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Measuring the diffusiveness of spatial sound: A common framework for binaural perception, neurophysiological correlates and modelling

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Binaural listening is generally thought to facilitate the separation of single sound sources from diffuse ambient noise and thereby enhance speech intelligibility. Therefore it is important to understand how the perceived diffusiveness in complex acoustical situations per se - or, as its related physical quantity, the normalized interaural cross correlation (IAC) - are represented in the auditory system.

This contribution investigates the binaural system's sensitivity to static and dynamic changes in the IAC of noise stimuli. Psychometric functions for the discriminability of signals with different IAC were obtained from pairwise comparisons in a 2-AFC-paradigm at 15 reference correlations. In EEG recordings the effect of different kinds of IAC changes on the amplitude of late auditory evoked potentials (LAEP) was studied. In contrast to previous electrophysiological research, the stimulus correlation was varied over the whole parameter range, including +1, 0, -1 and intermediate values.

Rescaling the stimulus parameters of the psychometric functions according to a Bradley-Terry-Luce model suggests that the binaural system's internal decision variable, representing the degree of spatial diffusiveness, is in good approximation proportional to the dB-scaled ratio of energies in the correlated vs. the anticorrelated signal components, AC[dB(N0/Npi)]=10*log(1+IAC/1-IAC).

LAEP amplitudes can be described as linear functions of the stimulus parameters, but only if the latter are transformed to their corresponding dB(N0/Npi)-value. In this case the goodness of fit is far better than for stimulus parameters expressed in terms of the normalized IAC.

A plausible model is introduced which extracts a signal's IAC directly in dB(N0/Npi). The model explains own data and is also compatible with recent binaural psychoacoustics and neurophysiology by qualitative and quantitative means. It might provide a common framework to explain perceptual phenomena and underlying physiological mechanisms beyond the scope of competing IAC models, in particular the effect of unilateral hearing loss on
binaural performance.