Enhanced envelope coding following acoustic trauma degrades speech-in-noise coding

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Psychophysical and modeling studies have highlighted the perceptual importance of slowly varying fluctuations in speech when listening in background noise, i.e., conditions in which people with sensorineural hearing loss (SNHL) have the most difficulty. In particular, recent speech-intelligibility models have suggested the importance of considering not just the envelope coding of the speech, but also the inherent fluctuations in the noise. While these models have been successful in accounting for normal-hearing speech-in-noise perception, their application to listeners with cochlear hearing loss has been difficult due to our limited physiological knowledge of how SNHL affects the envelope coding of speech in noise. Previous neurophysiological and perceptual studies have shown that SNHL can "enhance" envelope coding of simple and complex stimuli; however, how this "enhancement" leads to degraded neural coding of combined speech and noise has not been evaluated neurophysiologically. This question is of particular interest for fluctuating backgrounds where listeners with normal hearing can derive a large fluctuating-masker benefit in comparison to listeners with SNHL. Here, we measured single auditory-nerve-fiber responses to a natural speech sentence in steady and fluctuating speech-shaped noise from anesthetized chinchillas with normal hearing or with noise-induced hearing loss. Advanced spike-train analyses were used to analyze single-unit neural responses in terms of the output of individual modulation-filter bands (i.e., including both magnitude and phase). Using correlational analyses of speech-alone, noise-alone, and speech-in-noise responses, we found that, for both steady-state and fluctuating maskers, speech-coding fidelity was degraded with SNHL as expected, but also and importantly that the coding of inherent noise fluctuations was also enhanced. In fact, the effects of SNHL on noise distractions were greater for the fluctuating masker than for the steady-state masker, consistent with the reduced fluctuating-masker benefit in human listeners. These neural results support the importance of speech-intelligibility models including the effects of SNHL on both speech-coding fidelity and the coding of inherent noise fluctuations because both are important factors that affect speech-in-noise coding following SNHL.