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BRIEF REPORT

Approach motivational body postures lean toward left frontal brain activity

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Abstract

The present experiment examined the effect of different approach motivational body postures on relative left frontal cortical activity, which has been linked with approach motivation. Three body postures were manipulated to create three levels of approach motivation. Consistent with the motivational direction model, results indicated that leaning forward with arms extended (high approach) caused greater left frontal cortical activation as compared to reclining backwards (low approach). This is the first experiment to demonstrate this effect, and it suggests that leaning forward as compared to reclining backward increases approach motivation. These results provide important implications for the motivational direction model and embodiment research.

Descriptors: Emotion, Motivation, EEG/ERP

Asymmetrical frontal activity has been associated with the motivational direction of emotions (Harmon-Jones, 2003). Experiments have linked greater relative right frontal activity with withdrawal-oriented emotions. For example, film clips that evoke fear or disgust have been found to cause greater relative right frontal activity (Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Jones & Fox, 1992). Greater relative left frontal activity, on the other hand, has been associated with approach-oriented emotions. For example, 10-month-old infants displayed increased left frontal activation after watching film clips of a woman with a happy facial expression as compared to a sad expression (Davidson & Fox, 1982). In addition, hungry individuals who like desserts showed greater relative left frontal activation to pictures of desserts as compared to neutral pictures (Gable & Harmon-Jones, 2008). Additionally, studies have found that trait and experimentally manipulated approach-motivated anger relates to relatively greater left frontal activity than relatively greater right frontal activity (Harmon-Jones, 2004; Harmon-Jones & Allen, 1998; Harmon-Jones & Sigelman, 2001; Harmon-Jones, Vaughn-Scott, Mohr, Sigelman, & Harmon-Jones, 2004; Verona, Sadeh, & Curtin, 2009).

To arrive at a more causal relationship between approach motivation and left frontal activation, researchers have manipulated asymmetrical cortical activity using unilateral hand contractions and repetitive transcranial magnetic stimulation. These experiments have found that manipulated increases in left frontal activation caused more positive emotive responses to approach positive stimuli (Harmon-Jones, 2006), more aggressive responses following an interpersonal insult (Peterson, Shackman, & Harmon-Jones, 2008), and more attentional and memorial engagement with angry faces (d'Alfonso, van Honk, Hermans, Postma, & de Haan, 2000; van Honk & Schutter, 2006).[1]

Other studies have manipulated emotional facial expressions in order to observe how these expressions influence frontal asymmetry. For example, facial expressions of approach emotions such as joy and anger produced relatively greater left frontal cortical activity, whereas expressions of withdrawal-oriented emotions such as fear, sadness, and disgust produced relatively less left frontal activation (Coan, Allen, & Harmon-Jones, 2001). In these studies, however, only individuals' facial expressions were manipulated. The study of asymmetric frontal cortical activity and motivation would benefit by taking a "full body" approach to these issues. That is, would body postures associated with varying levels of approach motivation influence asymmetric frontal cortical activity?

This possibility has yet to be explored, but some past work suggests that body positions influence psychophysiological processes. Body postures have been found to affect motivation; participants positioned in a slumped posture showed lower persistence on insolvable puzzle tasks than participants positioned in an upright posture (Riskind & Gotay, 1982). In addition, body postures have also been found to influence asymmetrical cortical activity in response to emotion manipulations (Harmon-Jones &

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[1]Although the motivational direction model has received support from experimental and correlational designs (for a review, see Harmon-Jones, Gable, & Peterson, 2010), some correlational research has not supported the model (Stewart, Levin-Silton, Sass, Heller, & Miller, 2008; Wacker, Chavanon, Leue, & Stemmler, 2008).

Peterson, 2009). Participants in a supine posture who were insulted demonstrated less left frontal cortical activity than participants who were insulted while in an upright posture. These results suggest that participants in a supine posture experienced less approach-motivated anger when they were insulted. Empirical work is still needed, however, in order to determine if body positions alone are able to influence asymmetrical cortical activity or if a more direct emotional manipulation is also necessary while participants are in a particular body position.

Theoretically, the notion that posture alone might influence left frontal cortical activity fits with an embodied cognitive perspective. From this perspective, thought, action, and the body are closely associated with one another. Various mechanisms have been put forth to explain these relationships. From a grounded view, bodily states are one of many sources of information that drive cognition; other sources include situated action and simulating or reexperiencing modality specific sensations (e.g., tactile, auditory, visual; Barsalou, 2008). Some viewpoints stress the importance of how physical actions (e.g., goal-directed behaviors) inform cognition (Gallese, 2008). The neuroimaging support for this latter viewpoint has relied mainly on how individuals use the actions of others to inform their own actions, that is, work with mirror neuron responses (Gallese, 2009). Numerous behavioral studies, however, have shown that physical actions alone can influence psychological processes. Embodied cognition theories, therefore, would benefit from studies indicating that physical actions alone can also influence cortical activity.

The present experiment investigated this possibility by recording electroencephalographic activity (EEG) while participants were in one of three different body postures designed to elicit different levels of approach motivation. Leaning forward often occurs during approach motivation, as organisms lean toward desired objects; consider how one leans toward delicious foods. Reclining backward often occurs during low approach-motivated states, after a goal has been obtained; consider the posture that occurs following the consumption of a satisfying meal. These actions differ in approach motivational intensity, or the urge to move toward something. Leaning forward with arms extended was predicted to be more associated with approach motivation than a neutral condition, sitting upright, and reclining backward was predicted to be associated with the lowest levels of approach motivation. Because approach motivation has been found to be associated with asymmetric frontal cortical activity, we would expect to see the greatest relative left frontal activity in the leaning forward condition, followed by the upright condition, and finally the reclining backward condition. In other words, we predicted a linear effect of body posture on asymmetric frontal cortical activity.

The present experiment also tested a secondary research question: Would smiling increase the effects of the body posture manipulation? In addition to maintaining a neutral expression while in one of the aforementioned body postures, participants smiled in each body posture in order to increase the expression of positive affect. If smiling increased the effects of the body posture manipulation, then the predicted linear effect of body posture should be greater while smiling than while maintaining a neutral expression.

Method

Participants

One hundred and three introductory psychology students (50 women) at Texas A&M University participated for partial course credit. Informed consent was obtained, and the rights of human subjects were protected in the reported experiment. Participants were randomly assigned to condition, and experimenters were blind to condition. Two participants did not smile during the experiment, and their data were excluded from analyses. The data from an additional 14 participants, randomly distributed across conditions, were lost due to a malfunctioning reference electrode (6) and excessive movement artifacts not attributable to increased activity from making a smiling expression (8).

Materials and Procedures

Participants sat in a chair that could recline. After giving informed consent, participants were fitted with a set of Vuzix VR920 computer goggles so that visual images could be presented equidistant from the eyes while participants were in different body positions. Participants also wore a stereo headset with an attached microphone in order to communicate with the experimenter. EEG sensors were attached. When all of these items were in place, the experimenter turned off the lights to ensure that images were clearly visible on the computer goggles. She or he then closed the door and exited the room.

The experiment began with practice instructions for smiling. These instructions were conveyed through text screens presented on the goggles; participants were asked to contract their facial muscles so that the corners of their mouth were brought closer to their ears for 1 min. They were also informed that their mouth should remain closed during this time.

After practice with smiling, participants were instructed to adopt one of three randomly assigned body postures (e.g., leaning, upright, reclining). Leaning instructions asked participants to slowly bend forward so that their back was bent and their elbows were directly on their knees. Upright instructions asked the participant to sit as they normally would, and reclining instructions asked participants to fully recline the chair they were sitting in while keeping their legs suspended on the footrest. After these instructions, participants saw a picture of a leaning, upright, or reclining model depending on condition (see Figure 1). Each of these pictures informed participants that their posture should match the model's posture. Next, EEG was recorded for 1 min while participants were in the body posture. Afterward, participants were asked to smile for 1 min, followed by a 15-s break, then another minute of smiling. EEG was also recorded for these smiling minutes in each body posture. Finally, participants were debriefed.

EEG Assessment and Processing

To record EEG, 27 tin electrodes mounted in a stretch-lycra electrode cap (Electro-Cap, Eaton, OH) were placed on the participant's head. 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 with Neuroscan Synamps (El Paso, TX), bandpass filtered (0.1 to 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 movement correction was applied (Semlitsch, Anderer, Schuster, & Presslich, 1986). Then all epochs, each 1.024 s in duration, were extracted through a Hamming window (50% taper of distal ends) and re-referenced using an average ear reference. Consecutive epochs were overlapped by 50% to minimize data loss due to windowing. A fast Fourier

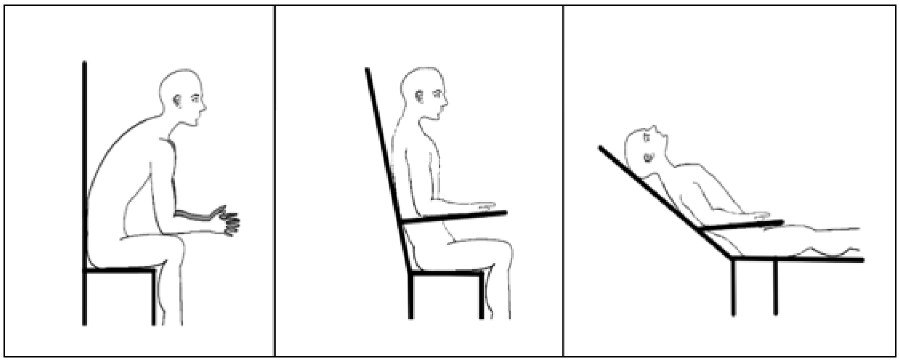

Figure 1. Instruction pictures participants received to illustrate the appropriate body posture (leaning, upright, reclining).

transform calculated power spectra. Power values within the alpha band (8–13 Hz) were averaged across epochs for the no-smiling minute, first minute smiling, and second minute smiling.

Asymmetry indices (log right minus log left) were computed for all sites, but predictions focused on midfrontal (F3/4; Harmon-Jones, Sigelman, Bohlig, & Harmon-Jones, 2003), frontal central (Fc3/4; Harmon-Jones & Gable, 2009; Peterson, Gravens, & Harmon-Jones, 2010), and lateral frontal (F7/8; Jensen-Campbell, Knack, Waldrip, & Campbell, 2007) sites based on past research examining frontal asymmetry. Because alpha power is inversely related to cortical activity, higher scores indicate greater left than right activity (Allen, Coan, & Nazarian, 2004). Because predictions were directional, derived from theory, and specified in advance, they were evaluated using planned comparisons and a one-tailed criterion of significance (Rosenthal, Rosnow, & Rubin, 2000).

Results

To compare posture by itself with smiling, separate planned comparisons were performed for the non-smiling minute and the combined two smiling minutes. For the body posture manipulation, asymmetric midfrontal and frontal-central cortical activity was affected. As predicted, significant planned linear contrasts emerged, midfrontal: $t(84) = 2.28$, $p = .02$; frontal-central: $t(84) = 3.10$, $p = .002$. Greater relative left midfrontal and frontal-central activity was observed in the leaning condition compared to the reclining condition (see Table 1). Posture by itself did not significantly influence lateral frontal activity, $t(84) = .51$, $p = .30$. Additionally, all other asymmetry indices produced nonsignificant effects for the non-smiling minute, $p\text{s} > .18$.

Next, planned comparisons were performed for the two smiling minutes combined, because the two minutes were highly correlated with one another: $r\text{s} > .66$. Also, examination of each minute separately revealed results almost identical to those reported below for the combined minutes. During smiling, the body posture manipulation did not significantly influence asymmetric midfrontal, $t(84) = 1.27$, $p = .10$, or lateral frontal activity, v$t(84) = .11$, $p = .45$, in the predicted direction (see Table 2). A marginally significant effect was found for frontal central activity, $t(84) = 1.35$, $p = .08$. All other asymmetry indices were examined for the smiling minutes of data. For none of these indices did significant effects emerge, $p\text{s} > .37$. In addition, sex of participant did not interact with body posture to influence results, $p\text{s} > .66$.

Discussion

The present findings add further support to the motivational direction model. Consistent with our embodiment perspective, leaning forward with arms extended, a posture indicative of reaching out and acquiring a desired object, led to greater relative left frontal cortical activity than reclining backward, a body posture that has been found to hinder approach-motivated anger (Harmon-Jones & Peterson, 2009). Our results extend this past work by suggesting that leaning forward might be associated with higher approach motivation than reclining backward. To our knowledge, this is the first study to provide evidence for such a process.

Interestingly, the predicted effect emerged when participants were in postures, but not when they smiled in postures. This may have occurred because the smiling trials always followed non-smiling trials, and participants may have habituated to the body posture manipulation. That is, something akin to a homeostatic process may have returned participants to a more baseline-like state following the first minute of recording. It is also possible that the smiling manipulation was poorly executed (e.g., the duration of the manipulation was unnaturally long; a tensing of muscles around the eyes was also needed; Matsumoto, 1987).

Table 1. *Relative Left Frontal Activity for Non-smiling Minute by Condition*

	Leaning		Upright		Reclining	
Scalp region	Mean	*SD*	Mean	*SD*	Mean	*SD*
Midfrontal	$-.011_a$	.04	$-.061_{ab}$	.04	$-.140_b$	.04
Frontal central	$.062_a$	.03	$-.004_{ab}$	.03	$-.108_b$	.03
Lateral frontal	$-.379_a$	.08	$-.310_a$	.08	$-.440_a$	.08

Note: Means in the same row with different subscripts differ significantly, $p < .05$.

Table 2. *Relative Left Frontal Activity for Smiling Minutes by Condition*

	Leaning		Upright		Reclining	
Scalp region	Mean	*SD*	Mean	*SD*	Mean	*SD*
Midfrontal	$-.060_a$	.03	$-.077_a$	.04	$-.131_a$	.03
Frontal central	$-.011_a$	.04	$-.031_a$	.04	$-.094_a$	.04
Lateral frontal	$-.419_a$	.08	$-.282_a$	.08	$-.432_a$	.08

Note: Means in the same row with different subscripts differ significantly, $p < .05$.

Past studies examining the effects of manipulated facial muscle activity on psychological and physiological variables have produced inconsistent results (e.g., Matsumoto, 1987). Regardless of the explanation for the null effects during smiling, the primary prediction was supported: Body position influenced frontal asymmetry.

Also of interest is the fact that the predicted effect emerged for midfrontal and frontal central but not lateral frontal cites. Other experiments that have manipulated frontal asymmetry with motor actions (i.e., hand contractions) have found similar patterns of results (Harmon-Jones, 2006; Peterson et al., 2010), suggesting that midfrontal and frontal central regions are more sensitive to motor/body posture manipulations than lateral frontal regions.

These results also extend past work with emotional expressions and frontal asymmetry (Coan et al., 2001). Specifically, our results indicate that a facial expression of emotion does not appear to be necessary to influence relative left frontal activity; posture alone can influence these neurophysiological processes. These results stress the importance of controlling for posture in experiments examining the relationship between frontal asymmetry and psychological variables. Together with other research (Harmon-Jones & Peterson, 2009), they suggest that neuroimaging methods that use a reclined or supine body posture may inadvertently reduce approach motivational processes.

Finally, our findings extend past research on embodied cognition viewpoints stressing the importance of physical actions. Specifically, whereas others have focused on how physical actions can be transferred to knowledge concepts via mirror neuron responses (Gallese, 2009), our results demonstrate that body position alone can influence underlying cortical activity associated with more than just physical movement. Furthermore, leaning participants were not presented with something they desired in the present experiment, nor were reclining individuals given something they desired. Nevertheless, leaning led to greater relative left frontal activity than reclining. In other words, certain postures or certain modality-specific states (e.g., the tactile sensation of leaning forward or reclining) previously associated with a particular stimulus (e.g., a desired object) might lead to patterns of cortical activity associated with high or low approach motivation even when a desired stimulus is not present. These findings strengthen the neurophysiological basis for action–cognition associations and complement past research investigating theories of embodied cognition (Barsalou, Simmons, Barbey, & Wilson, 2003; Winkielman, Niedenthal, & Oberman, 2008). In summary, posture influences how we think and feel, as well as underlying cortical activity.

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