auditory system changes its behavior in response to exposure to loud noise. This is called maladaptive plasticity, because auditory nerves have adapted to noise in a way that is abnormal. Noise exposure has been shown to affect the connections between nerve cells in the hearing system and to cause nerve pathways to change their organization. Researchers from the University of Pittsburgh sought to determine whether these same changes occur in mice, which would allow study of damage from noise exposure and might uncover ways to prevent that damage.

Sound therapy often is used to lessen the perception of tinnitus by reducing the relative loudness of tinnitus compared to surrounding noise. There is also research being conducted currently to determine how various stimuli (sound, magnetic, or electric stimulation) may help auditory circuits to reorganize to more normal function after maladaptive plasticity has occurred.

The researchers first exposed mice to short-duration noise levels that are known to cause hearing damage (116 dB for 45 minutes). A week afterward, they were able to show deficits in gap-detection, which is the ability of mice to change their behavior when a constant sound is stopped briefly. This inability to detect a brief silence—a gap in sound—is assumed to be an indication of tinnitus. The researchers also found a change in the behavior of auditory nerves which indicated that reorganization had occurred. The researchers specifically studied the inferior colliculus, which is part of the auditory system in the midbrain and is a major center for integration of sound stimuli from both ears. This has implications for both localization and for hearing in background noise.

Next, the research team presented the same loud noise to mice, but used acoustic enrichment in the form of a moderate-level white-noise stimulus. White noise was presented at 75 dB for seven days after noise exposure at the initial 116 dB level. After the period of acoustic enrichment, the researchers could not find any deficits in gap detection, indicating the tinnitus was not present. They also did not find indications that auditory nerves had reorganized.

This study suggests that sound therapy immediately after noise exposure may be helpful to lessen or prevent negative effects to the auditory system. We cannot assume that a similar treatment protocol will have the same effects for humans, but these findings provide a direction for future research. Perhaps one day we will have sound enrichment devices to prevent tinnitus, instead of just adapting to it.

Sturm, J., Zhang-Hooks, Y., Roos, H., Nguyen, T., Kandler, K. Noise trauma induced behavioral gap detection deficits correlate with reorganization of excitatory and inhibitory local circuits in the inferior colliculus and are prevented by acoustic enrichment. Journal of Neuroscience, June 2017, pp. 6314-6330; DOI: https://doi.org/10.1523/JNEUROSCI.0602-172017