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Brief report

Leaning embodies desire: Evidence that leaning forward increases relative left frontal cortical activation to appetitive stimuli☆

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ABSTRACT

We often lean toward things or people we desire. Does the converse happen as well? Does simply leaning forward increase patterns of neural activation associated with desire? Desire can be conceptualized as similar to the broader construct, approach motivation. Research has found that manipulated body postures *reduce* approach motivation (Harmon-Jones and Peterson, 2009; Riskind and Gotay, 1982). The present experiment tested whether leaning forward, a body posture associated with approach motivation, would increase approach motivation. We measured a pattern of neural activation associated with approach motivation, relative left frontal cortical activation, in response to pictures of appetitive (desserts) vs. neutral objects (rocks) while participants leaned forward or reclined backward. Leaning forward increased relative left frontal cortical activation to appetitive vs. neutral pictures; the reclining condition produced no differences between stimuli.

1. Introduction

We often lean toward things or people we desire. Does the converse happen as well? That is, does simply leaning forward increase patterns of neural activation associated with desire? Although much research has investigated the influence of manipulated facial expressions on psychophysiological processes (Coan et al., 2001; Levenson et al., 1990), almost no research has investigated the influence of body posture on these processes.

Desire can be conceptualized as similar to the broader construct, approach motivation. Research has found that manipulated body postures *reduce* approach motivation. Slumped postures lead to more "helpless behaviors" (Riskind and Gotay, 1982), and a reclined posture reduces relative left frontal cortical activation associated with approach-motivated anger (Harmon-Jones and Peterson, 2009). In a recent extension of these two studies, an experiment revealed that reclining backward caused lower relative left frontal cortical activity than leaning forward with arms extended (Price and Harmon-Jones, in press). The present research was designed to extend this most recent experiment in which individuals simply maintained these body postures but performed no other tasks that might evoke motivational responses.

Specifically, the present experiment tested whether leaning forward, a body posture associated with approach motivation, would increase a pattern of neural activation associated with approach motivation, relative left frontal cortical activation, to appetitive stimuli. Over 70 studies using individual difference designs or strong laboratory manipulations of emotive states have found relative left frontal cortical activation to be associated with approach motivational processes (Coan and Allen, 2004; Harmon-Jones et al., 2004, 2010). However, relative left frontal cortical activation has not been found to increase in response to pictures or films, which likely evoke weak appetitive states. One of the first demonstrations of appetitive stimuli increasing relative left frontal cortical activation observed the increase to positive emotional films only when participants were also smiling (Davidson et al., 1990). Subsequent research has also failed to find main effects of picture type on relative left frontal activation (Harmon-Jones et al., 2006). Psychological variables that increase approach motivational inclinations toward picture content (e.g., expectation of action), however, do cause the predicted increase in relative left frontal activation to appetitive pictures (Harmon-Jones et al., 2006). Would body posture have a similar effect?

The present experiment was designed to test whether a body posture associated with high approach motivation, leaning forward, would increase relative left frontal cortical activation to appetitive as compared to neutral pictures. Because past studies examining relative left frontal cortical activation in upright

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postures failed to observe differences between neutral and appetitive pictures,[1] we used a different body posture as a comparison: reclining backward. This posture is similar to leaning forward because it is more unusual in a laboratory than sitting upright, but it is different than leaning forward because it is associated with lower approach motivation. We expected reclining backward to produce no differences between appetitive and neutral pictures, similar to past studies using an upright body posture (Harmon-Jones et al., 2006).

2. Methods

Forty-three introductory psychology students (22 men), who reported that they agreed or strongly agreed with statements indicating liking for chocolate and desserts, participated for partial course credit. Sex of participant was examined in the analyses and it produced no main or interactive effects, so it is not discussed further.

Participants sat in a dark room in a chair that could recline. After obtaining informed consent, participants were fitted with a set of Vuzix™ VR920 computer goggles so that visual images could be presented equidistant from the eyes regardless of body posture. EEG sensors were attached.

Participants were instructed via computer to adopt a leaning forward or reclining postures (experimenter was blind to condition). Leaning instructions asked the participant to bend forward so that their back was bent and their elbows were directly on their knees. Reclining instructions asked the participant to fully recline the chair they were sitting in while keeping their legs suspended on the footrest. The participants were unobtrusively monitored to insure they adopted the assigned posture; all participants correctly adopted their assigned posture.

Pictorial stimuli were 32 dessert and 32 neutral rocks pictures presented in random order (used in Gable and Harmon-Jones, 2008b). Each picture was displayed 4 s and inter-trial interval was 15–20 s.

EEG was recorded from 27 tin electrodes mounted in a stretch-lycra electrode cap. The reference electrode was placed on the left earlobe, and data were acquired from an electrode on the right earlobe, so that an off-line, averaged ears' reference could be computed. All electrode impedances were less than 5 kΩ. EEG signals were amplified, bandpass filtered (0.1–100 Hz; 60 Hz notch filter enabled), and digitized at 500 Hz.

All data were hand scored to remove artifacts. Next, a regression-based eye blink correction was applied (Semlitsch et al., 1986). Then all epochs, each 1.024 s in duration, were extracted through a Hamming window and re-referenced using an average ears reference. Consecutive epochs were overlapped by 50% to minimize data loss due to windowing. A fast Fourier transform calculated power spectra. Across each picture type, high alpha power was averaged. Low alpha power and total alpha power were also examined but analyses using them produced no significant effects, as in past research (Pizzagalli et al., 2005).

Because research has suggested that it is the functional difference between frontal hemispheres that best captures the psychological variable, motivational direction (Hofman and Schutter, 2009), asymmetry indices (log right minus log left) were computed on a composite frontal index (F3/4, F7/8, FC3/4), based on research that has found effects over these sites (Amodio et al., 2008; Harmon-Jones and Gable, 2009; McGregor et al., 2009). Because alpha power is inversely related to cortical activity, higher scores indicate greater left than right activity (Allen et al., 2004).

3. Results and discussion

As predicted, leaning forward caused greater relative left frontal cortical activation to appetitive relative to neutral pictures. Reclining did not. These results were revealed in a significant interaction of body posture condition and picture type (i.e., a 2 [posture: leaning, reclining] between-subjects × 2 within-subjects [picture type: dessert, rocks] ANOVA), $F(1, 41) = 5.08$, $p = .03$, partial eta squared = 0.11). Follow-up comparisons indicated that within the leaning forward condition, relative left frontal activation was greater to appetitive than neutral pictures, $p = .009$, Cohen's $d = .83$. Within the reclining backward condition, relative left frontal activation did not differ between appetitive and neutral pictures, $p = .68$. The main effects of body posture and picture type were not significant, $ps > .10$[2] (Fig. 1).

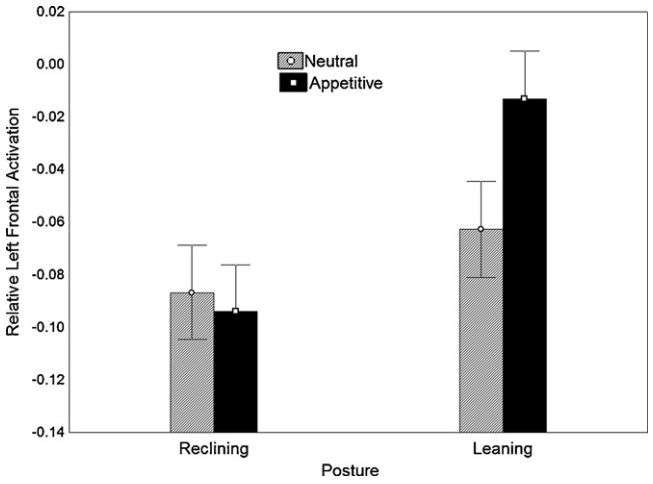

Fig. 1. Means for relative left frontal cortical activation as a function of body posture and picture type. Error bars are 95% confidence intervals, calculated using the methods recommended by Cousineau (2005).

All other asymmetry indexes were examined in an exploratory manner to assess whether any significant body posture × picture type interactions occurred. That is, each asymmetry index was tested in a 2 (leaning, reclining) × 2 (dessert, rocks) ANOVA. All asymmetries produced non-significant interactions, $ps > .30$, except C3/C4. Over this central region, a similar interaction to that observed with the frontal regions emerged, $F(1, 41) = 4.30$, $p = .04$. That is, within the leaning forward condition, relative left central activation was greater to appetitive ($M = .085$; $SD = .261$) than neutral pictures ($M = .031$; $SD = .236$), $p = .02$. Within the reclining backward condition, relative left central activation did not differ between appetitive ($M = -.025$; $SD = .237$) and neutral pictures ($M = -.013$; $SD = .192$), $p = .58$. These central electrodes may also capture variance in neural activity generated in dorsolateral prefrontal cortex and this activity may be diffused to these more central areas. On the other hand, these central region activations may also reflect motivational responses, as the central regions may be closely connected with frontal motivational processes in some instances (Hajcak et al., 2007; Peterson et al., 2008; Schutter et al., 2008).

The present results extend the work of Price and Harmon-Jones (in press), who recently found that simply leaning forward caused greater relative left frontal activity than reclining backward when individuals were in something akin to a resting, baseline state. That is, the individuals in this past experiment were not explicitly processing any stimuli, such as appetitive and neutral pictures as in the present experiment. One question that may emerge is why the manipulated body posture of the present experiment did not influence asymmetric frontal cortical activation to neutral pictures. It is possible that in the absence of any explicit stimuli (e.g.,

[1] In addition to Harmon-Jones et al. (2006), other studies have failed to find asymmetric frontal cortical activations to emotional as compared to neutral pictures (Elgavish et al., 2003; Harmon-Jones, 2007) even with the same stimuli as used in the present experiment (Gable and Harmon-Jones, 2008a; Harmon-Jones and Gable, 2009).

[2] Another ANOVA was conducted with frontal asymmetry index (F3/4, F7/8, FC3/4) entered as a factor in the 2 (body posture) × 2 (picture type) design. This 3 × 2 × 2 ANOVA did not reveal any significant interactions involving asymmetry index, and the significant 2 (body posture) × 2 (picture type) interaction remained significant, suggesting that our approach of collapsing over the three frontal asymmetry indices was appropriate. Based on the suggestion of a reviewer, we conducted an additional set of ANOVAs, one for each frontal asymmetry index. The ANOVA for FC3/4 revealed a significant interaction of body posture condition and picture type (neutral vs. dessert), $F(1, 41) = 4.95$, $p = .03$, partial eta squared = 0.108. The ANOVAs for F3/4 and F7/8 revealed similar interactions that just missed being statistically significant at conventional levels, for F3/4, $F(1, 41) = 2.77$, $p = .10$, partial eta squared = 0.063; for F7/8, $F(1, 41) = 2.41$, $p = .13$, partial eta squared = 0.056.

during a resting, baseline session), the body posture itself may influence asymmetric frontal cortical activity and presumably approach motivational intensity. However, when neutral stimuli are explicitly presented, these stimuli rather than the body posture control asymmetric frontal cortical activity, so that individuals show no increase in relative left frontal activity to neutral pictures when in a leaning forward posture.

The results of the present experiment suggest that simply leaning forward increases a pattern of neural activation associated with approach motivation. They also concur with embodiment theories that impute a role of the body in mental processes (Winkielman et al., 2008). Practically, they suggest that leaning forward may increase desire or interest in situations (e.g., learning) or individuals (e.g., depressed) who may need such. Body posture may also influence other cognitive processes associated with approach motivational intensity (Price and Harmon-Jones, 2010). Together with past research (Harmon-Jones and Peterson, 2009), the current results suggest that body posture can influence neural activations associated with motivational processes, and consequently, future neuroimaging studies should be attentive to the body positions of their participants and note those limitations.

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