

Dissociating bottom-up responses in the amygdala from top-down processing in the orbitofrontal cortex using an event-related emotion rating paradigm

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Hypothesis

Emotional responses may be bottom-up (stimulus-driven) or top-down (knowledge-driven). Previous studies reported top-down responses to explicit rating of emotional pictures in the anterior cingulate cortex and ventral prefrontal cortex, and bottom-up responses to unpleasant picture content in the amygdala and insula. We attempted to replicate these findings using for the first time a fully event-related paradigm design.

Method

Participants rated pleasant and unpleasant pictures using emotional and non-emotional rating scales. Picture content was randomized at the event level, preventing expectancy of emotional content (a top-down effect), and tasks instructions were also randomized to equalize the timing of bottom-up and top-down responses. Data were collected using standard BOLD-sensitive echo planar imaging on a 3T Siemens Allegra scanner (Munich, Germany), and were analyzed using BrainVoyager QX (Maastricht, Holland). Factorial analysis was used to map the main effects of picture content (bottom-up responses), the main effects of rating task (top-down responses), and their interactions (top-down modulation of bottom-up responses).

Results

Main effects of rating task were seen in the left orbitofrontal cortex (Figure 1A) and right insula. Using reduced-threshold region of interest analysis, main effects of picture content were seen in the left amygdala (Figure 2A). Both effects were seen in the anterior cingulate cortex. No interaction effects were seen. Responses in the orbitofrontal cortex were greater to emotion rating than non-emotional rating, regardless of picture content: a top-down effect (Figure 1B). Responses in the amygdala were greater to unpleasant than pleasant pictures, regardless of rating task: a bottom-up effect (Figure 2B). Responses in the anterior cingulate cortex were less specific than those in other regions.

Discussion

We demonstrated using an event-related paradigm top-down emotion processing in the orbitofrontal cortex and bottom-up emotion processing in the amygdala, confirming previous findings. Future studies may resolve discrepant findings in the insula between previous studies and the current study by including neutral pictures to control for emotional arousal. Future studies may also investigate whether strong responses to emotion rating in the anterior cingulate cortex may be elicited only using block-design paradigms. This paradigm dissociated top-down processing in the orbitofrontal cortex and bottom-up processing in the amygdala, enabling future studies to investigate separately and in parallel two possible substrates for altered emotion processing in affective disorders.

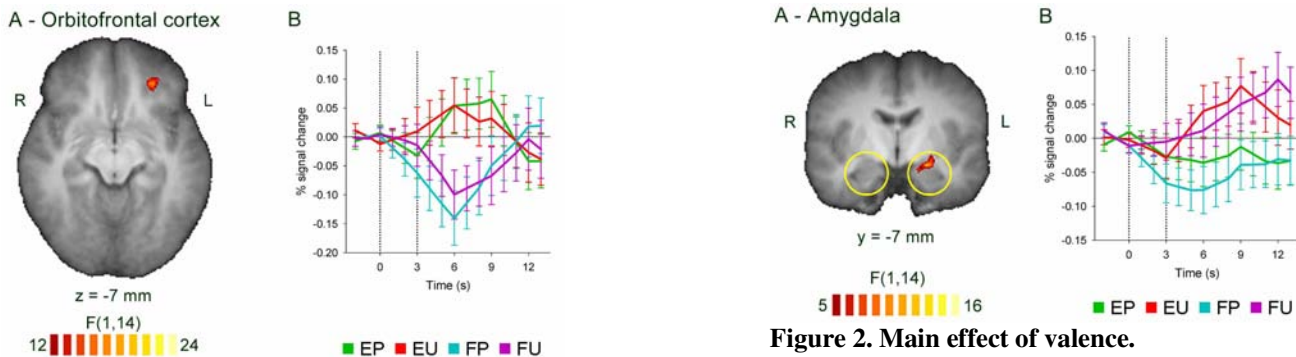


Figure 1. Main effect of task.

A) Statistical map showing a main effect of task in the left orbitofrontal cortex. L: left. R: right. Z: position of axial slice in Talairach space. Color scale indicates F score on two-way ANOVA. B) BOLD responses in the left orbitofrontal cortex. Error bars show standard error. Vertical dotted lines show beginning and end of trial. EP: emotion rating on pleasant pictures, EU: emotion rating on unpleasant pictures, FP: frequency rating on pleasant pictures, FU: frequency rating on unpleasant pictures.

Figure 2. Main effect of valence.

A) Reduced-threshold statistical map showing a main effect of valence at the left amygdala. Responses are only shown inside the *a priori* regions of interest (yellow circles). Y: position of coronal slice in Talairach space. B) BOLD responses in the left amygdala