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## Brief report

# Attentional states influence early neural responses associated with motivational processes: Local vs. global attentional scope and N1 amplitude to appetitive stimuli

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## ABSTRACT

Positive affects vary in the degree with which they are associated with approach motivation, the drive to approach an object or a goal. High approach-motivated positive affects cause a narrowing of attention, whereas low approach-motivated positive affects causes a broadening of attention. The current study was designed to extend this work by examining whether the relationship between motivation and attentional bias was bi-directional. Specifically, the experiment investigated whether a manipulated local attentional scope would cause greater approach motivational processing than a global attentional scope as measured by neural processes as early as 100 ms. As compared to a global attentional scope, a local attentional scope caused greater neural processing associated with approach motivation as measured by the N1 to appetitive pictures.

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## 1. Introduction

Positive affects of different motivational intensities have distinct effects on attention and cognition. Low approach-motivated positive affects cause broadening of cognition and attention (Fredrickson and Brannigan, 2005; Gable and Harmon-Jones, 2008a, 2010a; Gasper and Clore, 2002; Rowe et al., 2007), presumably because these positive affects suggest a stable and comfortable environment (Fredrickson, 2001). In contrast, high approach-motivated positive affects cause narrowing of cognition and attention (Gable and Harmon-Jones, 2008a, 2010a; Harmon-Jones and Gable, 2009; Price and Harmon-Jones, 2010), presumably because narrowed processes assist in the shutting out of irrelevant stimuli and cognitions as organisms approach and attempt to acquire desired objects (Gable and Harmon-Jones, 2010b,c; Harmon-Jones and Gable, 2008). The current study was designed to extend this work by examining whether the relationship between approach motivation and narrowed attention was bidirectional. That is, would a manipulated narrow attentional scope cause greater early motivational neural responses than a broadened attentional scope?

Functionally, a narrowed attentional scope may enhance attention toward desirable goals, whereas a broadened attentional scope may reduce attention toward goals. Zeroing-in on an appetitive

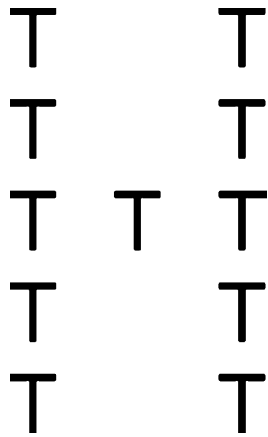
object is likely to increase desire for the object, whereas a broader consideration of an appetitive object may decrease the desire for the object. Liberman and Forster (2009) found that a local as opposed to a global attentional scope (using Navon, 1977, letters) reduced the estimates of psychological distances of time, space, and social distance. Balcetis and Dunning, 2010 suggested that “perceiving desirable objects as closer can energize actions meant to obtain those objects.” (p. 151). Both increased desire and narrowed attentional scope bring things psychologically closer, and psychological proximity to a goal enhances motivation (Liberman and Forster, 2009).

Other findings supportive of this bi-directional relationship have been found in neurophysiological investigations. Harmon-Jones and Gable (2009) showed that both narrowed attentional scope and approach motivation have similar neurophysiological underpinnings and thus suggest a bi-directional relationship between approach motivation and narrowed attention. This hypothesis is consistent with the idea that motivational and cognitive systems are integrated at some levels of processing because they share similar neural substrates (Gray, 2001; Gray et al., 2002). The present study expanded on this recent research by testing the hypothesis that manipulating local vs. global scope will influence appetitive motivation even as early as 100 ms into stimulus processing as measured by the N1 of the event-related potential.

The N1 has been found to be sensitive to motivationally relevant stimuli such as affective pictures (Foti et al., 2009; Keil et al., 2001). Also, research suggests that the N1 is an indicator of enhanced visual processing for selected goal-related actions, as

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**Fig. 1.** Example of the Navon Letter stimuli with local element letter “T” and global element letter “H”.

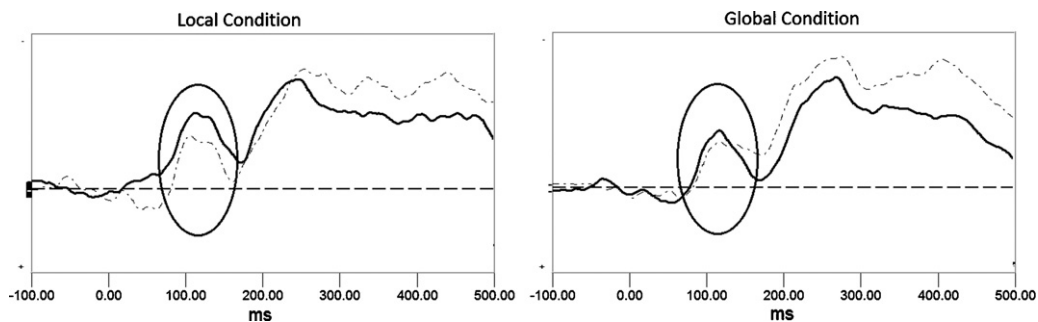
the N1 is larger to visual probes that appear in goal-relevant positions (Baldauf and Deubel, 2009). In addition, larger N1s occur to food-related words when individuals are in a food-deprived compared to satiated state (Plihal et al., 2001). The N1 is likely driven by several cortical and sub-cortical structures (Olofsson et al., 2008). Based on previous research indicating the N1 is related to appetitive attentional processing, our predictions focused on the N1.

We predicted that compared to global attention, local attention should cause greater neural processing toward appetitive stimuli as early as 100 ms into the processing of appetitive stimuli. Specifically, N1 amplitudes to appetitive pictures should be larger under a local attentional manipulation than under a global attention manipulation.

**2. Method**

Seventy-nine (29 women) right-handed students participated for course credit. After informed consent, 64 EEG electrodes were applied. Half the participants were in the attentional narrowing condition; the other half were in the attentional broadening condition. Narrowed vs. broadened attentional scope was manipulated by having half the participants identify the small letter in the Navon pictures (i.e., local elements) and the other half identify the large letter in the Navon pictures (i.e., global elements; see Fig. 1). Approximately half the participants in each condition ( $n = 36$ ) were asked to identify the local and global elements by responding orally; the other half responded with button presses. Responses were checked to ensure participants in both conditions correctly identified the local or global letter. Six participants were excluded from analyses because they had error rates greater than 10% of the trials. Response type was manipulated to assess whether it influenced the outcome; results revealed it did not.

After 12 practice Navon letters pictures, participants viewed 64 total picture trials (32 appetitive, 32 neutral). Each trial consisted of a fixation cross (500 ms) followed by a Navon letters picture (1500 ms). Then, another fixation cross appeared (3000 ms), followed by a dessert or rock picture (9000 ms). Rock pictures were matched to dessert pictures on size, shape, and color. Previous studies have found the dessert pictures are rated as more pleasant, arousing, and desirable than the rock pictures (Gable and Harmon-Jones, 2008a,b, 2010a; Harmon-Jones and Gable, 2009). Picture ratings were not obtained in the current study due to time constraints.



**Fig. 2.** Dessert pictures (solid) vs. neutral pictures (dashed) ERP waveforms at CZ with N1 circled.

**Table 1**

The columns of numbers are means (SDs) of N1 amplitudes ( $\mu\text{V}$ ) for picture type across EEG sites. Differing subscripts indicate differences at  $p < 0.05$ . First subscript indicates comparisons between the within-subjects manipulation (picture type: dessert vs. neutral) within each between-subjects manipulation (local vs. global attention manipulation). Second subscript indicates comparisons of the same picture type across the between-subject manipulation (e.g., comparing dessert pictures from local to global condition).

	Local condition		Global condition	
	Dessert	Rocks	Dessert	Rocks
FZ	-3.33 (0.35)aa	-2.68 (0.36)ba	-2.41 (0.35)ab	-2.74 (0.36)aa
FCZ	-3.77 (0.35)aa	-2.86 (0.34)ba	-2.71 (0.35)ab	-3.03 (0.34)aa
CZ	-3.49 (0.36)aa	-2.57 (0.34)ba	-2.68 (0.35)aa	-2.65 (0.34)aa

All sites were referenced online to the left earlobe and re-referenced offline using the common average reference. Impedances were under 5000  $\Omega$ . Signals were amplified, bandpass filtered (0.1–100 Hz; 60-Hz filter enabled), and digitized at 500 Hz. Artifacts (e.g., aberrant signals due to muscle movement; 25% of trials were removed in the local condition, 22% were removed in the global condition) and sensor failures (0.1% of channels) were removed by hand and rejected from analyses. Only one sensor failure (at site FZ) affected subsequent analyses; data from this site were excluded for this participant. A regression-based eye blink correction using FP1 as the eye blink channel was applied (Semlitsch et al., 1986). Data were epoched for 100 ms before picture (dessert or rocks) onset until 1200 ms after picture onset, and filtered with a lowpass of 35 Hz (Picton et al., 2000). Based on visual inspection of the pronounced N1 in aggregated waveforms, amplitude was measured as the minimum amplitude within a window of 60–160 ms.

N1 amplitudes at midline sites FZ, FCZ, and CZ were targeted, consistent with prior research showing these sites to be sensitive to emotive processing (Foti et al., 2009; Keil et al., 2001; Plihal et al., 2001). In addition to these sites, parietal, occipital, and lateral-occipital N1 and P1 amplitudes were investigated (Di Russo et al., 2003). Although these occipital components are modulated by spatially-focused attention (Hillyard and Anllo-Vento, 1998), it was not predicted that these components would be sensitive to emotive modulations.

**3. Results**

As predicted, within the local attentional scope condition, N1 amplitudes were larger to appetitive than neutral pictures, whereas in the global attentional scope condition, they were not (see Fig. 2). In addition, N1 amplitudes to appetitive pictures were larger in the local than global attentional scope condition (see Table 1). This pattern of results was revealed in a significant 2 (appetitive or neutral picture)  $\times$  2 (local or global target) interaction,  $F(1, 70) = 7.99, p = 0.006, \eta_p^2 = 0.10$ . Moreover, this effect emerged over all 3 predicted sites, as the three-way interaction involving the above two factors and predicted midline sites (FZ, FCZ, or CZ) was not significant,  $F(2, 140) = 0.34, p = 0.72, \eta_p^2 = 0.004$ . As expected, N1 amplitudes did not differ as a function of attention manipulation and picture type at other midline sites,  $ps = 0.87$ . Furthermore, occipital N1 and P1 amplitudes did not differ as a function of picture and attention manipulations,  $ps > 0.22$ .

#### 4. Discussion

Results suggest that relative to a global attentional scope, a local attentional scope causes greater neural processes associated with approach motivation while viewing appetitive pictures. Manipulated local vs. global attentional bias was selective to N1 responses to appetitive pictures. It is unlikely that these effects can be attributed merely to valence, because low approach-motivated positive affects are associated with global attentional scope (Fredrickson and Brannigan, 2005; Gable and Harmon-Jones, 2008a).

Generally, the N1 in emotion paradigms is thought to reflect motivated attentional processing (Foti et al., 2009; Keil et al., 2001). The current results extend past research by showing these rapid neural processes can be modulated by a broad or narrowed attentional scope. However, it should be noted that the behavioral impact of the N1 is unclear based on the current results.

Together with previous research, the current study indicates that attentional scope and approach motivation have a bidirectional relationship: approach motivation causes attentional narrowing (Gable and Harmon-Jones, 2008a), and attentional narrowing (as opposed to broadening) causes greater approach-oriented neural processing (the present study). These results indicate that emotion and cognition are integrated during processing (Gray, 2001). Moreover, the functional specialization of both approach motivation and attentional narrowing is not attenuated, but enhanced by this bidirectional relationship.

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