Loss of auditory enhancement with hearing loss: Peripheral contributions to a higher-level effect?

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Abstract

Auditory enhancement is a type of spectral contrast aftereffect. The amount of auditory enhancement is often defined as the difference in pure-tone target level at threshold (or at a specified loudness) embedded in a multi-tone simultaneous masker with and without a preceding copy of the masker (precursor). Enhancement may help in the detection of novel events in an ongoing background and may also play an important role in our ability to achieve perceptual constancy in the face of changing acoustic environments, different talkers, and background noise. Enhancement has been documented both behaviorally and physiologically via cortical EEG measures. In traditional measures of enhancement, where the spectral content of the masker and target remained fixed throughout a block of trials, the amount of enhancement is typically on the order of 6-10 dB; however, when the frequency content is randomized or roved across trials, the amount of enhancement can increase to as much as 20 dB. Traditional enhancement is typically reduced in listeners with hearing loss, although it is similar to that found in normal-hearing listeners when defined in terms of proportion of overall dynamic range. However, the larger enhancement effects observed under frequency roving have not yet been studied in hearing-impaired listeners. Here we measured auditory enhancement with frequency roving in a group of hearing-impaired listeners, as well as in groups of age-matched and younger listeners with normal hearing. Our first results replicated the large (15-20 dB) effects previously observed in young normal-hearing listeners, but showed almost no enhancement in the group of hearing-impaired listeners. Results from the age-matched normal-hearing listeners, with stimuli presented at the same sound pressure level (SPL) and same sensation level as for the hearing-impaired listeners (by embedding the stimuli in a background noise to elevate thresholds) also resulted in very little enhancement. Follow-up experiments with young normal-hearing listeners at the same high SPL with and without background also showed little-to-no enhancement. These results suggest strong level-dependent effects in enhancement, with greatly reduced enhancement at high sound levels even in young normal-hearing listeners. These results may be due to the effects of peripheral (basilar-membrane) compression, which could effectively increase enhancement at low-to-medium sound levels, where compression is maximal, relative to very high sound levels, where compression is reduced or absent, even under conditions of normal hearing. If confirmed, the level-dependence of enhancement may provide a window into how higher-level effects, such as enhancement, are influenced by peripheral processing in ways that make adaptation to real-world acoustic variations more challenging for people with hearing loss.

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