When individual differences are more important than age: Subcortical envelope encoding of sustained amplitude modulation predicts speech-in-noise performance in difficult listening conditions

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Aspects of auditory temporal processing, including the perception of word onsets and syllable transitions, are known to decline with age and negatively impact speech understanding in difficult listening conditions. However, the role of sustained envelope encoding in successful speech communication remains to be clarified. This study investigates the relationship between sustained envelope encoding and speech-in-noise perception in extremely difficult listening environments, where the amplitude envelopes are degraded. We hypothesized that sustained envelope encoding declines with age and contributes to speech recognition deficits in these noisy environments. Participants were 22 younger (18-30 years) and 35 older (55-90+ years) normal-hearing adults. Sustained envelope encoding in the brainstem was evaluated using the envelope following response (EFR), a noninvasive scalp-measured potential. EFRs were elicited by 400-ms amplitude modulated (AM) tones with 3000 Hz carrier frequencies and 80 Hz modulation frequencies, presented at 70 dB SPL. AM tones had modulation depths of 0 dB, -4 dB, or -8 dB, corresponding to m = 1, .631, or .398, respectively. EFRs were quantified in three ways: the strength at the modulation frequency was measured via FFT, the robustness to degradation was evaluated via time-domain correlational analyses, and synchrony was quantified via phase-locking value (PLV). Speech-in-noise performance was assessed via the QuickSIN test in the most difficult signal-to-noise ratio (SNR) conditions of 5 and 0 dB. Physiological results show that all EFR metrics decreased as modulation depth decreased and there were no age group effects. Behavioral results show no age group differences at 5 and 0 dB SNR. All EFR metrics at the shallowest modulation depth (-8 dB) predicted QuickSIN 0 dB SNR speech scores. EFR stimulus-to-response correlation coefficients and PLV at -4 dB modulation additionally predicted QuickSIN 0 dB SNR scores. No EFR metrics reliably predicted QuickSIN 0 dB SNR scores at 0 dB modulation. QuickSIN 5 dB SNR scores were not predicted by any EFR metric. Taken together, results show that individual differences in sustained subcortical encoding of shallow envelope fluctuations predict speech-in-noise performance in challenging environments but not in less challenging ones. These findings also demonstrate the utility of shallow AM depths for investigating temporal processing via the EFR. That we see no effect of age in these data demonstrates that individual differences in the strength, robustness, synchrony of subcortical envelope processing are more important than age for predicting speech-in-noise performance in extremely challenging listening environments.

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Conflict of Interest:

The authors declare no conflict of interest.