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Title:
Spectral Patterns of Spontaneous Otoacoustic Emissions are Not Dependent on Morphology

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Abstract:
Spontaneous otoacoustic emissions (SOAE) are highly idiosyncratic in nature: most mammals do not show them, while most non-mammalian groups do. Previously, some obvious similarities have been noted between spectral patterns of SOAE in different groups of animals in which the morphology of the hearing organ varies hugely, raising the question as to the generation mechanisms of SOAE. We studied SOAE from a bird, the barn owl (papillar length 11.5mm), and 9 lizard species with papillar lengths from 0.3 to 2.1mm). SFOAEs were also studied in the owl and one lizard species, the green anole, evoked by swept tones and extracted using a suppression paradigm (Kalluri R, Shera CA. J Acoust Soc Am. 2013, 134:356-68.) . All measurements were made in lightly-anesthetized animals in a sound-isolation booth. In all species, SOAE spectra generally showed many peaks with a quasi-periodic spacing. Median inter-peak distances were 405 Hz for 181 SOAE in the owl, and between 219 and 461 Hz for between 29 and 286 SOAE in the lizards. SFOAE were routinely measurable at stimulus levels of 20 dB SPL and lower (owl) or 30 dB SPL (anole). SFOAE amplitude could exceed that of the evoking stimulus and showed pronounced interactions with SOAEs. Low-level SFOAE phase accumulation between adjacent SOAE peak frequencies in both species clearly clustered around one period and corresponded in total to a delay of > 2 ms. Together with published results from humans, the present data argue for a common underlying mechanism patterning otoacoustic emissions across very disparate macromorphologies of the inner ear. Despite up to a 40-fold size difference between papillae, SOAE peak spacing was remarkably similar. We suggest that otoacoustic emissions originate from phase coherence in any system of coupled, active oscillators, which is consistent with the notion of coherent reflection but does not explicitly require a traveling wave. The concept of phase coherence ties together our understanding of ears with grossly different morphologies, suggesting that despite some different biomechanical constraints, ears of mammals, birds, and lizards retain fundamental similarities in sound processsing. Wave-based (coherent reflection) and `local oscillator'-based formulations need not be orthogonal notions, but simply reflect differences in inter-element coupling.