

Neuroanatomical correlates of visual field bias

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Introduction: It's a long held believe that the right hemisphere is dominant in emotional processing [1], but there is increasing evidence that the lateralisation of emotional processing also depends on valence and gender [1, 2, 3]. A recent review of neuroimaging studies of emotion concludes that the lateralisation of emotional activity is more complex and region-specific than predicted by previous theories [4], but a visual-field bias in the judgment of facial expressions [5] suggests that there might nevertheless be preferred pathways for emotional contents depending on the side of input. In order to investigate preferred pathways and potential lateralization in the neural substrates of emotional processing we performed an fMRI study where fearful and neutral faces were presented in the left, right or center of the visual field.

Methods: Twelve healthy male volunteers (mean age 26.2 ± 7.6 years, range 19 to 44) gave written informed consent before participating in this study. Imaging was performed on a 3.0 T MR head scanner (Siemens Magnetom Allegra) equipped with a 4-channel head coil. Imaging parameters of gradient echo EPI: parallel imaging method: GRAPPA (R = 2) TE/TR 30 ms/1530 ms, FA 90°, 29 slices, distance factor 40%, matrix size 64x64, voxel size 3x3x3 mm³. The stimulus presentation, using video goggles (Resonance Technology), was completely randomized and contained 25 images for each image quality (neutral and anxious faces [6]) and location (left, center, right). Presentation duration was 1 sec, interstimulus interval 1750 ± 750 msec. Subjects were instructed to fixate a central cross throughout the experiment; the performance was monitored by an eyetracker. Standard spatial preprocessing and statistical analyses were performed using SPM2 (Wellcome Department of Imaging Neuroscience, London, UK). Single subject analyses (general linear model) resulted in contrast images for neutral and anxious faces in the left, center and right visual field which were incorporated in a second level ANOVA.

Results: We found areas of significant interaction of facial expression and site of image presentation (see Fig. 1). A significantly higher response to peripherally presented fearful as well as centrally presented neutral faces was found in left inferior and middle frontal, and superior temporal areas, the temporal pole and putamen, and in right inferior frontal, inferior, middle and superior temporal areas, the temporal pole and anterior cingulate. A subset of these areas showed a significant preference for fearful faces in the right visual field. At $p < 0.001$ (uncorrected) these areas were the left inferior temporal gyrus, orbital part [-24 21 -18], the left superior temporal pole / lateral Amygdala [-33 0 -24] and the right middle/superior temporal pole [36 15 -33].

Conclusion: In our opinion, these results indicate a sensitive network for a preferential processing of potential threat signals as signalled by a fearful face appearing in the periphery. Also a clearly recognizable neutral face may be more closely analysed with regard to a potential threat. This probably offered an evolutionary advantage in early stages of human evolution where dangerous threats or signs of fear of attendant group members had to be processed as quickly as possible. Remarkable is the significant preference for fearful faces presented in the right visual field in a subset of this network pointing to a preference of visual perception.

References: 1) Demaree et al. *Behavioural and Cognitive Neuroscience Reviews* 4(1): 3-20 (2005). 2) Rodway et al. *Brain and Cognition* 53: 542-463 (2003). 3) Proverbio et al. *BMC Neuroscience* 7: 44 (2006). 4) Wager et al. *NeuroImage* 19: 513-531 (2003). 5) Asthana & Mandal. *J Gen Psychol* 128(1): 21-29 (2001). 6) Ekman & Friesen. Palo Alto, Calif: Consulting Psychologist Press, 1976.

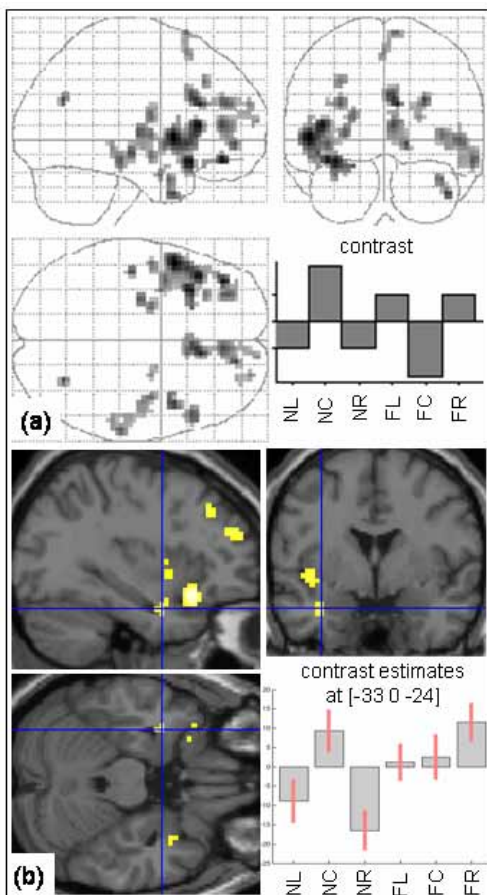


Fig 1: Significant interaction ($p < 0.0001$, uncorrected) of facial expression (neutral (N) or fearful (F)) and site of presentation (left (L), center (C), right(R)). (a) Glassbrain representation of contrast: $NC > NL + NR$ and $FL + FR > FC$ (see inset). (b) Sections and contrast estimates at [-33 0 -24] (Amygdala).