Negative Picture Processing: Engagement of the Temporal-Limbic System and Beyond

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INTRODUCTION
Converging evidence suggests that processing of affective stimuli engages a complex of spatially distributed neural circuitry. Several theories have been constructed around the neural systems involved in various aspects of affective processing, but many questions remain unanswered. For example, Lane et al. (1997) explored whether selectively attending to subjective emotional salience, in the context of processing emotional stimuli, would elucidate activation in differing neural structures than when participants were not explicitly required to judge the affective salience of the stimuli. They shifted participants attention by first asking them to report their emotional responses to the stimuli, followed by a second run in which the participants were asked to indicate whether the image shown was ‘indoors’, ‘outdoors’, or ‘either’. The present study was focused on elucidating the neural systems associated with processing of negatively valenced stimuli during a task that made no explicit demands on determining affective salience.

HYPOTHESIS
We hypothesized that the temporal-limbic system would show greater activation in response to negative stimuli than neutral stimuli (Lane et al. 1999, 1997; Bradley et al. 1996; Lang et al. 1993). In particular, areas of interest include the amygdala, hippocampus, and rostral anterior cingulate.

MATERIALS AND METHODS
Twenty-three right-handed male participants with a mean age of 29 years performed a picture categorization task. Participants were asked to determine whether the image presented was either living or nonliving. The images were categorized into 14 blocks according to arousal and valence ratings into two categories – negative and neutral. Each block consisted of 8 images selected from the International Affective Picture System (IAPS), and 24 second rest periods existed between each block (see Figure 1).

•Responses were acquired with fiber-optic response device
•Imaging was performed on a GE 1.5T echo speed system
•Custom Visual and Auditory Presentation Package (VAPP) employed
•Echo-planar images (EPI) were collected using a GRE sequence (TR/TE 3000/40, 90° flip, 3.75 x 3.75 x 5.00 mm, 29 slices)
•A GE 3D SQR imaging sequence was used to collect structural MRIs (TR/TE 11.2/21 ms, flip angle 60°, FOV 26 x 26 cm, 255 x 256 matrix, slice thickness 1.5 mm; 124 slices)

RESULTS
The random-effects analysis confirmed the hypotheses that greater activation was observed for processing of negative slides than neutral slides in the temporal-limbic system including, bilateral amygdala, hippocampus, and rostral anterior cingulate.

In addition, negative stimuli also elicited greater activation than the neutral stimuli in bilateral middle occipital gyrus, inferior frontal cortex, and medial frontal cortex.

We replicated Lane et al. (1997) in that both studies found greater hemodynamic activity in bilateral parieto-occipital cortices for affective relative to neutral stimuli during a task that did not explicitly focus on the emotionality of the stimuli.

CONCLUSIONS
These results suggest that processing of affective stimuli engage a spatially distributed neural network that includes, but is not limited to, the temporal-limbic system. The findings of Lane et al. (1997) were replicated in respect that both studies found that the bilateral parieto-occipital cortices displayed increased neural activity during the external focus task.

The current study also found that the rostral anterior cingulate displayed greater activation during the onset of negatively valenced stimuli rather than neutrally valenced stimuli, demonstrating the rostral anterior cingulate’s role in emotional processing.

These results also demonstrate that the neural structures that mediate emotion can be activated during experimentation without the need for explicit focus on the affective salience of the stimuli. This is important in distinguishing between the neural structures that activate during the recognition of emotion and actual emotional activity.

REFERENCES

FIGURE 1: Representation of stimuli presented during the first eight blocks of the emotional slides task.

FIGURE 3: Areas of significant activation to neutral stimuli relative to baseline rest. (Left hemisphere corresponds to left side of image)

FIGURE 4: Areas of significant activation to neutral stimuli relative to baseline rest. (Left hemisphere corresponds to left side of image)

FIGURE 5: Areas of significant activation to negative stimuli relative to neutral stimuli. (Left hemisphere corresponds to left side of image)

FIGURES 2a and b: Signal change time courses for Left and Right Amygdala during the onset of both neutral and negative stimuli

Table 1: Behavioral data from each of the response conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Avg Reaction Time (sec)</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative/Right</td>
<td>74.23</td>
<td>93.30%</td>
</tr>
<tr>
<td>Negative/Left</td>
<td>72.12</td>
<td>93.00%</td>
</tr>
<tr>
<td>Neutral/Right</td>
<td>69.90</td>
<td>93.05%</td>
</tr>
<tr>
<td>Neutral/Left</td>
<td>72.40</td>
<td>93.05%</td>
</tr>
</tbody>
</table>

Negative stimuli were responded to more slowly than neutral stimuli (main effect of condition, F (1, 21) = 70.12, p < .001). No reliable errors were responded to more slowly than living items (main effect of task, F (1, 21) = 22.84, p < .001).