Annals of General Psychiatry

BioMed Central

Oral presentation

Neuronal mechanisms underlying the perception of pitch and harmonicity

Gerald Langner*

Address: Institute of Zoology, University of Technology, Darmstadt, Germany

* Corresponding author

from International Society on Brain and Behaviour: 2nd International Congress on Brain and Behaviour
Thessaloniki, Greece. 17–20 November 2005

Published: 28 February 2006

Annals of General Psychiatry 2006, **5**(Suppl 1):S3 doi:10.1186/1744-859X-5-S1-S3

Harmonicity is a fundamental property of signals in a world of resonances. This is particularly true for acoustic communication in animals, speech, and music. Many communication sounds are periodic vibrations, which elicit the perception of a pitch and are composed of a fundamental frequency and multiples of this fundamental. Moreover, because of physical constraints many sound sources tend to favour sequences of sounds with harmonically related fundamentals. Therefore, for all communicating animals, including man, it would be of advantage if their auditory systems were able to detect and discriminate harmonic relationships of acoustic signals. In contrast to cochlear frequency analysis, temporal processing of periodicity information includes harmonic analysis as a by-product. This is because with temporal correlation of any kind as an underlying mechanism, neurons tuned to a fundamental have a tendency to also respond to frequencies which are multiples of the fundamental.

Periodicity tuning, as found in neurons of the auditory midbrain (IC), was explained by a correlation model which is based on temporal synchronization and coincidence of delayed and undelayed responses to periodic signals as processing elements (Langner, *Hear Res* 1992, 60 and 2002, 168). In addition, periodicity information in the IC of various animals was found to be mapped orthogonal to tonotopy (Schreiner and Langner, *J Neurophysiol* 1988, 60). Similar maps have also been found in the auditory cortex, with electrophysiological recordings, optical recording, and 2-deoxyglucose technique (2-DG) in animals and with magneto-encephalography in humans (Langner *et al.*, and Schulze and Langner, *J Comp Physiol* 1997, 181). On the basis of these findings the periodotopic axis may be considered as the 2nd neural axis of the auditory system.

As expected electrophysiological and 2-DG experiments in gerbils showed that neurons, which are tuned to a particular periodicity, do also respond to a certain extent to corresponding harmonics. Results from iontophoretic experiments indicate that these harmonic responses are normally suppressed by an synchronous inhibitory input from the ventral nucleus of the lateral lemniscus (VNLL). Investigation of the spatial representation of periodicity information with the 2-DG technique indicate that low pitch is represented dorsally and high pitch ventrally in the VNLL. A 3-D-analysis gave evidence for a helical periodicity map with 7 to 8 turns representing one octave per turn, an organization which is reminiscent of the pitch helix well-known by music psychologists.