

Localisation of regions of hedonia in the normal brain using an original, event-related, group specific, sporting paradigm

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Introduction: A known symptom of major depression is anhedonia [1]. Accurate localisation of regions of anhedonia and hedonic responses will lead to a better understanding of the reward mechanisms in the brain that may be affected in various mood disorders. Previous studies assessing pleasure responses in the brain have used standardised pictorial stimuli to evoke pleasurable responses [2]. Similarly, many studies have previously aimed to resolve the anticipation and pleasure responses of reward mechanisms in the brain. This has been most frequently performed using gambling paradigms [3]. However, the methods that have been applied generally include subject decision making processes. Both anticipation and decision making processes [4] have been observed in the orbitofrontal cortex which could potentially be a confounding factor in attempting to illicit hedonic responses which have also been implicated in this region of the brain.

Aim: The aim of this study was to use fMRI to localise hedonic regions of the brain and isolate these from regions responsible for the anticipation of pleasurable responses and from regions involved in decision making processes.

Method: Paradigm construction: A group specific, digital video stimulus was used as the subject stimulus. An event-related paradigm was constructed and optimised. The reward element of the paradigm was goals being scored in soccer matches (4s). The non-reward element of the paradigm was missed goal scoring opportunities (4s). The baseline (emotionally null) condition of the paradigm was open play soccer footage (2s-22s). The stimulus was chosen to evoke high levels of pleasure in the selected group of soccer supporters.

Subject selection: Eight healthy male subjects with an average age of 26 (± 6) were recruited. Subjects were all supporters of a local soccer team.

Experimental imaging procedure: Imaging was performed using a GE 3T MR system. Whole brain, 3D T1-weighted anatomical images were acquired for all subjects using an IR FSPGR sequence, TR= 6.9ms, TE = 1.6ms, TI = 500ms. Functional images were acquired using an EPI sequence, TR = 2s and TE = 30ms. Eighteen 4mm slices were acquired. This defined a volume in the coronal plane which was used to assess the functionality of the frontal region of the brain.

Analysis of data: Using the FSL expert analysis tool three functional contrasts were created to assess activations: (i) goals vs. open play; (ii) missed chances vs. open play and (iii) goals vs. missed chances. Brain extraction was performed using BET, motion correction was performed using MCFLIRT, image registration was performed using FLIRT and group analysis of the data was performed using FLAME.

Results: Statistically significant activation clusters ($p < 0.05$, $Z > 2.3$) were determined on the goals vs. open play, see figure 1, and missed chances vs. open play contrasts in the superior temporal gyrus (Brodmann areas (BA) 38, 6, 8), inferior frontal gyrus (BA 47, 9, 45, 44), middle frontal gyrus (BA 46), medial frontal gyrus (BA 44), cingulate (BA 32), anterior cingulate (BA 24), lentiform nucleus pallidus, putamen and caudate head. For goals vs. missed chances similar activation regions were recorded with additional activations in the medial frontal gyrus (BA 10, 6, 11) and notably, an absence of significant activations in the lentiform nucleus and caudate, see figure 2.

Figure 1: Activations from goals vs. open play

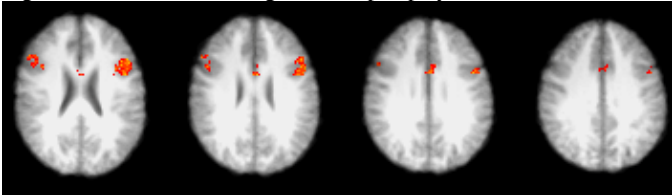
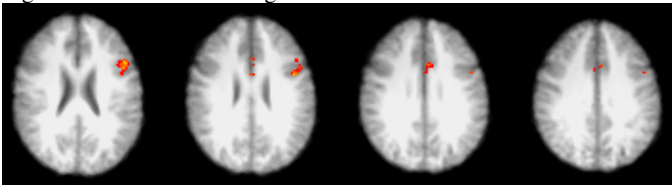


Figure 2: Activations from goals vs. missed chances



Discussion and Conclusion: Regions of the brain were activated in all three contrasts that have been previously implicated in the literature as being responsible for pleasant (and unpleasant) emotions. The absence of activations in the lentiform nucleus and caudate from the goals vs. missed chances contrast strongly implies that these areas are involved in the anticipation of reward processes.

In addition, these results illustrate that using a group-specific, digital video stimuli presented in rapid fashion to investigate subtle psychological processes is a valid method of paradigm construction in fMRI. It has also been shown that by careful selection of the digital video stimulus it was possible to avoid the requirement for any subject decision making process during the paradigm.

References

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