

Listening to a musical rhythm often spontaneously triggers toe tapping or head nodding, synchronous with the beat. This is an automatic and often involuntary process which does not require attention in order to perform these movements in good synchronicity with the perceived beat. Therefore, there is an emerging discussion whether music might not only be culture but have also a biological origin. Striking evidence for this argument is that there is no known human culture which did not has produced music. In addition, it seems that there are fundamental rules in the processing of music that every human knows, without being explicitly taught, such as differential responses to consonant and dissonant intervals, that already six month old infants can do.

Neuroimaging studies have repeatedly shown that music processing, i.e. the processing of pitch and rhythm are reliably activating a neuronal network, which only partly overlaps with general auditory processing. Furthermore, the basal ganglia have been shown to be key areas for processing of rhythm.

However, most neuroimaging studies have used more artificial than natural stimulations, such as rhythms, generated by simple tones, or presenting only short pieces of music. Therefore, this study aimed to detect brain responses to dance-floor-like music, by playing a 12 min music sequence, while the subjects were asked to relax, lie still, and listen to it.

EFFECTIVE CONNECTIVITY ANALYSIS DEMONSTRATES INVOLVEMENT OF PREMOTOR CORTEX DURING SPEECH PERCEPTION

In order to have the fMRI scanner noise not as a disturbing background noise, the scanning was performed with short silent gaps, mirroring the beat of the music. Thereby, the scanner acted as an addition rhythm instrument.

The data were analysed using a combined independent component analysis (ICA) and functional connective approach. The results demonstrated that listening to musical rhythm activates predominantly three cortical networks, with one comprising the motor areas, one comprising the auditory cortex, and one a fronto-parieto network. Interestingly, all three components overlapped in the left medial aspect of Heschl's gyrus. In addition the functional connective analysis showed a strong coupling of the left and right auditory cortex with the basal ganglia.

In conclusion, these results are reflecting that passive listening to musical rhythms already activates the entire motor network, including the basal ganglia, even in the absence of motor performance. In addition, the results confirmed that the right hemisphere is more involved in the processing of music than the left, as there were more extended and intense activations in the right auditory, frontal and parietal areas.

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Rauschecker and Scott suggested recently a bi-directional loop linking areas for speech perception and speech production. Delineating such dynamical and interactive processes in humans has proven to be difficult by conventional imaging analysis alone. In order to test such a functional loop in relation to speech perception in humans we tested different models involving Heschl's Gyrus (HG), Planum Temporale (PL), mid-STS and PMC applied to fMRI data using parametrically varied speech stimuli. The fMRI study included 16 healthy adults participants. A parametrically graded stimulus paradigm, where white noise was gradually changed through 7 steps into a speech sound (consonant-vowel syllable) was used, creating a continuous morphing sequence.

The stimuli were presented in a randomized event-related fMRI design. The fMRI results were modelled by applying dynamic causal modelling (DCM). The fMRI results revealed a graded increase in activation in the left STS area until the 5th manipulation step where it ceased to increase. PMC activity was only present at this the 5th manipulation step. Concurrent to these results, the sounds was rated significantly more often the sounds as speech sounds from the same manipulation step and onwards.

The Bayesian model selection favoured a model that demonstrated a linearly increasing connectivity between Heschl's gyrus and PT as well as between Heschel's gyrus and STS but a linearly decrease