Processing of Affective and Neutral Acoustic Stimuli in Patients with Dysthymia and Healthy Subjects – A Pilot Study Using fMRI

A. Pöllinger, P. Forschler, P. Georgiewa, C. Zrouya, B. Klapp
1) Institut für Radiologie, Universitätsklinikum Charité, HU-Berlin; 2) Abteilung Neuroradiologie, Zentrum für diagnostische Radiologie, Universitätsklinikum Leipzig
3) Medizinische Kliniken mit Schwerpunkt Psychosomatik, Universitätsklinikum Charité, HU-Berlin
4) Medizinische Kliniken mit Schwerpunkt Psychosomatik, Universitätsklinikum Charité, HU-Berlin

Introduction

One of the neurophysiologic models currently adopted in therapeutic and scientific approaches attributes psychosomatic disorders to changes in neuronal connections, irrespective of their generator. The assumed changes in cerebral processing have in recent years been investigated by imaging modalities. PET studies [1, 2] have demonstrated changed activities in the prefrontal cortex, temporal and parietal lobes and other areas. These are centers associated with attentive and conscious behavior. The available data thus suggests that factors like stress, depression, insomnia, anxiety, or spams may reinforce psychosomatic disorders.

Purpose

This pilot study was performed to investigate whether psychosomatic processing of acoustic stimuli differs in patients and normal subjects and to identify a possible underlying change in perceptive and processing sensibility that is common to different disorders. It is hypothesized that external strain/stress changes perception and cognition in patients and/or that emotional modulation of information processing differs from that of healthy individuals.

Subjects and MR Imaging

Eight patients with dysthymia and five healthy controls underwent functional magnetic resonance imaging (fMRI) (Fig. 1).

- Beeps (440 Hz) not allowing for assignment of cognitive, emotional, or motivational meaning.
- Ringing of bells, which is expected to mainly activate primary and secondary areas of the auditory cortex with additional activation of networks processing emotional information.
- Neutral words, which are assumed to have a lexical representation in normal subjects but no emotional representation. It is therefore expected that these words induce word processing activities more or less without involvement of affective processes.
- Words with affective connotations, which are expected to induce emotional processing in addition to activating the auditory cortex and speech areas.

Baseline conditions were intervals in which the subjects only heard the noise of the MR Scanner: 1,5 T Siemens Magnetom Vision (Erlangen).

Sequence: EPI, TR=4000 ms, TE=66 ms MP-Rage

Measurement: 128 x 128, FOV 256; (Voxel Size 2 x 2 x 6,0 mm³)

Slice Thickness: 4 mm with 0,6 mm Gap 1 mm without Gap

Results of the functional scan and the 3D-sequence.

MR-Imaging and Stimulation Protocol (Fig. 1 and 2):

<table>
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<th>Measurements</th>
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<td>fMRI, EPI</td>
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Analysis (Fig. 3 - 5):

- Fitting of the functional images into the morphologic 3D data set (Fig. 3).
- Generation of a 4D data set from the source images of the functional studies with subsequent correction for motion.
- Normalization of the morphologic and functional data in Talairach’s space (Fig. 4).
- Averaging of the functional data sets of all controls and of all patients (Fig. 5).

Analysis of the fMRI studies applying Student’s t-test to mean values and superimposition of the result maps on the 3D data sets.

Analysis (Fig. 3 - 5):

- Fitting of the sections of the fMRI data set into the anatomic 3D data set.
- Averaging of the functional data sets of all patients and of all controls.

Discussion

The preliminary findings presented here suggest that processing of external stimuli is changed in psychosomatic patients. In particular, the patients showed markedly stronger activation of the prefrontal cortex, which is involved in emotional processing, when hearing 440 Hz beeps described as unpleasant by the study subjects. The activation of periaqueductal gray matter in patients only remains to be clarified in further investigations.

References


Fig. 1: Initial image parameters for the functional scan with and without gap.

Fig. 2: Stimulation protocol.

Fig. 3: Fitting of the sections of the fMRI data set into the anatomic 3D data set.

Fig. 4: Normalization and functional data in Talairach’s space.

Fig. 5: Averaging of the functional data sets of all controls and of all patients.

Fig. 6: In patients, beeps and bell ringing additionally stimulate the periaqueductal gray matter.