Getting closer to real-life experience in research. An investigation of emotional faces and scenes using fMRI

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Introduction

Emotions are, among others, commonly investigated using visual affective stimuli in fMRI studies. Phan et al. 2002). Many researchers use emotional faces and emotional scenes (e.g. IAPS stimuli) as stimulus material. In some of these studies, brain activity in response to these stimuli was compared directly (e.g. Hariri et al., 2002). According to a recently conducted meta-analyses, emotional faces and scenes activate a similar cluster of brain regions, including the primary and extrastriate visual cortex, prefrontal cortex, temporal cortex as well as the amygdala. In addition, both kinds of stimuli also evoke activation in distinct brain regions that can be ascribed to the processing of other image properties (Sabatinelli et al., 2011).

Objective

Using novel image databases, the current study investigates, whether emotional faces or scenes are better suited to further study emotions, especially with regard to emotional dysfunctions in patient populations.

Materials & Methods

Subjects

19 healthy volunteers (8 male, 11 female, 24.3 ± 3.6 years) participated in the current study. All subjects were right-handed and did not display any neurological or psychiatric diseases. Furthermore, they did nit have any other medical problems and did not receive any medical treatment related to cerebral metabolism and blood flow.

Study Design & Stimuli

Based on a standard block design, participants were either presented with emotional faces (sadness, disgust, fear) or emotionally charged scenes, respectively. Face stimuli were drawn from the Radboud Faces Database (University of Nijmengen) (Langner et al., 2010) and scene stimuli were taken from the Nencki Affective Picture System (NAPS, Nencki Institute of Experimental Biology, Warsaw) (Marchewka et al., 2014). Experimental paradigms were created using Cogent 2000 and Cogent Graphics (http://www.vislab.ucl.ac.uk/cogent.php). Subjects performed two runs per condition, consisting of nine experimental blocks, alternating with ten baseline blocks (10 images per block displayed for 2 s, interstimulus interval: 200 ms).

Magnetic resonance imaging

fMRI data acquisition was performed on a 3T Siemens MAGNETOM Prisma MRI scanner (Siemens, Erlangen, Germany) with a 64-channel head array. The acquisition included an anatomical T1-weighted image, a 2-dimensional field-map image, and four T2*-weighted gradient echo planar images (EPI).

Data were analyzed using FMRIB Software Library (FSL) v5.0 (https://fsl.fmrib.ox.ac.uk/fsl) (Jenkinson, Beckmann, Behrens, Woolrich & Smith, 2012). Analysis was carried out according to standard principles of fMRI data analysis. Pre-processing included motion correction, unwarping, non-brain removal, spatial smoothing (8mm), and highpass temporal filtering. Statistical analysis was based on general linear modeling. Emotional faces and scenes were included as regressors of interest into the model, respectively. In the face-experiment the emotion categories sadness, disgust and fear were added as regressors of interest. Z-statistical contrast images were calculated separately for each regressor of interest (z = 3.1 and p = 0.001).

Results

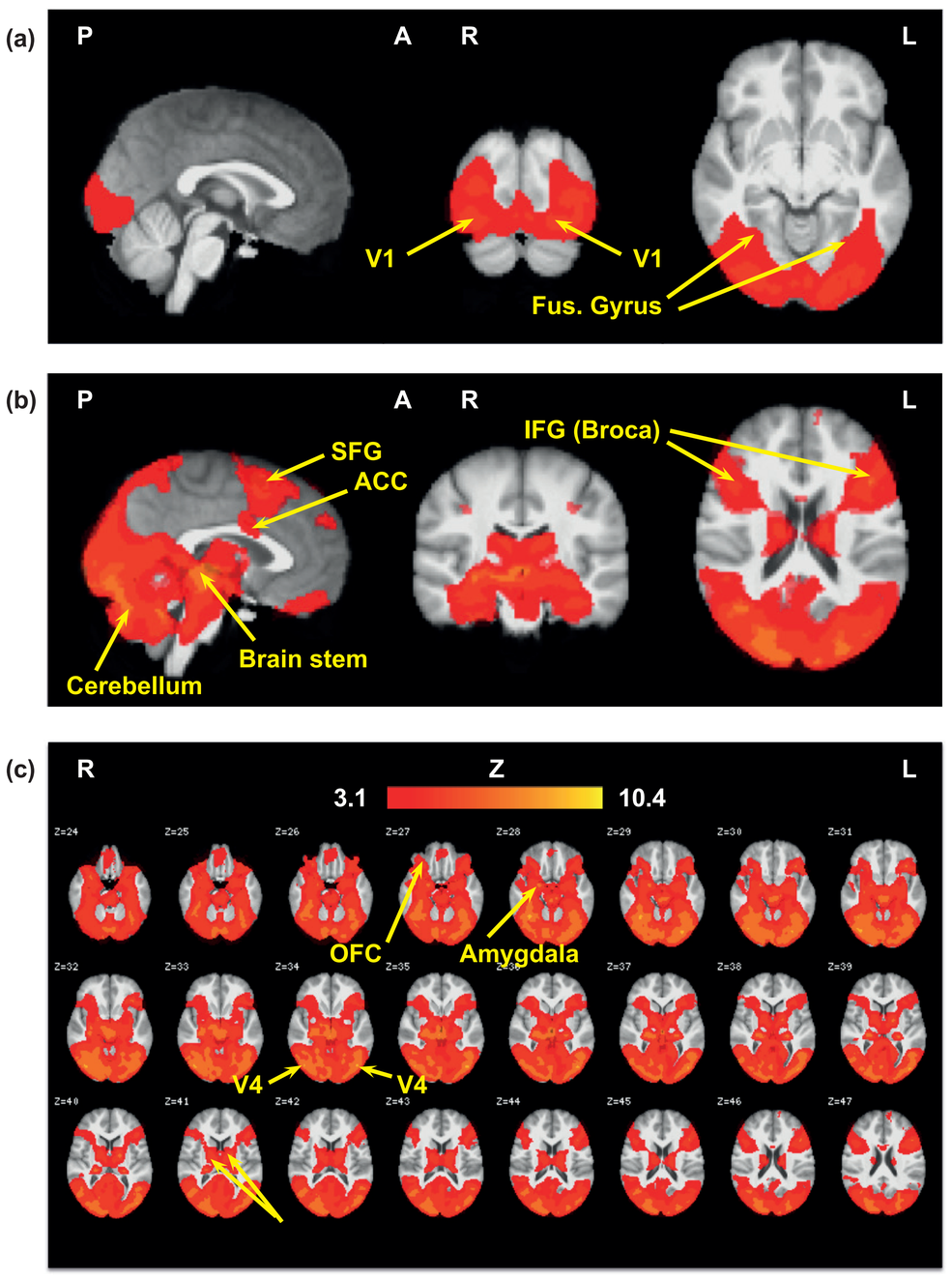

Figure 1 Group brain activation for the emotional face & scene experiment. Results displayed at [x, y, z] = [0, -86, -8] for the contrast ‚emotional faces > neutral faces' (a), at [x, y, z] = [0, 0, 0] for the contrast ‚emotional scenes > neutral scenes' (b), and in axial slices for the contrast ‚emotional scenes > neutral scenes' (c). All contrast images were calculated on the basis of z > 3.1, p < 0.01 and corrected clusterwise with a threshold p < 0.001. Yellow arrows point at peak activations in the images.

Conclusions

Comparing the brain activity in response to both kinds of stimuli, it is apparent that scenes evoke stronger BOLD responses in a lot more regions of the brain. Peaks of activation in subcortical structures, like the amygdala and the thalamus, as evoked by the scenes, had been found in comparable experiments before. However, activation in response to faces did only span the visual cortex and posterior parts of the temporal cortex. Therefore, NAPS stimuli seem to produce comparable results to previous studies (Sabatinelli et al., 2011) whereas stimuli from the Radboud Database did not (see Fusar-Poli et al., 2009). In terms of ecological validity, it is possible that emotional faces were recognized but did not elicit emotions in the subjects. NAPS stimuli serve more realistic content with the potential to directly elicit negative emotions. Furthermore, NAPS stimuli seem to activate brain regions that are associated with modern emotion theories (Lindquist et al., 2012). Summarizing this with regard to the research question, NAPS stimuli produce more promising results and should be used in further experiments to investigate emotions, even in patient populations.

References

Fusar-Poli, P., Placentino, A., Carletti, F., Landi, P., Allen, P., Surguladze, S., Benedetti, F., Abbamonte, M., Gasparotti, R., Barale, F., Perez, J., McGuire, P. & Politi, P. (2009). Functional atlas of emotional faces processing: a voxel-based meta-analysis of 105 functional magnetic resonance imaging studies. Journal of psychiatry & neuroscience: JPN, 34(6), 418.

Hariri, A. H., Tessitore, A., Mattay, V. S., Fera, F. & Weinberger, D. R. (2002). The Amygdala Response to Emotional Stimuli: A Comparison of Faces and Scenes. NeuroImage, 17, 317-323. doi: 10.1006/nimg.2002.1179

Phan, K. L., Wager, T., Taylor, S. F., Liberzon, I. (2002). Functional Neuroanatomy of Emotion: A Meta-Analysis of Emotion Activation Studies in PET and fMRI. NeuroImage, 16, 331-348. doi: 10.1006/nimg.2002.1087

Sabatinelli, D., Lang, P. J., Bradley, M. M., Costa, V. D., & Keil, A. (2009). The timing of emotional discrimination in human amygdala and ventral visual cortex. Journal of Neuroscience, 29(47), 14864-14868. doi: 10.1523/JNEUROSCI.3278-09.2009