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Transient interference of right hemispheric function due to automatic emotional processing

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Abstract

We examined the effects of emotional stimuli on right and left hemisphere detection performance in a hemifield visual discrimination task. A group of 18 healthy subjects were asked to discriminate between upright and inverted triangles (target). Targets were randomly presented in the left or right visual hemifield (150 ms target duration). A brief emotional picture (pleasant or unpleasant; 150 ms stimulus duration) or neutral picture selected from the International Affective Picture System was randomly presented either in the same (47%) or the opposite (47%) spatial location to the subsequent target. Emotional or neutral stimuli offset 150 ms prior to the subsequent target. Subjects were instructed to ignore the pictures and respond to the targets as quickly and accurately as possible. Independent of field of presentation, emotional stimuli prolonged reaction times ($P < 0.01$) to LVF targets, with unpleasant stimuli showing a greater effect than pleasant stimuli. The current study shows that brief emotional stimuli selectively impair right hemispheric visual discrimination capacity. The findings suggest automatic processing of emotional stimuli captures right hemispheric processing resources and transiently interferes with other right hemispheric functions.

Keywords: Emotion; Hemispheric specialization; Laterality; Cognitive processing

1. Introduction

Asymmetries in hemispheric involvement for several cognitive functions, most notably for language, have been demonstrated. However, rather than each hemisphere specializing in distinct cognitive processes, the cerebral hemispheres have been characterized as complementary and integrative processing systems [1]. While basic bilateral and complementary organization appears to be true also for emotional processing, neuropsychological [9], electrophysiological [5,11], neuroimaging [3] and behavioral [23] evidence supports cerebral asymmetries relating to perceiving, expressing, experiencing and responding to emotions. An overall right hemispheric bias for mediating the perception and expression of emotion has been suggested, while the lateralization of functions subservient to emotional experience seems to depend upon the valence of the emotions, with the left hemisphere being more engaged in pleasant and the right hemisphere in unpleasant emotions (for reviews see Refs. [10,21]). While the evidence for emotion-related asymmetries is robust, there is limited evidence on how this asymmetric hemispheric activation affects other lateralized brain processes.

The cerebral hemispheres may be asymmetrically activated by processes that favor one hemisphere over the other [12]. Furthermore, depending on task-specific factors, this activation may lead to facilitation [12] or interference [8,13] with other processes performed by the activated hemisphere. Facilitation of perceptual processes may occur due to attentional bias to the contralateral hemifield of the activated hemisphere [12]. This type of facilitation for left visual field (LVF)

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performance has been shown using threatening words [22]. On the other hand, interference may occur due to limited resources [8,13]. For example, emotional Stroop studies show interference of task-irrelevant emotional stimuli on cognitive performance [18].

It is clear that emotional processing interacts with cognitive processes in a variety of ways. However, little is known how emotion-related asymmetries in hemispheric activation contribute to this interaction. We examined whether brief, lateralized, task-irrelevant emotional pictures affect subsequent hemispheric visual discrimination performance and whether the valence of the pictures (pleasant, unpleasant or neutral) has an effect. In accordance with the hypothesis of the right hemispheric bias for emotional processing, we predicted greater right hemispheric activation with both pleasant and unpleasant emotional stimuli affecting performance in the contralateral left hemifield. In contrast, according to the valence hypothesis, pleasant emotional stimuli would be predicted to affect the RVF performance and unpleasant stimuli the LVF performance.

Another contributing factor in interactions between lateralized emotional and cognitive processes is spatial attention. According to Stormark et al. [20], emotional stimuli may attract attention leading to improved performance in the location of the emotional stimuli. Bradley et al. [2], on the other hand, has shown attentional bias away from threatening stimuli in nondysphoric subjects leading to improved performance in the opposite location to the emotional stimuli. These reports led us to further investigate how visual performance in a bi-field discrimination task is influenced by the spatial relation between the emotional stimuli and a subsequent target.

2. Methods

2.1. Subjects

Eighteen college students (11 females, seven males) with no neurological or psychiatric disorders were recruited and paid for their participation. All subjects were right-handed. The age of the subjects ranged from 18 to 29 years (mean: 22). Each of the subjects gave their consent according to university guidelines.

2.2. Stimulus selection

Three sets (pleasant, unpleasant and neutral) of 48 colored pictures were chosen from the International Affective Picture System [4]. The mean pleasure ratings for pleasant, unpleasant and neutral pictures used in the study were 7.3 ± 0.6, 2.8 ± 0.8, 5.2 ± 0.4 and the mean arousal ratings were 4.7 ± 0.9, 5.8 ± 0.8, 3.5 ± 0.6, respectively. These ratings were based on IAPS norms [16]. The pleasant pictures included photographs of puppies, babies, happy couples, sporting events, beautiful scenery, etc. Unpleasant pictures consisted of photographs of frightening animals, sad or angry humans, threatening pictures of gun or knife attacks, accident scenes, graveyards, etc. Neutral pictures included photographs of animals, people during daily activities, city scenes, inanimate objects such as hairdryers, etc. Erotic pictures and pictures of mutilated people were excluded from the current study.

2.3. Procedure

The subjects were seated in a sound attenuated booth facing a computer screen at a distance of 1 m. Subjects were instructed to keep their eyes on a fixation cross in the middle of the screen throughout the presentation of the stimuli. Eye movements were monitored with a videocamera during the experiment.

The stimuli extended 12° horizontally of visual angle. The targets occurred 8° from fixation, which was also the center of the stimuli. The experiment was divided into four blocks, each lasting ≈ 5 min. The initial response hand was counterbalanced across subjects and after each block. All 144 pictures were randomly presented once in each block.

An upright or inverted triangle (target) was flashed for 150 ms on either side of the fixation cross. Targets were randomly presented in the left or right visual hemifield. Half of the targets were upright and half were inverted. Subjects were asked to respond to the orientation of the triangle, pressing one button with their middle finger if the triangle was pointing up and another button with their index finger if the triangle was pointing down. A brief emotional (pleasant or unpleasant; 150 ms stimulus duration) or neutral picture was randomly presented, either in the same (47%) or the opposite (47%) spatial location to the subsequent target. Six percent of the targets were not preceded by picture stimuli. The emotional and neutral stimuli offset was 150 ms prior to the onset of the target. The intertarget interval was 2100 ms. Subjects were told to ignore the pictures and respond to the targets as quickly and accurately as possible.

3. Results

Repeated analysis of variance (ANOVA) was performed on reaction times (RT) of correct responses with 'emotional valence' (pleasant, unpleasant, neutral), 'picture location' (pLVF, pRVF) and 'target location' (tLVF, tRVF) as factors within subjects and sex as a factor between the subjects. In addition, separate ANOVA's were performed for unpleasant, pleasant and neutral stimuli as well as for comparing unpleasant to