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Right hemispheric dominance in processing of unconscious negative emotion

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Abstract

Right hemispheric dominance in unconscious emotional processing has been suggested, but remains controversial. This issue was investigated using the subliminal affective priming paradigm combined with unilateral visual presentation in 40 normal subjects. In either left or right visual fields, angry facial expressions, happy facial expressions, or plain gray images were briefly presented as negative, positive, and control primes, followed by a mosaic mask. Then nonsense target ideographs were presented, and the subjects evaluated their partiality toward the targets. When the stimuli were presented in the left, but not the right, visual fields, the negative primes reduced the subjects' liking for the targets, relative to the case of the positive or control primes. These results provided behavioral evidence supporting the hypothesis that the right hemisphere is dominant for unconscious negative emotional processing.
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1. Introduction

The neuro-cognitive mechanism of emotion without conscious awareness has long been a subject of great interest (Pribram & Gill, 1976). Neuropsychological studies in split-brain patients suggested that unconscious emotion might be lateralized to the right hemisphere. For example, Gazzaniga and LeDoux (1978) reported that when emotional stimuli were presented to the left visual field (i.e., stimulating the right hemisphere) of a split-brain patient, the patient could not verbally describe the stimuli but showed emotional reactions. As some psychological abilities (e.g., language) are dominantly processed in a single hemisphere, evidence of hemispheric functional asymmetry in unconscious emotion would have intriguing implications regarding its neuro-cognitive mechanism. However, other neuropsychological studies with a split-brain patient (Ladavas, Cimatti, Del Pesce, & Tuozzi, 1993) and unilateral temporal lobectomy patients (Glascher & Adolphs, 2003; Kubota et al., 2000) have not reported such hemispheric asymmetry in unconscious emotion.

Neuroimaging studies in non-brain-damaged subjects have revealed that masked presentations of emotional stimuli, which are not accessible to subjects' conscious awareness, activate the amygdala, particularly when the stimuli are emotionally negative (Killgore & Yurgelun-Todd, 2004; Morris, Ohman, & Dolan, 1998, 1999; Nomura et al., 2004; Rauch et al., 2000; Sheline et al., 2001; Whalen et al., 1998). Some of these studies (Morris et al., 1998, Morris, Ohman, & Dolan, 1999; Nomura et al., 2004) have reported right hemispheric dominance for unconscious negative emotional processing. For example, Morris et al. (1998) reported that when the stimuli were presented subliminally, an angry facial expression conditioned with emotionally negative noise activated the right, but not left, amygdala more than an unconditioned angry facial expression. Other studies (Killgore & Yurgelun-Todd, 2004; Rauch et al., 2000; Sheline et al., 2001; Whalen et al., 1998), however, did

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not report such hemispheric asymmetry in amygdala activity in response to masked emotional stimuli. There have also been a number of neuroimaging studies of brain-damaged patients that have investigated unconscious emotional processing due to cortical lesions (Morris, De Gelder, Weiskrantz, & Dolan, 2001; Pegna, Khateb, Lazeyras, & Seghier, 2004; Vuilleumier et al., 2002). These studies reported inconsistent laterality in amygdala activity in response to unseen emotional stimuli (right in Pegna et al., 2004, left in Vuilleumier et al., 2002, and bilateral in Morris et al., 2001).

Taken together, there is some evidence from neuropsychological and neuroimaging literature for the dominance of the right hemisphere in unconscious emotional processing, particularly for negative emotion, but results thus far have been inconsistent. With regard to this inconsistency, it should be noted that all of these studies tested a relatively small number of subjects (e.g., eight in Whalen et al., 1998). The sample sizes may have been too small to provide statistically reliable data about the existence or otherwise of hemispheric asymmetry in unconscious emotional processing.

Psychophysiological studies in normal subjects using relatively large sample sizes have consistently revealed that subliminal presentations of negative emotional stimuli elicit electrodermal activity (EDA), particularly when the stimuli are presented in the left visual field (Johnsen & Hugdahl, 1991; Kimura, Yoshino, Takahashi, & Nomura, 2004; Peper & Karcher, 2001; Zaidel, Hugdahl, & Johnsen, 1995). For example, Zaidel et al. (1995) tested 33 normal subjects, and revealed that negative emotional scenes elicited more EDA than positive scenes when the stimuli were presented in the left, but not the right, visual field. These data suggest that unconscious negative emotion is processed predominantly by the right hemisphere. However, using EDA as a measure of emotional reactions has a disadvantage in that it could be reflecting various types of psychological processes; even if it does reflect purely emotional responses, it indicates only the arousal level of the emotion without valence information (Bauer, 1998).

To provide behavioral evidence of hemispheric asymmetry in unconscious emotional processing, we tested 40 normal participants using a subliminal affective priming paradigm (Murphy & Zajonc, 1993). In the most typical case in this paradigm, an emotional stimulus with negative (e.g., an angry facial expression) or positive valence (e.g., a happy facial expression), or a control stimulus (e.g., a polygon), is flashed briefly as a prime, and then a nonsense target ideograph is presented. Subjects are asked to judge the target as either preferred or not preferred. Previous studies have reported that subjects' judgment of the target was biased toward having less preference by the unconscious negative primes, but not by the positive or control primes (Murphy, Monahan, & Zajonc, 1995; Murphy & Zajonc, 1993; Winkielman, Zajonc, & Schwarz, 1997). This effect is regarded as evidence that unconscious emotion is elicited and spills over into the judgment of unrelated targets (Murphy & Zajonc, 1993). This subliminal affective priming paradigm could provide information about the valence of unconsciously elicited emotion. Here, we combined the affective priming paradigm with the unilateral visual field presentation. We presented the angry and happy facial expressions as negative and positive primes. Plain gray images were also presented as control primes. Based on the aforementioned evidence indicating right hemispheric dominance in unconscious negative emotion, we predicted that when the stimuli were presented in the left visual field, the negative primes would reduce the subjects' preference for nonsense targets relative to the positive or control prime conditions.

2. Methods

2.1. Subjects

Forty healthy male volunteers (mean $\pm$ *SD* age, 23.9 ± 3.2 years) participated in this experiment. Only male subjects were recruited because there is some evidence that males show clear hemispheric functional asymmetry than do females (Kimura, 1999). All of the subjects were right-handed by self-report. Only right-handed subjects were tested, because left-handed individuals have been reported to have different patterns of hemispheric functional asymmetry (e.g., Heller & Levy, 1981). All of the subjects had normal or corrected-to-normal visual acuity. All of them were Japanese, and none of them knew Korean characters (the target ideographs in this experiment). All were ignorant of the purpose of the experiment.

2.2. Experimental design

The experiment was constructed as a within-subjects two-factorial design, with prime (negative/positive/control) and visual field (left/right) as the factors.

2.3. Stimuli

Grayscale photographs were chosen from the Ekman and Friesen's (1976) standardized facial expression set to serve as emotional primes. These stimuli were the faces of 12 models (six females and six males) expressing the emotions of anger and happiness. The 24 faces were oval-shaped for the purpose of minimizing extraneous clues (e.g., hair). As a mask stimulus, a mosaic pattern made up of fragments of these faces was prepared. As a number of previous studies utilized no prime presentations as a control condition (Murphy & Zajonc, 1993), a no prime control condition was prepared; an oval-shaped plain gray image, the same size as the emotional primes, was created.

Korean characters were used as the target nonsense ideographic stimuli. To ensure that the target stimuli were emotionally neutral, we initially showed 96 Korean characters to 32 subjects (none of whom took part in the experiment itself). These subjects evaluated each stimulus for

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