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Title:
Towards clinical evaluation of frequency selectivity using stimulus frequency otoacoustic emissions

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Abstract:

As a sound detector, healthy ears are both highly sensitive & selective. Loss of selectivity can contribute to hearing impairment (HI) in a variety of ways, such as affecting speech intelligibility in noise. Rapid and objective audiological measurements of selectivity are thus highly desirable for clinical use. While distortion product otoacoustic emissions (DPOAEs) have proved enormously useful for probing sensitivity, they have not for selectivity, presumably due to the complexity of their generation (e.g., interference amongst multiple sources). However, a relatively rapid means to estimate frequency selectivity has been developed using phase-gradient delay methods for stimulus frequency emissions (SFOAEs), which are evoked using a single low-level tone. SFOAEs have been shown to correlate well to direct neurophysiological tuning measures in a variety of species. Several unresolved challenges remain regarding potential for clinical use. First, while SFOAE phase gradients change systematically with stimulus level, in a fashion qualitatively similar to psychoacoustic tuning measures, a precise quantitative interrelationship has yet to be determined. Second, SFOAE tuning measures have been confined to pooled group data and the suitability of the method for individuals has yet to be ascertained. Lastly, an additional difficulty is the relative loss in HI individuals of SFOAEs evoked using lower stimulus levels. To help ascertain the suitability of SFOAE tuning measures in HI populations, we report for normal-hearing individuals measurements of SFOAE-dependence upon stimulus level and the correlation with spontaneous emissions (SOAEs). At low stimulus levels (20-30 dB SPL), SFOAE magnitudes and phase gradient delays showed localized increases near SOAE peak frequencies, irrespective of their magnitude. As such, "microstructure" apparent in the magnitudes was also present in the phase gradients. These effects lessened for increasing stimulus levels (40-50 dB SPL). Regions of both linear and nonlinear growth were observed in individuals, though areas about SOAE peaks (when present) typically exhibited the most nonlinear behavior. We characterized how phase gradient delays were affected by stimulus level for both pooled and individual data. For pooled data, delays decreased by approximately 25-30% for every 20 dB

of increasing stimulus level. Taken together, these data should help serve as a baseline for future studies (empirical and theoretical) looking at how to best use SFOAEs as a means to objectively and rapidly measure frequency selectivity, including the potential for use in HI populations.