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(G*) Title: To Emit or Not to Emit: Collective Dynamics of the Inner Ear

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The healthy ear not only detects incident sound, but also generates and emits it as well. These sounds, known as otoacoustic emissions (OAEs), can arise spontaneously (SOAEs) and thus provide salient evidence that there is an active (metabolic-based) process taking place at the level of the inner ear. Such a process appears to enhance the sensitivity and frequency selectivity of hearing. However, a detailed understanding of the underlying mechanisms of OAE generation still remains unclear. Our work here focuses on the inner ear of a lizard, developing a theoretical model to characterize their OAE generation. Broadly, the model consists an array of active oscillators, each of which describes an individual hair cell with its own unique characteristic frequency. They are coupled together in varying fashions (e.g., nearest-neighbor via visco-elastic elements; globally via a rigid/resonant substrate). Broadly, we aim to use the model to elucidate how collective dynamics emerge from the system as a whole, as well as constrain the model (e.g., is the coupling required to get some effect actually physiologically reasonable?). Several general features have thus far emerged. First, coupling allows elements to synchronize into groups, where they share a common (self-sustained) oscillation frequency. Such an effect can explain some qualitative aspects of SOAE features (e.g., presence of spectral peaks), but fails to explain others (e.g., width of said peaks). Second, we explore how variations in coupling might lead to "amplitude death", where the active oscillators collectively become quiescent. This phenomenon could lead to improved sensitivity and selectivity, as well as explain the observation that not all ears emit SOAEs.

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