Monitoring Cerebral Pain Processing with event-related FLASH

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Introduction

Although visual and motoric areas are well investigated, little is known about cerebral pain processing using functional MRI. In this work we present first results on pain processing acquired with an event-related FLASH technique.

Materials and Methods

Healthy volunteers (n=4) were examined in a circular polarized head coil of a standard 1.5 T clinical whole body scanner (Magnetom VISION, Siemens, Germany) during contact heat pain. An MR compatible thermode system (TSA2001, MEDOC, Israel) was used for stimulation at the thenar (n=2) or at the ventral side of the forearm (n=2) of the subjects. The base temperature of the thermode was set to 34°C, during painful stimulation it was raised 2°C above the volunteer's redetermined pain threshold (between 43°C and 46°C). The duration of the heat pain period was varied between 2 and 7 seconds (see Fig. 1).

A modified T2*-weighted FLASH sequence [1] (TE/TR/α/FOV/MAT/TH = 56ms/112ms/40°/240mm/28/4 mm) was used to measure a time series of 36 images in 4 transversal slices. In order to achieve a temporal resolution of 448 ms, a single line of k-space is acquired after the application of one stimulus. This is repeated 128 times to fill the complete matrix. The application of the stimulus was synchronised with the continuously running MR-sequence.

Results and Discussion

All maps show an activation in the insula region (see Fig. 2). From PET studies this region is known to take part in pain processing [2]. Also parts of the thalami and of the amygdala (in another slice) are activated. Fig. 3 shows a timecourse of the activated insula region marked in Fig. 2. The maximum is observed 5 seconds after stimulus presentation, which is the typical delay time of the BOLD effect. Therefore, the insula region is assumed to take part in the first steps of pain processing.

Conclusion

This event-related FLASH technique provides the possibility to acquire several slices with an equal temporal resolution compared to EPI sequences. Since the signal-to-noise ratio of FLASH is superior to that of EPI by a factor of 5 the complex responses to pain stimulation can be studied more efficiently with this technique. The multidimensionality of the pain experience implies multifocal cerebral pain processing, therefore several slices of functional data should be measured simultaneously.

Fig. 1: Temperature vs. time. The arrow denotes the acquisition of one line of k-space of the first image of the time series.

Fig. 2: Map of the correlation coefficient overlayed on a T1-weighted spin-echo image. A circular ROI indicates the area used for the plot in Fig. 3.

Fig. 3: Timecourse of the ROI indicated in Fig.2.

References