Summary

„Monaural stimulus-presentation with contralateral noise-presentation as paradigm to investigate lateralized processing in human auditory cortex"

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Several processes in the human auditory cortex are lateralized. There exist different theories for the specialization of the left and right auditory cortex. However, which aspects of auditory analysis are lateralized in which hemisphere is still a matter of debate. Different methods, namely lesion studies, dichotic listening tasks, tests on split-brain-patients and imaging studies are used to investigate lateralized processing in the auditory cortex. The interpretations of the results obtained in these studies are not always unproblematic.

The aim of the present studies was to develop and validate a new method for the investigation of lateralized processing in the human auditory cortex. This new approach compares the activation pattern during monaural stimulus presentation with and without contralateral noise (KLR-method). It is based on the assumption, that noise enhances the activation especially in the auditory cortex, which is specialized for the given task. This was shown in a previous study using a task, which is mainly processed in the right hemisphere (Behne et al 2005).

The present work includes three functional magnetic resonance imaging (fMRI)-studies and one magnetoencephalography (MEG)-study.

The aim of study I was to confirm the general applicability of the KLR-method for investigations of lateralized processing in auditory cortex. For that a lexical decision task employing words and pseudowords was used. The additional contralateral noise modified the activation especially in left auditory cortex. This confirms the dominant role of the left hemisphere in lexical decision and by that the applicability of the KLR-method for the investigation of lateralized processing in auditory cortex.

Study II measured the activation caused solely by the noise. Both ipsilateral and contralateral noise led to similar activation in left and right auditory cortex, respectively. Therefore, the observed effects of noise during the KLR-method were not caused by noise presentation alone but were rather due to the interaction of noise and the processing of the task-relevant stimuli.

In Study III the KLR-method was used to investigate lateralized processing during a task composed of two subtasks. Subjects had to compare the direction of frequency modulation (FM) of two FM tones. Contralateral noise had an influence on the activation in both hemispheres. Because of the known right hemispheric processing of directional categorization of FM, the effect of the noise on the left auditory cortex points to an involvement of this hemisphere in the comparison task. Furthermore, the results suggest that the involvement of the left hemisphere in the comparison task depends on the degree of performance of the subjects. The effect of noise on the activation in the left auditory cortex was stronger in subjects with low performance compared to subjects with high performance.

Study IV tested the applicability of the KLR-method to reveal lateralized processing in auditory cortex with MEG. The task was to categorize the direction of FM tones. Under this condition, noise reduced the M100-amplitude in both hemispheres. Based on this result a statement about lateralized processing is not possible. Nevertheless, the obtained results suggest that the contralateral noise has a specific effect on the activation later than 100 ms after stimulus onset.

In conclusion, the results of all three fMRI-studies suggest, that the KLR-method can be used as a tool to investigate lateralized processing in auditory cortex.