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COGNITION (OTHER)

DISTINCT PATHWAYS INVOLVED IN SOUND RECOGNITION AND LOCALIZATION: A HUMAN fMRI STUDY

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Purpose:

Evidence from human psychophysical, neuropsychological, and anatomical studies suggests that distinct neuronal populations are involved in the processing of auditory informations relevant to recognition and localization. We investigated how far these pathways are distinct anatomically.

Methods:

Brain activations associated with performance of sound localization in space and sound recognition were investigated in human subjects, using fMRI. Both tasks were active. In the localization task the subject had to identify and compare the spatial positions of the stimuli. In the recognition task, the subject had to identify and classify the nature of the sound presented. Both types of stimuli were presented during the same fMRI acquisition in a triple epoch related study (localization – recognition – rest). BOLD fMRI acquisitions were conducted on a 1.5 T magnet fitted with echoplanar imaging. A long TR and careful adjustment of the timing of the stimuli presentation allowed to acquire fMRI data without interference with the gradient noise.(1) Eighteen right-handed volunteers between age 23 and 47 were studied The right handedness was established by Oldfield questionnaire. The subject had no history of neurological illness, there were 8 female and 10 male. Auditory stimuli of a total duration of 5 seconds consisted in a background and a target. For stimuli with spatial content the background was made of 25 samples of whitenoise of 15 milliseconds duration each, with variable DIT simulating a variable location in the horizontal plane. Stimuli were presented approximately every 200 milliseconds. The target consisted of filtered white noise, lasting 500 milliseconds. The first target was presented 1.5 seconds after the beginning of the background; the second after 3 seconds. Both stimuli were lateralized on the same side. The subject was asked to press a pneumatic device with the right hand when the two stimuli had a different spatial localization. For identification of stimuli with a significant pattern, five different backgrounds lasting 5 seconds were used, representing common every day life auditory background (grocery shop, street, beach, shop, railway station). Targets was a significant noise lasting 2 seconds and starting 1.5 second after the beginning of the background. The subjects were instructed to press the pneumatic device when an animal sound was recognized. Images were mosaics of 16 slices covering the whole hemispheres in the bicomissural plane. Postprocessing was conducted separately on a Silicon Graphic Indigo 2 workstation with SPM 99 software (the welcome Department of cognitive neurology, Queen's Square, London). After coregistering and reslicing, images were normalized and smoothed. The results from 18 subjects were pooled.

Results:

In both conditions, primary temporal auditory cortex was strongly activated bilaterally. Moreover, both localization and recognition task preferentially activated areas outside the primary auditory cortex. The spatial localization task activated both inferior parietal lobules and inferior parietal sulcus (more on the right than on the left side) and posterior part of middle and inferior frontal gyrus bilateraly. Sound recognition task activated preferentially both temporal convexities (centered on middle temporal gyrus), precuneus on both sides and inferior temporal gyrus on the left side.

Conclusion:

These findings demonstrate the existence of different pathways for processing sound localization and sound recognition in the human brain.

Reference:

1) Meuli R., Maeder P., Adriani M. et al. Optimisation of stimuli and acquisition technique for fMRI of the auditory system, submitted to HBM 2000