How to map the auditory azimuth: Through many channels, Just two populations, Or something that is in between?

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Abstract

At the moment two neuronal algorithms as used by the auditory system are known to map a sound source's azimuth in the brain by means of interaural time differences (ITDs). The Jeffress algorithm (1948), which until recently was thought to be universal, as represented by the barn owl, assumes that a peak response occurs at those neurons where the neuronal delay offsets the acoustic delay between the two ears. These neurons then encode the position, a multi-channel coding since for a different direction other neurons take over.

In small animals such as gerbil and guinea pig the interaural distance is too small to resolve the azimuth through a neuronal peak response. Recently it was found (McAlpine et al. 2001) that a stimulus ITD is encoded instead by population activity depending monotonically on the azimuth angle.

We present a theory [1] comprising both extremes and all that is in between, and explain how the corresponding, temporally amazingly precise (μs), neuronal interplay of excitation and inhibition arises during ontogeny. In particular, we show how new experimental data of Seidl & Grothe [2] provide the first experimental evidence for this ontogenetic tuning of synaptic efficacies.

[1] C. Leibold and J.L. van Hemmen & [2] A.H. Seidl, C. Leibold, J.L. van Hemmen, and B. Grothe, manuscripts in preparation.