

## Research Report

# Neural Activity Underlying the Effect of Approach-Motivated Positive Affect on Narrowed Attention

Eddie Harmon-Jones and Philip A. Gable

Texas A&amp;M University

**ABSTRACT**—Positive affects high in approach motivational intensity narrow attention. The present study extended this recent finding by testing whether a neural activation associated with approach-motivation intensity—relative left frontal-central activity—would underlie the effect of appetitive stimuli on narrowed attention (as measured by local attentional bias). It also tested whether individual differences in approach motivation relate to this attentional narrowing. Results supported predictions, suggesting a common association of relative left frontal hemispheric processing for approach-motivational processes and narrowed attention.

Directly in front of you lies a delicious piece of chocolate cake. Will you notice the pattern of the china plate upon which the cake sits? Decades of research on positive affect suggest you will notice the china pattern, because positive affects broaden attention (Fredrickson, 2001; Rowe, Hirsh, & Anderson, 2007). However, recent research suggests you will completely miss the pattern (Gable & Harmon-Jones, 2008a). Your attentional breadth will be influenced by whether the positive affect is low or high in approach motivation—the urge to move toward something in the environment. On the one hand, if you are in a positive affective state high in approach motivation, your attention will be narrowed. On the other hand, if you are in a positive state low in approach motivation, your attention will be broadened (Gable & Harmon-Jones, 2008a). Approach-

motivated positive affective states are essential in the process of acquiring outcomes. They may also be involved in addiction processes. Such states should be associated with attentional narrowing, because organisms shut out irrelevant stimuli, perceptions, and cognitions as they approach and attempt to acquire the desired objects.

The frontal cortex is asymmetrically involved in approach and withdrawal motivation, with greater relative left frontal activity associated with approach motivation and greater relative right frontal activity associated with withdrawal motivation (Davidson, 1995; Harmon-Jones, 2003). Thus, relatively greater left frontal activation should be associated with the narrowing of attention, particularly after the activation of approach-motivated positive affect by exposure to appetitive stimuli. Much cognitive research has suggested that left-hemispheric processing is involved in the narrowing of attention (Volberg & Hübner, 2004). These two diverse literatures have yet to be integrated.

The present research examines two novel questions: First, do neural activations involved in approach motivation also underlie the effect of approach-motivated positive affect on narrowed attention? Second, do individual differences in approach motivation relate to this attentional narrowing?

## METHOD

Forty-three right-handed introductory psychology students (all women) participated for course credit. They indicated how long it had been since they had last eaten (in minutes).

Participants viewed 32 dessert pictures and 32 neutral pictures in random order. The dessert pictures have been found to significantly increase approach-motivated positive affect rela-

Address correspondence to Eddie Harmon-Jones or Philip A. Gable, Department of Psychology, Texas A&M University, 4235 TAMU, College Station, TX 77843; e-mail: eddiehj@gmail.com or pagable@gmail.com.

tive to neutral pictures (Gable & Harmon-Jones, 2008a, 2008b). Each trial involved a fixation cross (500 ms), a picture prime (6,000 ms), another fixation cross (500 ms), and a Navon letter (Navon, 1977), which was displayed until there was a response. The intertrial interval was 3,000 ms. Participants were instructed to respond to the Navon letter as quickly as possible by pressing one button upon detection of the letter *T* and another button upon detection of the letter *H*. The stimuli in this letters task were large letters composed of smaller letters; each line of a large letter was made of five closely spaced local letters in Times New Roman font. Global targets ( $n = 32$ ) consisted of a large *T* or *H* composed of smaller *L*s or *F*s. Local targets ( $n = 32$ ) consisted of a large *L* or *F* composed of smaller *T*s or *H*s. Large letters had a visual angle of  $3.34^\circ$  (height) by  $1.91^\circ$  (width); small letters had a visual angle of  $0.48^\circ$  by  $0.32^\circ$ .

Electroencephalography, recorded with 64 tin electrodes, was referenced to the left earlobe. Eye movements were recorded from the supra- and suborbit of the left eye. Electrode impedances were under  $5,000 \Omega$ ; homologous sites were within  $1,000 \Omega$  of each other. Signals were amplified, band-pass-filtered (0.1–100 Hz; 60-Hz filter enabled), and digitized at 500 Hz.

Artifacts were removed by hand. A regression-based eye movement correction was applied. All epochs 1.02 s in duration were extracted through a Hamming window and rereferenced to averaged ears. Consecutive epochs were overlapped by 50%. A fast Fourier transform was used to calculate power spectra. Power values within the low alpha band (8–10.25 Hz) were averaged across epochs of picture viewing. Asymmetry indexes (log right minus log left) were computed for frontal (F3–F8), frontal-central (FC3–FC6), central (C3–C6), and parietal (P3–P8) regions. Of these, the frontal and frontal-central regions were expected to be sensitive to approach motivation (Harmon-Jones, 2003; Urry et al., 2004). Because alpha power is inversely related to cortical activity, higher scores indicate greater left-hemispheric activity. Predictions were directional, derived from theory, and specified a priori; they were evaluated using a one-tailed criterion of significance (Rosenthal, Rosnow, & Rubin, 2000).

## RESULTS AND DISCUSSION

Appetitive pictures caused a local bias, as revealed in a 2 (dessert or neutral picture)  $\times$  2 (local or global target) within-subjects analysis of variance of log-transformed reaction times (RTs),  $F(1, 42) = 9.14$ ,  $p_{\text{rep}} = .97$ . After neutral pictures, participants responded faster to global targets ( $M = 6.66$ ,  $SD = 0.19$ ) than to local targets ( $M = 6.71$ ,  $SD = 0.18$ ),  $p_{\text{rep}} = .98$ . After dessert pictures, participants responded faster to local targets ( $M = 6.69$ ,  $SD = 0.17$ ) than to global targets ( $M = 6.72$ ,  $SD = 0.18$ ),  $p_{\text{rep}} = .89$ . Also, more time since having eaten predicted greater relative left frontal-central activity to dessert pictures,  $r = .33$ ,  $p_{\text{rep}} = .91$  (and marginally predicted relative left frontal

activity,  $r = .27$ ,  $p_{\text{rep}} = .84$ ), even though picture type did not affect asymmetry. No other asymmetries were related to time since having eaten ( $r$ s  $< .02$ ). These results replicate past findings (Gable & Harmon-Jones, 2008a, 2008b), thus permitting tests of the hypotheses. Because effects were stronger in frontal-central than frontal regions, we focused on the frontal-central region (see also Urry et al., 2004).

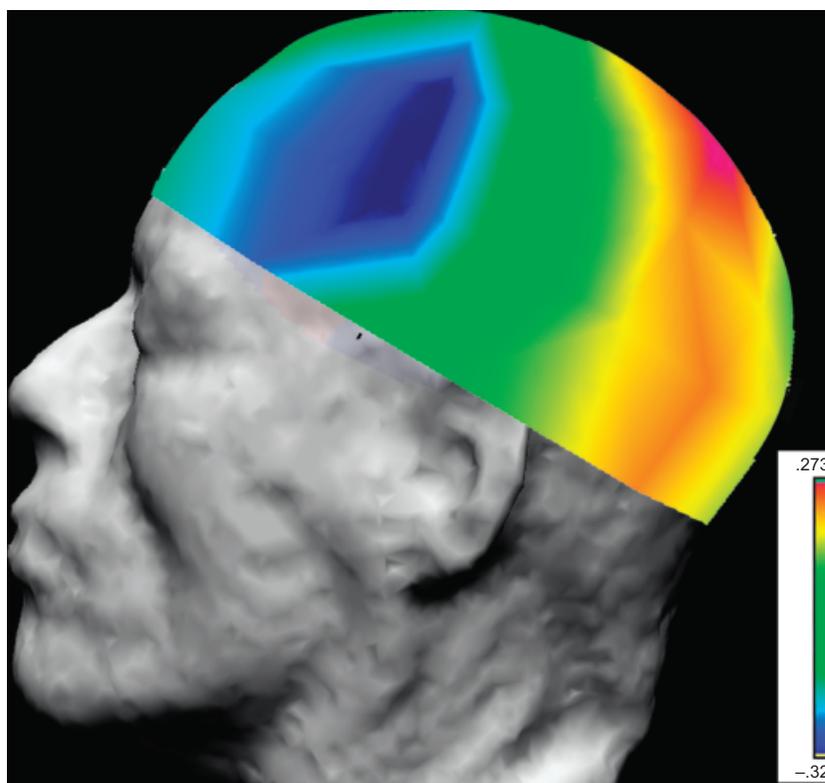
Greater left frontal-central activation during dessert pictures predicted faster local-target RT after dessert pictures,  $pr = -.31$ ,  $p_{\text{rep}} = .93$ , controlling for local-target RT after neutral pictures (Fig. 1). More time since having eaten predicted faster local-target RT after dessert pictures,  $pr = -.31$ ,  $p_{\text{rep}} = .93$ , controlling for local-target RT after neutral pictures.

Other analyses were performed to test the specificity of these effects. Greater left frontal-central activation during neutral pictures did not significantly predict local-target RT after neutral pictures,  $p_{\text{rep}} = .81$ , controlling for local-target RT after dessert pictures. For global targets, greater left frontal-central activation during dessert pictures or neutral pictures did not predict faster global-target RT after dessert pictures ( $p_{\text{rep}}$ s  $< .33$ , controlling for global-target RT after the other type of picture). Also, controlling for global-target RT (dessert minus neutral global) did not reduce the relationship between relative left-frontal-central activation to desserts and local bias,  $pr = -.37$ ,  $p_{\text{rep}} = .97$ .

Even when left frontal-central activation to neutral pictures was statistically controlled, greater left frontal-central activation to dessert pictures still predicted greater local bias following dessert pictures,  $pr = -.28$ ,  $p_{\text{rep}} = .89$ . This effect of dessert left frontal-central activation on dessert local bias remained significant when controlling for relative left central, central parietal, parietal, and parietal-occipital activations to dessert pictures,  $pr = -.33$ ,  $p_{\text{rep}} = .93$ . None of these other asymmetrical cortical indexes were significant predictors,  $p_{\text{rep}}$ s  $< .84$ .

Using established procedures (Kenny, Kashy, & Bolger, 1998), we found that relative left frontal-central activity did not mediate the effect of time since having eaten on local bias after viewing dessert pictures, as revealed by a nonsignificant Sobel (1982) test ( $z = 1.43$ ). Because of concerns with the Sobel test (Shrout & Bolger, 2002), bootstrapping analyses were performed; these analyses did not provide evidence of statistical mediation. These results may have been caused by measurement error (mediation tests assume no measurement error in the mediator), or they may suggest that other processes mediate the effect of time since having eaten on local bias.

Our recent past research replicated earlier work showing that low-approach positive affect caused broadening of attention, and extended it by showing that high-approach positive affect caused narrowing of attention (Gable & Harmon-Jones, 2008a). The present research further extended our recent work by demonstrating that a cortical activation involved in approach-motivational processes—relative left frontal-central activa-



**Fig. 1.** Topographic map displaying partial correlations between relative left-hemispheric activation during presentation of dessert pictures and reaction time (RT) to local targets after presentation of dessert pictures. The display is a left lateral head view. Deep blue coloring marks cortical regions in which greater relative left-hemispheric activation during presentation of dessert pictures was significantly associated with faster RTs to local targets after presentation of dessert pictures. No significant correlations occurred in other regions.

tion—related to the narrowing of attention following appetitive stimuli. Our previous studies have found that these appetitive pictures increase self-reported positive affects such as enthusiasm, good mood, and pleasantness, consistent with the idea that affects and motivations are often intertwined (Gable & Harmon-Jones, 2008a, 2008b). Because of time constraints, such self-reports were not included in the present study.

The present results demonstrated that greater narrowed attention induced by appetitive stimuli is driven by approach-motivation processes. Individual differences in time since having eaten and relative left frontal-central activation to dessert stimuli both related to greater narrowed attention following dessert stimuli. Did hungry individuals show increased left frontal-central activation because of frustration? According to our research, the answer is “no”: Dessert pictures, compared to neutral pictures, decrease frustration and increase positive affect even in hungry individuals (Gable & Harmon-Jones, 2008b). The present study integrates research on motivation, attentional focus, and their associated neural processes. Approach motivation engages the same neural circuitry that drives local attention in general, and the approach-motivated activation of this circuitry biases local attention even more.

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