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Title:
The notion of "frequency clusters" in spontaneous otoacoustic emission generation

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Abstract:
Normal, healthy ears can emit unprovoked low-level sounds called spontaneous otoacoustic emissions (SOAEs). These arise in a wide variety of different species (e.g., humans, lizards) despite gross morphological differences commonly thought important to the associated biomechanics. As such, theoretical models of SOAE generation differ significantly in their underlying assumptions. One model class (Vilfan and Duke, 2008 Biophys. J. 95:4622-4630; Wit & van Dijk, 2012 JASA 132:918-926) uses a coupled nonlinear oscillator framework, where each element exhibits a limit cycle (with a unique characteristic frequency) and is visco-elastically coupled to its nearest neighbor. This model proposes that SOAEs arise by groups of oscillators that self-entrain into "clusters", defined simply as the frequency where the largest peak in the steady-state spectral magnitude occurs. Our study sought to computationally explore more precisely what constitutes a cluster in terms of the underlying oscillator's dynamics. We found that oscillators within a cluster exhibit relatively complicated motions and poor phase coherence. Coupled with the model's inability to reproduce realistic SOAE spectra, the biomechanical relevance of a "cluster" is called into question. Modifications to the model for lizard ears (e.g., universal coupling via the rigid basilar membrane; Bergevin & Shera, 2010 JASA 2398-2409) are explored.