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CHAPTER THREE

Embodying Approach Motivation: A Review of Recent Evidence*

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Contents

Abstract

Recent evidence suggests that certain postures and facial expressions are associated with motivational and emotional responses. This review considers behavioral, neuroscientific, and cognitive research associating movements of the body with emotive responses. Facial and bodily feedback theories of emotion have suggested that subjective reactions and outward expressions of emotions may be bidirectional; in particular, manipulated outward expressions of emotion may also trigger subjective emotional

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reactions. In addition, manipulated postures and facial expressions have been shown to influence physiological responses associated with emotion and motivation, such as skin conductance, heart rate, and blood temperature. More recent evidence suggests that manipulated bodily states influence prefrontal cortical activation measured with electroencephalography—which has been associated with the motivational direction of emotional states. Furthermore, bodily manipulations influence neurophysiological correlates of motivated attention and defensive reflexes. Bodily manipulations also influence the broadening and narrowing of attentional scope, which has been associated with motivational intensity. Finally, postural manipulations influence cognitive processes, such as dissonance reduction. This research, therefore, suggests that outward expressions of emotive states play a pivotal role in our emotive responses.

We smile from ear to ear when we are reunited with an old friend—we are urged to run forward and embrace this individual. Our bodies slump and our heads hang low when we are depressed; our ability to move forward is inhibited by our closed posture. These changes in bodily responses are easy to observe, but do these bodily responses themselves have the power to influence motivational responses? In other words, we often assume that motivation influences bodily expressions but do bodily expressions themselves influence motivational responses? Might our leaning forward and smiling influence our motivational responses? Might our reclining backward and putting our feet up influence other motivational responses? Might these physical actions also influence biological signals associated with motivational processes? Over the last few decades, research has suggested that bodily expressions do indeed influence neural, cognitive, and behavioral outcomes associated with motivation. This research is reviewed in this article.

The purpose of this article is to discuss the relationship between bodily manipulations and approach motivation, or the urge to move forward (Harmon-Jones, Harmon-Jones, & Price, 2013). To begin with, we define the construct of approach motivation. Thereafter, we review bodily feedback theories of emotion. Then, we review the role of the prefrontal cortex in emotive processes. Next, the relationship between manipulated bodily states, prefrontal cortical activity, event-related potentials (ERPs), and startle eyeblink responses are examined. Finally, we consider research linking bodily states with cognitive processes related to approach motivation, based on theories of cognitive embodiment. Based on this research, we conclude that manipulated bodily states influence (1) motivational behavior, (2) psychophysiological measures sensitive to motivational responses, and (3) cognitive processes associated with approach motivation.

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1. DEFINITIONS

Approach motivation can be defined as the urge to move forward (Harmon-Jones, Harmon-Jones, et al., 2013). Approach motivation is often contrasted with avoidance motivation, the urge to move away. Both approach and avoidance motivation can range from being low to high in intensity (Harmon-Jones, Price, & Gable, 2012). Motivation is also connected to emotional processes. High-approach motivational states may manifest as feelings of desire or determination, which may propel an organism toward a specific goal (C. Harmon-Jones, Schmeichel, Mennitt, & Harmon-Jones, 2011). Low-approach motivational states may manifest as feelings of contentment, once a goal has been accomplished (Gable & Harmon-Jones, 2010).

Many theorists believe that approach motivation is confounded with positive emotions, wherein all positive states (eg, joy) are associated with approach, and all negative states (eg, disgust) are associated with avoidance (Watson, 2000). An important caveat, however, is that approach motivation may also be associated with negative emotional states, such as anger (Carver & Harmon-Jones, 2009).

Approach motivation may be evoked by an external stimulus, or it may be evoked by internal processes such as traits or moods (Harmon-Jones, Harmon-Jones, et al., 2013). Approach urges, therefore, are considered a fundamental ability of all organisms capable of movement.

2. BODILY FEEDBACK THEORIES OF EMOTION

William James (1890) posited that emotive states are the consequence of bodily states—we smile and, consequently, we realize that we are happy. Self-perception theorists, similarly, theorized that acting as though one feels a certain way will lead to that subjective feeling (Bem, 1972). Together, these ideas led to facial feedback theories of emotion, which posited that the covert or explicit manipulation of individuals' facial expressions leads to the subjective experience of emotions (Adelmann & Zajonc, 1989; Kraft & Pressman, 2012; Laird, 1974; Strack, Martin, & Stepper, 1988).

This hypothesis is typically tested by manipulating participants' facial expressions with muscle specific instructions (eg, pull the corners of our mouth closer to your ears—smiling; Laird, 1974) or through nonobtrusive methods. For example, research has demonstrated that facilitating (holding

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a pen between the teeth) versus inhibiting (holding a pen with the lips) smiling caused participants to have more humorous reactions to cartoons (Strack et al., 1988). Other methods have revealed conceptually consistent results. For instance, denervating facial muscles with botulinum toxin-A has been shown to slow the reading of emotional passages (Havas, Glenberg, Gutowski, Lucarelli, & Davidson, 2010). Importantly, these results were emotion specific. For example, when the corrugator supercilii muscle, involved in frowning and forming anger expressions, was denervated, participants read emotional content related to anger slower.

Darwin (1872) had similar theoretical ideas concerning the nature of outward expressions and emotional experiences. Darwin, however, was more interested in naturalistic expressions of emotion, given that all of his observations were based on them. In one instance, Darwin questioned if the frowning that occurs when an individual faces the sun has the ability to influence anger emotions, given that anger also involves frowning. Recent research has investigated this hypothesis (Marzoli, Custodero, Pagliara, & Tommasi, 2013). In this experiment, researchers approached individuals walking along Italian beaches adjacent to the Adriatic Sea. They asked participants to fill out a questionnaire assessing current anger and aggressive emotions. An equal number of participants walking toward the sun with and without sunglasses, and walking away from the sun, were included. Results indicated that walking away from the sun with and without sunglasses did not produce significant differences in aggressive emotions. Walking toward the sun without relative to with sunglasses, however, produced more aggressive emotions.

3. PHYSIOLOGICAL MECHANISMS UNDERLYING BODILY FEEDBACK EFFECTS

Given these types of effects, researchers have been interested in the physiological mechanisms responsible. Zajonc, Murphy, and Inglehart (1989) posited that the downward movement of the corrugator supercilii muscle, which often occurs during the forming of negative affective facial expressions, might restrict air-intake into the nasal cavity. This would in turn cause more mouth—as compared to nose—breathing and may raise the temperature of blood entering the brain. This rise in temperature was hypothesized to cause the experience of negative affect. In contrast, activation of the zygomatic major muscle, which often occurs during the forming of positive affective facial expressions (eg, smiling), might open

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the nasal cavity. This would in turn increase nose breathing and reduce the temperature of blood entering the brain. This reduction in temperature due to smiling was hypothesized to cause the experience of positive affect. Predictions were based on the thermoregulation of the brain, which involves areas such as the hypothalamus. Hypothalamic activity could influence hedonic states and associated neurotransmitter (eg, norepinephrine) activity.

In order to test these hypotheses, Zajonc et al. (1989) had participants recite German vowels that caused greater or lesser brow furrowing. Results indicated that greater brow furrowing caused more negative evaluations of information and higher facial temperatures. Later research manipulated hypothalamic cooling versus heating in rats and found that cooling caused more eating but not more hedonic reactions to taste (Berridge & Zajonc, 1992). These results suggest that thermoregulation of the hypothalamus is influenced by facial expressions. Movement of facial muscles associated with affective responses, as a result, might influence an organism's emotional state based on hypothalamic activity (see also McIntosh, Zajonc, Vig, & Emerick, 1997).

Related research has suggested that facial feedback responses are caused by multiple mechanisms. Facial expressions of emotion have been shown to cause inherent, parallel changes in autonomic nervous system activity (Ekman, Levenson, & Friesen, 1983). Levenson, Ekman, and Friesen (1990) asked participants to form emotional facial expressions with step-by-step (individual muscle) instructions. Participants formed discrete emotions such as anger and fear. Once the facial expressions were fully expressed, participants' skin conductance, heart rate, finger temperature, and forearm muscle tension were recorded. Levenson et al. (1990) found that discrete patterns of autonomic nervous system activity were elicited by the manipulated facial expressions. For example, facial expressions of sadness, anger, and fear caused greater heart rate acceleration than expressions of disgust. In addition, facial expressions of fear caused lower finger temperature than expressions of anger. Later studies replicated these original results, which were obtained with American samples and with men of the Minangkabau from West Sumatra (Levenson, Ekman, Heider, & Friesen, 1992).

Taken together, these results suggest that facial expressions have direct effects on autonomic nervous system activity and thermoregulation of subcortical brain structures. More recently, researchers have questioned how the brain/body transforms these signals into subjective emotional states. Some researchers have proposed that sympathetic and parasympathetic

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bodily signals carried from projections from the brain stem to nuclei within the anterior insular cortex and the anterior cingulate cortex are involved in this process (for a review, see Craig, 2002, 2009). It must be stressed, however, that these relationships are complex. Caution must be exercised when attempting to identify neural generators of bodily feedback effects.

Recent research has revealed that the insula need not be present for an individual to experience bodily as well as emotional feelings (Damasio, Damasio, & Tranel, 2013). In the study by Damasio et al. (2013), a patient whose insula was bilaterally destroyed by the herpes simplex virus nevertheless experienced feelings of thirst and hunger, as well a desire to engage in enjoyable activities (eg, playing checkers). Furthermore, this patient contained a robust sense of self. These researchers concluded that the first substrate of feelings occurs in subcortical brain regions (eg, amygdaloid complex). They reasoned that feelings states may be repeated cortically (eg, insula) when integrated with higher order cognitive processes (eg, the integration of sensory signals with aspects such as episodic memory).

While researchers have focused mainly on facial expressions in this line of research, other bodily manipulations have been used. For example, head nodding as compared to head shaking from side to side has been show to generate more positive attitudes toward neutral stimuli (Tom, Pettersen, Lay, Burton, & Cook, 1991) and more agreement with persuasive messages (Wells & Petty, 1980).

Related research has found that flexing the arm in a motion that would bring desired stimuli toward the body causes individuals to form more positive attitudes toward neutral stimuli. Contrastingly, extending the arm in a motion that would push stimuli away from the body causes individuals to form more negative attitudes toward neutral stimuli (Cacioppo, Priester, & Berntson, 1993). There are, however, several moderators of these effects (Centerbar & Clore, 2006; Eder & Rothermund, 2008).

4. THE INFLUENCE OF PARTIAL BODY MOVEMENTS ON APPROACH MOTIVATION AND ASYMMETRIC FRONTAL CORTICAL ACTIVITY

4.1 Overview of the Emotive Role of the Prefrontal Cortex

Cortical activity of the prefrontal cortex has been associated with emotive processes. The prefrontal cortex contains orbitofrontal, medial, and lateral surfaces (Fuster, 2008). The orbitofrontal cortex designates the

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entire ventral surface of the frontal lobes (Mesulam, 2002). At the posterior end, this section has intermediate to strong cortical connections with limbic brain structures (eg, cingulate complex, olfactory cortex, insula). At the anterior end, the orbitofrontal cortex blends into the dorsolateral components of the prefrontal cortex (DLPFC). The DLPFC shares strong cortical connections with premotor areas, the thalamus, and subcortical regions such as the head of the caudate nucleus (Fuster, 2008). Importantly, the neurons within the prefrontal cortex are largely heteromodal; resulting lesions are always associated with deficits in multiple psychological processes (Goldstien, 1939; Mesulam, 2002). Though we consider the prefrontal cortex's emotive function, it would be erroneous to conclude that the prefrontal cortex is specialized toward an emotive function; it is also strongly involved in other psychological processes, such as working memory (Fuster, 2008).

Seventy-five years ago, researchers began to consider that the prefrontal cortex plays a role in emotive states (Goldstien, 1939). These effects were initially observed in patients with prefrontal cortical lesions who developed behavioral abnormalities. In particular, they displayed heightened anxiety and even "catastrophic reactions"—becoming extremely upset and avoidant of everyday tasks (Goldstien, 1939). These findings were later extended in individuals who had lesions to the left prefrontal cortex and later developed depressive symptoms (Turner et al., 2007). Lesions to the right prefrontal cortex, however, were associated with the development of mania—elevated mood (Starkstein, Boston, & Robinson, 1988). Empirical findings using the Wada test (Alema, Rosadini, & Rossi, 1961; Perria, Rosadini, & Rossi, 1961; Rossi & Rosadini, 1967; Terzian & Cecotto, 1959) indicated a reciprocal relationship between the right and left hemispheres of the brain. The Wada test involves the injection of a tranquilizer, sodium amytal, into the left or right carotid artery of the neck. The left hemisphere receives blood flow from the left carotid artery, and the right receives blood from the right artery. Results using this test indicated that injections into the left artery, suppressing left hemispheric activity, produced dejection, dysphoria, and at times led to catastrophic reactions. Such symptoms, furthermore, mirror the symptoms generated by left hemispheric infarcts (Mesulam, 2002). Injections into the right artery, suppressing right hemispheric activity, produced inappropriate jocularity, euphoria, and elevated moods. These symptoms are consistent with right hemispheric infarcts. Thus, the two hemispheres of the brain share a reciprocal relationship; reducing activity on one side releases its inhibitory control over the other (Schutter & Harmon-Jones, 2013).

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More recent research has relied on electroencephalography (EEG) to study the emotive role of the prefrontal cortex. Researchers take right minus left homologues of prefrontal EEG sites on the surface of the scalp (Allen, Coan, & Nazarian, 2004). This metric is consistent with past lesion and drug injection studies suggesting a reciprocal relationship between hemispheres. EEG asymmetry looks at the inverse of alpha power, as alpha power is inversely related to regional brain activity (Cook, O'Hara, Uijtdehaage, Mandelkern, & Leuchter, 1998; Davidson, Chapman, Chapman, & Henriques, 1990). Source localization studies, furthermore, have suggested that the DLPFC may be the neural generator of EEG asymmetry over the prefrontal cortex (Pizzagali, Sherwood, Henriques, & Davidson, 2005).

Lateralized EEG activity over the prefrontal cortex has been associated with the motivational direction of emotions (Harmon-Jones, 2003). Research has demonstrated that relative right frontal cortical activity is associated with withdrawal-oriented emotions, such as fear and disgust (Davidson et al., 1990; Jones & Fox, 1992). Also, relative right frontal activity has been positively associated with the incorporation of another individual's suffering and empathic concerns (Tullet, Harmon-Jones, & Inzlitch, 2012). Relative left frontal activity, however, has been associated with approach-oriented emotions, such as joy (Davidson & Fox, 1982) and anger (Harmon-Jones & Sigelman, 2001; Verona, Sadeh, & Curtin, 2009). The emotive functions of asymmetric frontal cortical activity has also been tested with other neuroscience techniques, including event-related brain potentials (Cunningham, Epinset, DeYoung, & Zelazo, 2005), functional magnetic resonance imagining (fMRI) (Berkman & Lieberman, 2010), transcranial direct current stimulation (Hortensius, Schutter, & Harmon-Jones, 2012; Kelley, Hortensius, & Harmon-Jones, 2013), and repetitive transcranial magnetic stimulation (van Honk & Schutter, 2006).

4.2 Facial Expressions and Asymmetric Frontal Cortical Activity

In an early experiment testing manipulated facial expressions and asymmetric frontal cortical activity, Ekman and Davidson (1993) instructed participants to covertly form one of two different smiles while EEG was recorded. Some participants were instructed to form genuine Duchenne smiles, which involves contraction of the zygomatic major (cheek) and orbicularis oculi (underneath the eye) muscles. Other participants were instructed to form less genuine smiles, which only involves contraction of

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the contract zygomatic muscles. Ekman and Davidson (1993) found that when participants formed Duchenne smiles, they had greater relative left frontal cortical activity than participant who formed less genuine smiles.

Other experiments have more directly considered the relationship between facial expressions and approach motivation measured with frontal EEG asymmetry. An experiment by Coan, Allen, and Harmon-Jones (2001) manipulated discrete facial expressions of joy, anger, fear, sadness, and disgust. Results indicated that facial expressions associated with higher approach motivation (eg, anger and joy) increased relative left frontal cortical activity. Facial expressions associated with less approach motivation (eg, fear and disgust) reduced relative left frontal cortical activity.

More recent experiments have extended these results. Price, Hortensius, and Harmon-Jones (2013) examined whether facial expressions within the same affective valence (ie, positive) influence relative left frontal cortical activity depending on motivational intensity. Related research has demonstrated that positive emotions can vary in approach motivational intensity (Gable & Harmon-Jones, 2008). Given this, relative left frontal cortical activity should be greater for positive emotions higher versus lower in approach motivational intensity. Determination, for example, has been associated with heightened approach motivation (E. Harmon-Jones, Harmon-Jones, Serra, & Gable, 2011), whereas satisfaction has been associated with lower approach motivation. Participants in this experiment (Price et al., 2013) made determination, satisfaction, or neutral facial expressions with explicit instructions. More specifically, instructions indicated that participants should make facial expressions so that anybody would be able to recognize them as determination, satisfaction, or neutral. This design characteristic was intended to prevent participants in the determination condition from simply creating anger facial expressions, which are morphologically similar to determination expressions. Participants often confuse the two (C. Harmon-Jones et al., 2011). Thus, muscle by muscle instructions used in prior research were not used in this experiment.

Results from the experiment indicated that when individuals expressed determination, their relative left frontal activity increased compared to baseline. In contrast, when individuals expressed satisfaction or neutral facial expressions, their relative left frontal activity did not increase relative to baseline. Furthermore, within the determination facial expression condition, relative left frontal cortical activity was positively correlated with more task persistence on an impossible/unsolvable task. These results suggest

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that determination-related left frontal cortical activity was associated with more behavioral persistence.

Together, these studies suggest that higher approach-oriented facial expressions cause greater relative left frontal cortical activity. Importantly, these effects occurred in reasonably neutral situations. That is, external cues impelling approach motivation were not present in these experiments. As a result, these findings suggest that bodily expressions can serve as stimuli associated with approach motivation. Other experiments have pushed these results even further to suggest that other partial body movements are associated with approach motivation.

4.3 Unilateral Body Movements and Asymmetric Frontal Cortical Activity

As hinted previously, unilateral bodily movements can also influence neural correlates of approach motivation. The DLPFC shares strong cortical connections with primary motor (idiotypic) brain regions (Harmon-Jones, 2006; Schiff & Lamon, 1989, 1994). Importantly, the hand and foot representations of the primary motor cortex have no callosal connections (Mesulam, 2002). Furthermore, given that sensory and motor pathways are crossed (Rinn, 1984), unilaterally moving the right side of the body may lead to an increase in left hemispheric activation, whereas moving the left side of the body may lead to an increase in right hemispheric activation. Via spreading of activation, therefore, left (right) unilateral hand contractions may influence right (left) prefrontal cortical activity (Gable, Poole, & Cook, 2013).

Harmon-Jones (2006) demonstrated that unilateral hand contractions can influence prefrontal cortical activity measured with EEG. In this study, right-handed participants squeezed a ball with either their right or left hand while they listened to a mildly positive, approach-oriented radio broadcast. As predicted, right-hand contractions caused greater relative left frontal cortical activity than left-hand contractions. Furthermore, right-hand contractions caused greater self-reported approach affect to a radio broadcast about apartment living options. These changes in motivational affect were indexed by scores on the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988).

Peterson, Shackman, and Harmon-Jones (2008), furthermore, demonstrated that unilateral hand contractions can influence angry-aggressive responses. In this experiment, participants wrote about a controversial topic and received insulting feedback on it from another participant. In actuality,

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this other participant did not exist. Prior to receiving feedback, participants squeezed a squeeze ball with either their right or left hand. Next, participants were informed they would play a reaction time game against the "individual" who insulted them. This game involved the delivery of noise blasts to the "individual" who insulted the participant. Results indicated that participants who engaged in right-hand contractions gave longer and louder noise blasts to their partner during the game. Moreover, aggressive responses were correlated with relative left frontal cortical activity. Further analyses indicated that right and left-hand contractions influenced coherence between the motor, parietal, and prefrontal cortex. Right-handed contractions caused greater coherence between the motor and prefrontal cortex. Left-handed contractions caused greater coherence between the motor and parietal cortex.

The results from these experiments reveal that unilateral body movements influence asymmetric frontal brain activity as well as approach-related affective experiences and behaviors. These findings suggest that connectivity between the prefrontal cortex and primary motor areas may be one mechanism whereby these affective experiences and behaviors can occur.

5. BODILY MANIPULATIONS AND PHYSIOLOGICAL INDICES OF APPROACH MOTIVATION

Despite considerable findings with facial expressions, there is a dearth of empirical research on whole body postures as they relate to psychophysiological processes. This is surprising, given that theorists have considered that whole body displays may indeed be associated with approach-oriented behavior (Zajonc, Pietromonaco, & Bargh, 1982). In some cases, body postures can actually convey more emotional information to observers than facial expressions, such as when these emotional episodes are high in intensity (Aviezer, Trope, & Todorov, 2012). We believe that others eager to hear our stories may lean toward us. We suspect that depression may make an individual slump down. When an individual is at ease with life, however, reclining backward may come naturally to this individual. Relatively little research, however, has tested whether whole body postures influence psychophysiological processes related to approach motivational states.

Some prior research has considered that manipulated bodily states may have peripheral feedback on more generalized motivational behaviors. Riskind and Gotay (1982) created two postures hypothesized to influence

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motivation. Stemming from prior accounts of the physical expression of depression, the "depressed" posture in this experiment had participants' torsos bent forward at the waist, their chests and necks dropped downward, and their heads and necks pushed forward and down so that participants were stooped and hunched over. A second posture similar to the physical expression of pride (Tracey & Robins, 2007), which is associated with heightened approach (Williams & DeSteno, 2008), had participants' shoulders pushed from the spine, the spine straightened so that the back was erect and upright, and the shoulders raised slightly and pulled back so that the chest was posed in a full expansive position. The participants' heads were raised slightly at the chin so that they looked forward and slightly upward. Participants assumed one of the two postures for 8 min. They were informed that the purpose was to collect physiological data for a "biofeedback task."

Afterward, participants resumed a normal posture and participated in a second unrelated study on "spatial thinking." In fact, the two experiments were connected, and the second task was a measure of motivational persistence. This task involved the completion of several geometric puzzles (Glass & Singer, 1972). Some of these puzzles were in fact unsolvable, and persistence was measured as the number of attempts participants made at solving them. Results revealed that participants placed in the stooped posture, compared to the upright/expansive posture, persisted less (made less attempts) at the unsolvable puzzles.

Based on these results and our intuitions about body postures and approach motivation, we have conducted several experiments to test whether other whole body postures would indeed influence approach motivation. In particular, we reasoned that a supine or reclining posture compared to an upright posture would reduce approach motivation. This theoretical idea is based on the observation that supine or reclining postures are often associated with goal accomplishment and relaxation. For example, reclining backward may occur following the acquisition of a desired goal, such as after eating a delicious meal.

5.1 Influence of Whole Body Posture on Asymmetric Frontal Activity to Emotive Stimuli

In our first experiment, we predicted that a reclining posture would reduce approach-motivated anger and associated relative left frontal cortical activation (Harmon-Jones & Peterson, 2009). Participants wrote an essay on a controversial topic in this experiment. They were led to believe it would be evaluated by another ostensible participant. Participants were instructed

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to sit upright in a recliner or sit in the reclined position before receiving feedback on their essay. Half of the participants in the upright condition and all of the participants in the reclining condition received insulting feedback. The other half of the participants in the upright condition received neutral feedback. Results indicated that upright participants who were insulted versus not insulted had greater relative left frontal cortical activity. These results conceptually replicated the results of past experiments (eg, Harmon-Jones & Sigelman, 2001). Importantly, participants in the insult-reclined condition had less relative left frontal cortical activity than participants in the insult-upright condition. These results suggest that approach-motivated anger is reduced when participants adopt a supine body position. Interestingly, the Prophet Mohammad, over 1400 years ago, predicted these results when he said, "When one of you becomes angry while standing, he should sit down. If the anger leaves him, well and good; otherwise he should lie down." (Abu Daud; Book 41, No. 4764).

Price and Harmon-Jones (2010a) extended this experiment by examining multiple postures. As in the previous experiment, lower approach motivation was anticipated in the reclining posture. Leaning forward from a seated position with arms partially outstretched was added to evoke higher approach motivation. During goal acquisition, an organism may lean forward, such as toward a delicious meal. A sitting-upright posture was also included and anticipated to be associated with a level of approach motivation between the other two conditions. EEG was recorded for 1 min while participants adopted these postures. Results indicated a linear trend effect, with reclining causing less relative left frontal cortical activity than leaning forward. Sitting upright fell between these conditions, as predicted.

Thus far, we only tested postures in regards to negative stimuli (insults) and by themselves. In another experiment, we examined if whole body postures influence relative left frontal cortical activity to desirable, appetitive stimuli. In this experiment (Harmon-Jones, Gable, & Price, 2011a), we used the two extremes in approach motivational postures—leaning forward and reclining. In each posture, participants viewed appetitive dessert and neutral rock pictures. Results indicated that leaning participants had greater relative left frontal cortical activity to the appetitive dessert pictures as compared to the neutral rock pictures. When reclining, however, no change in relative left frontal activity to picture type was observed. These results indicated that motivational posture can influence cortical activity to appetitive, but not neutral pictures.

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This result with neutral pictures, however, may appear as inconsistent with the earlier finding (Price & Harmon-Jones, 2010a) that postures can influence relative left frontal cortical activity when participants are in a resting or baseline-neutral state. We suspect that the effects of body posture in a resting state may be subtle. When a stimulus is presented, even if it is neutral, it may override the subtle effect of posture that might otherwise be observed in a resting-baseline state.

These results indicated that whole body postures are associated with approach motivational responses and, more specifically, relative left frontal cortical activity. Certainly, however, many other psychophysiological processes are sensitive to approach motivation (Harmon-Jones & Harmon-Jones, 2015). Stronger evidence for the effect of posture on approach motivation, therefore, could be gleaned by examining the effect of whole body posture on other psychophysiological measures.

5.2 Whole Body Posture Influences Event-Related Potentials to Emotional Stimuli

The late positive potential (LPP) of the ERP is an extensively studied neural variable associated with motivational intensity and motivated attention. The LPP starts approximately 300 ms after the onset of a stimulus and lasts for several hundred miliseconds (for a review, see Hajcak, Weinberg, MacNamara, & Foti, 2011). LPPs are larger to motivational stimuli, such as erotica, and lower to stimuli not associated with basic motivational urges, such as scenes of persons enjoying roller coasters (Briggs & Martin, 2009). LPPs are larger to other motivational significant images, such when a mother views pictures of her own children versus those of unfamiliar children or familiar/unfamiliar adults (Grasso, Moser, Dozier, & Simons, 2009).

In a study by Prause, Steele, Staley, and Sabatinelli (2014), men and women were both shown slightly "erotic" stimuli (eg, a man and women in a heated embrace). In addition, they were shown more explicit sexual images depicting penetration. All images included one man and one woman. Results indicated that more sexually explicit images elicited larger LPPs than less explicit erotic images. In addition, results indicated that male and female participants who reported having more sexual partners within the last year had larger LPPs to both the erotic and explicitly sexual images. These researchers concluded that larger LPPs may be associated with the motivational urge to engage in sexual behavior.

Other research has examined the relationship between LPPs and anger, which is often associated with approach-oriented motivations (Carver & Harmon-Jones, 2009). In a study by Gable and Poole (2014), participants'

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trait levels of approach and withdrawal motivations were recorded using the behavioral approach system (BAS) and behavioral inhibition system scales (Carver & White, 1994). In this study, participants viewed images designed to elicit anger (eg, American flag burning) and neutral pictures. Results indicated that the pictures designed to elicit anger evoked larger LPPs than neutral pictures. More importantly, however, higher trait approach motivation was positively associated with LPPs to anger, but not neutral pictures. These results suggest that larger LPPs are associated with approach motivational intensity.

Importantly, however, LPP amplitudes are not specific to approach motivational intensity. Relative to neutral pictures, LPPs are also larger to negative affective pictures, such as pictures of threat and mutilation. More specifically, LPPs are larger to these types of negative affective pictures relative to pictures less associated with an avoidant response, such as pictures of loss and contamination (Schupp et al., 2004). The LPP, therefore, is larger for both approach-oriented and avoidant-oriented stimuli relative to neutral stimuli.

There are several neural generators of the LPP. fMRI and EEG studies have suggested that the LPP is also associated with activity in the parietal cortex. The occipitotemporal cortex has also been implicated (Keil et al., 2002; Sabatinelli, Lang, Keil, & Bradley, 2007).

We have examined if whole body manipulations influence this reliable measure of motivational attention to affective stimuli, in particular, appetitive stimuli (Price, Dieckman, & Harmon-Jones, 2012). In this experiment, we presented leaning and reclining participants (within-subject design) with two types of pictures matched for composition: erotica involving men and women together, and pictures of men and women walking or talking in public. Results indicated that leaning forward versus reclining backward caused participants to have larger LPPs to appetitive erotica. Posture, however, did not influence LPPs to our neutral stimuli (see Fig. 1).

In addition, the postural manipulation influenced other ERPs, influencing neural responses as early as 100 ms into picture viewing, that is, the P1 component of the ERP. The P1 is thought to relate to the rapid processing of visual stimuli; low-level stimulus features influence P1 amplitudes (Pourtois, Dan, Grandjean, Sander, & Vuilleumier, 2005). Furthermore, the amplitude of the P1 increases as a stimulus becomes increasingly visible (Schupp et al., 2008). Fig. 2 depicts that leaning caused an emotion modulation of the P1. Reclining, however, did not cause an emotion modulation of the P1. These results, therefore, suggest that heightened approach motivation facilitated by leaning forward influences

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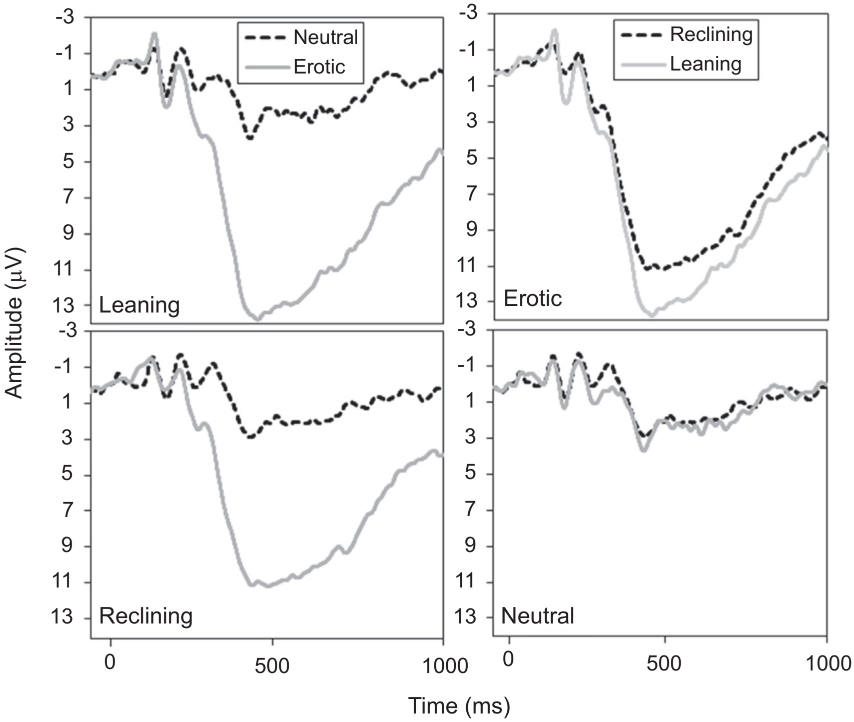

Figure 1 Averaged event-related potentials (ERPs) at site Pz. The left side displays ERPs while leaning or reclining for erotic (top) and neutral (bottom) pictures. The right side displays ERPs while leaning (top) or reclining (bottom) to erotic and neutral pictures. Late positive potentials (LPPs) occur in the range of 300−1000 ms.

how individuals process the motivational significance of images within even a very early time frame.

Some research has questioned our motivational interpretation of this supine posture. Some have suggested that more generic cortical inhibition elicited by supine postures may account for these effects, and that they are not specific to approach motivation. A study by Benvenuti, Bianchin, and Angrilli (2013) tested participants in a control sitting position or an extreme supine position, wherein participants lay on a bed placed at a −6 degree angle. Participants maintained these postures for 3 h before completing a passive picture viewing task of positive, neutral, and negative pictures in the designated postures. Results for the LPP, specifically, indicated significant differences between neutral and emotional pictures in the sitting condition. In the extreme supine position, however, LPPs to both positive and negative images did not differ from neutral pictures.

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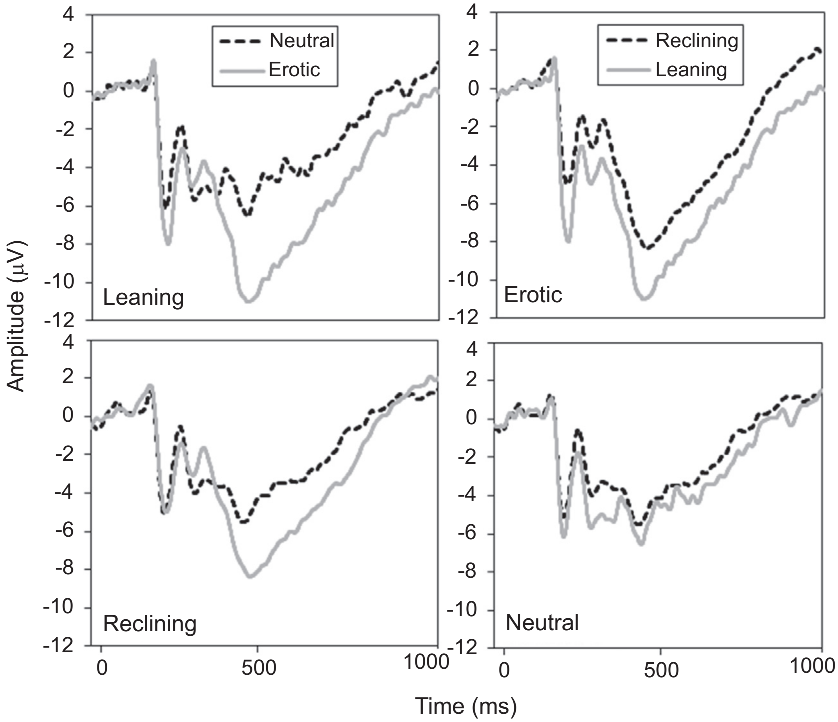

Figure 2 Averaged event-related potentials (ERPs) at site Oz. The left side displays ERPs while leaning or reclining to erotic (top) and neutral (bottom) pictures. The right side displays ERPs to erotic (top) and neutral (bottom) pictures while leaning or reclining. P1s are in the range of 100–200 ms.

As the authors note, there are several methodological differences between these two studies. Alongside a difference in the supine (versus extreme supine) and leaning (versus sitting) postures, there are differences in the types of analyses used between the two studies. Whereas we tested focus predictions with planned contrasts, Benvenut et al. (2013) used traditional omnibus interaction tests. One of the problems with these traditional tests is that often they do not reveal meaningful comparisons between conditions (Rosenthal, Rosnow, & Rubin, 2000). Oddly, the interactive effects found by Benvenut et al. (2013) appear to be driven by their neutral conditions. That is, LPPs to neutral stimuli are significantly larger in the extreme supine versus sitting control conditions. If cortical inhibition, and likely some aspect of arousal, is responsible for these posture based differences, then why would LPP amplitudes be larger to neutral images in the condition intended to represent cortical inhibition? LPPs have been shown

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to increase in response to more arousing pictures (Hajcak et al., 2011), which make interpreting the results of Benvenuti et al. (2013) difficult.

5.3 Startle Responses to Emotional Stimuli and Bodily Manipulations

Research has also indicated that bodily manipulations influence the startle eyeblink reflex, which is reliably modulated by the emotive significance of stimuli (Bradley, Codispoti, Cuthbert, & Lang, 2001; Lang, Bradley, & Cuthbert, 1990; Vrana, Spence, & Lang, 1988). This reflex is part of the full startle response that occurs in response to aversive, unanticipated events presented suddenly to an individual. In the lab, participants are presented with loud (100 db) bursts of white noise, which have instantaneous rise time (Blumenthal et al., 2005). In response to this noise (or startle probe) the orbicularis oculi muscle around the eye contracts. This response functions to protect the eye from harm.

When startle probes are presented during the viewing of affective pictures, the magnitudes of the startle eyeblink are influenced by whether the picture is associated with an avoidance or appetitive motivational state. Startle eyeblink responses are attenuated during the viewing of pictures that evoke appetitive motivation, and potentiated during the viewing of pictures that evoke avoidance motivation. The response matching hypothesis explains these effects. It posits that the startle eyeblink is triggered by aversive stimuli (startling sound) and is therefore a defensive response. The magnitude of the eyeblink response is determined by whether an affective stimulus (eg, affective picture) is associated with a motivational state that either matches or mismatches the aversive motivation elicited by the startling stimulus. If an aversive stimulus (eg, aversive picture) is presented during a startle probe, then the aversive motivational state evoked by the picture stimulus matches that of the startle probe itself, increasing the startle response. If an appetitive stimulus (eg, appetitive picture) is presented during a startle probe, then the appetitive motivational state evoked by the picture stimulus mismatches that of the startle probe, decreasing the startle response. Based on this hypothesis, smaller startle responses are thought to indicate more appetitive responses to the stimuli. Neuroscientific research with animals has indicated that nuclei within the amygdala drive this basic response (Davis, 2006).

Consistent with the hypothesis that decreased startle responses during the viewing of appetitive stimuli reflects approach motivational responses, individuals high in trait behavioral approach system sensitivity show smaller

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startle responses during positive pictures that are arousing (Hawk & Kowmas, 2003). Individuals who score high in trait approach-oriented emotions, such as anger, enjoyment, and surprise, also show smaller startle responses during positive-arousing pictures (Amodio & Harmon-Jones, 2011). In addition, startle responses to images less associated with basic motivational impulses, such as scenes of sail boats, elicit larger startle responses than images more associated with approach motivational impulses, such as images of erotica (Gard, Gard, Mehta, Kring, & Patrick, 2007).

Based on these findings, we tested if our motivational postures would influence startle eyeblink responses to appetitive versus neutral stimuli (Price et al., 2012). This experiment had participants adopt high approach leaning and lower approach reclining postures while viewing picture sets containing images of neutral and erotic pairs of individuals. Consistent with prior research, two-thirds of each picture type contained startle probes, to prevent participants from guessing when a probe might be presented (ie, making it more unexpected). Consistent with past research, startle eyeblink responses were smaller during the viewing of arousing appetitive/positive pictures (eg, erotica) than during the viewing of neutral pictures. More importantly, leaning forward compared to reclining caused even smaller startle responses during arousing positive/appetitive pictures. Startle responses to neutral pictures, however, were not influenced by our body posture manipulation. At the reflexive level, therefore, body posture influences approach motivational responses. These results suggest that embodiment manipulations influence subcortical amygdala activations.

Other research has used other bodily manipulations. Recall that extending the arm is often associated with avoidance—pushing away—whereas flexing the arm is often associated with approach—pulling an object toward oneself (Cacioppo et al., 1993). Deuter, Best, Kuehl, Neumann, and Schàchinger (2014) tested whether these hand postures influence startle reflexes to affective pictures. In this experiment, participants viewed positive (sport scenes, erotica), neutral, and negative (mutilation, disgust) pictures. Picture trials began with a fixation cross. Following the cross, participants were instructed to either flex or extend their arm. Thereafter, an affective picture was displayed, and startle probes were presented during that picture. Results indicated a typical linear trend effect for affective picture content, with positive stimuli being associated with smaller startle responses than neutral and negative stimuli. In addition, manipulated flexion (pulling toward) versus extension (pushing away) enhanced startle responses during negative images. In this instance, the flexing arm posture is incongruent

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with the normal response to push negative stimuli away; thus, the startle reflex to these negative images becomes magnified.

6. PARTIAL AND WHOLE BODY MANIPULATIONS INFLUENCE APPROACH EMOTIVE–COGNITIVE PROCESSES

6.1 Breadth of Cognitive Scope

Research conducted in the 1980 and 1990s suggested that positive affect broadens cognitive scope, whereas negative affect narrows cognitive scope (Fredrickson, 2001). A more recent line of research suggested that the distinction of low- to high-approach motivation associated with positive affect was crucial to understanding whether positive affect broadens or narrows attentional and cognitive scope. Pregoal or high-approach positive emotions were expected to narrow attention, as the organism focuses in on stimulus acquisition and shuts out peripheral details. Over 15 published experiments have indicated that positive affect low in approach motivational intensity broadens cognitive scope relative to positive affect high in approach motivational intensity, which narrows cognitive scope (for reviews, see Harmon-Jones et al., 2011a, 2011b, Harmon-Jones, Gable, et al., 2013).

Hand contractions also influence the narrowing and broadening of cognitive scope. As previously mentioned, right unilateral body movements, such as hand contractions, have been associated with heightened approach motivation (see previous discussion of the neural mechanism). Left unilateral body movements have been associated with lower approach motivation. An experiment (Gable et al., 2013) had participants that perform these body movements (ie, squeezing a squeeze ball) before completing an attentional task designed to measure the broadening/narrowing of attentional scope. This attentional task (Navon, 1977) involved speeded reaction times to local and global targets. Local targets in this task were capital letters (eg, F). Global targets were larger letters made up of these smaller letters (eg, the letter H comprised of capital F's). Participants, across a series of trials, were asked to respond to local (smaller) or global (larger) targets. Faster responses to the larger targets than to the smaller targets indicated a global (broad) focus. Faster responses to the smaller targets than to the larger letters indicated a local (narrow) focus. Results indicated that, indeed, bodily movements can influence how individuals attend to information. Right-hand contractions, which should activate left central and frontal cortical regions, caused

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a more local relative to global focus. Left-handed contractions, which should activate right central and frontal regions, did not produce a difference between global or local attentional focus.

Other cognitive processes have also been examined within this line of research. For example, positive versus negative affect has been shown to influence how individuals categorize related information, with positive affect causing broader categorizations. With a broad cognitive scope, an individual may be more likely to include typical (eg, car) and atypical (eg, camel) members within a specific category (eg, vehicle). With a narrower cognitive scope, however, individuals may only consider typical members within the category (Isen & Daubman, 1984). This past research manipulated positive affect by giving participants a free gift (Isen & Daubman, 1984). This manipulation, however, probably induced low-approach positive affect. That is, when one receives a gift, one is not motivated to go toward anything; instead, one passively enjoys the gift.

We conducted an experiment wherein we manipulated high-approach (leaning forward), moderate-approach (sitting upright), and low-approach (reclining backward) postures while participants completed a cognitive categorization task (Price & Harmon-Jones, 2010b). Participants smiled in each posture in order to elicit positive affect. Results indicated that leaning forward while smiling caused narrower categorizations of material relative to reclining backward and smiling. Sitting upright fell between these conditions, producing a linear trend effect.

6.2 Appetitive Behavior

Research has also examined the effect of motivational arm postures on consumer-related approach behavior. van den Bergh, Schmitt, and Warlop (2011) conducted five experiments examining individuals' shopping behaviors. The first of these experiments was a field study wherein researchers followed shoppers in a grocery store. They compared participants using a shopping cart and shopping baskets. Using a shopping cart requires an arm posture most associated with arm extension, often associated with avoidance (Cacioppo et al., 1993). Using a shopping basket requires an arm posture most associated with arm flexion, often associated with approach behavior. These researchers found that arm flexion relative to arm extension was associated with more purchases of products offering immediate benefits (eg, candy bars). These results suggested that arm flexion may be associated with biases toward more immediate rewards, more reward-seeking behavior.

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A second experiment asked basket carrying and cart pushing shoppers to select between items associated with "virtue" (eg, fruit) or "vice" (chocolate bar). Cart/basket carrying was manipulated. Results indicated that the odds of choosing vice over virtue items were three times more likely in the basket relative to cart conditions. Again, reward-seeking and approach behavior were implicated in these results. Subsequent studies used more traditional arm-flexion and arm-extension manipulations and found that these experimentally controlled postures produced similar results for reward-seeking behavior. Even further, additional studies found that the effect of arm-flexion postures on reward-seeking was dependent on trait measures of BAS sensitivity. Together, these results suggest that approach-oriented bodily manipulations have the ability to influence cognitive behaviors related to decision-making.

Similar research has also been conducted within a clinical context, to examine if avoidance, rather than approach, oriented arm motions can curb harmful appetitive responses. Wiers, Eberl, Rinck, Becker, and Lindenmeyer (2011) examined alcohol addiction. They studied alcohol-dependent individuals with an implicit associations test (IAT). In this test, participants classified presented beverage images as alcoholic or soft drinks. In this experiment, images were presented in portrait and landscape formats. Participants, in a pretest, were trained to make avoidance motions, moving a joystick away from themselves, toward portrait formatted images. Participants made approach motions, moving the joystick toward themselves, to landscape formatted images. There were two experimental and two control conditions. In the first experimental condition, participants were explicitly instructed to respond to all alcoholic images by making avoidance-oriented motions. In the second experimental condition, participants were implicitly instructed to make these evaluations; all alcoholic images in this condition were portrait formatted. Thus, participants in this condition simply continued to respond as they were initially trained in the pretest. Participants in the control conditions were not trained to make avoidance motions to alcoholic images.

Participants self-reported cravings for alcohol were examined before and after the IAT. Results indicated that cravings did not change within the control condition. Cravings were significantly reduced, however, after avoidance training. Even further, avoidance training predicted better treatment outcomes for participants. Together, these results suggest that avoidance motions can diminish harmful appetitive behaviors, and that even these simple motions can have prolonged effects.

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6.3 Cognitive Dissonance Reduction

Other cognitive processes are associated with approach motivation, such as cognitive dissonance reduction, particularly when a commitment to action is involved. In support, experiments have revealed that following difficult decisions, individuals who are primed to be high in approach motivation are more likely to evaluatively spread apart the alternatives (ie, evaluate the chosen alternative more favorably and the rejected alternative less favorably; Harmon-Jones & Harmon-Jones, 2002; Harmon-Jones, Harmon-Jones, Fearn, Sigelman, & Johnson, 2008). Other studies have revealed that individuals who score higher in trait approach motivation are more likely to engage in dissonance reduction following commitments to difficult decisions and counterattitudinal behaviors (E. Harmon-Jones et al., 2011). Also, other research has found that immediately after individuals commit to a chosen course of behavior, they show increased relative left frontal cortical activity, which is associated with approach motivation (Harmon-Jones, Gerdjikov, & Harmon-Jones, 2008; Harmon-Jones, Harmon-Jones, et al., 2008; E. Harmon-Jones et al., 2011).

These results are consistent with predictions derived from the action-based model of cognitive dissonance (Harmon-Jones, 1999; Harmon-Jones, Amodio, & Harmon-Jones, 2009). According to this model, immediately after an individual commits to a course of action, he/she should be more approach motivated to enact the chosen course of action. In other words, he/she should be approach motivated to translate the intention into action, and this approach motivation should manifest in changes in evaluations that are consistent with and supportive of the intention/commitment. For example, individuals who have agreed to eat meat (compared to those who have agree to eat fruit) reduce dissonance by denying that animals have minds, after being reminded that animals suffer when butchered (Bastian, Loughnan, Haslam, & Radke, 2012). This denial reduces the negative affect of dissonance and presumably would assist in enjoyment of consuming the meat.

Our lines of research on the action-based model and the embodiment of approach motivation were recently integrated by testing whether the body posture manipulation of approach motivation would influence dissonance reduction. According to the predictions derived from the action-based model, body postures associated with lower approach motivation should reduce the approach motivation that is typically involved in the process of dissonance reduction. In other words, a supine body posture should lower

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the amount that one reduces dissonance. This prediction was tested in two experiments; one experiment used the difficult-decision paradigm and the other used the effort justification paradigm. In the difficult-decision experiment, participants who were (randomly assigned to) sitting upright showed the typical spreading of alternatives effect, but participants who were in a supine body posture showed no evidence of spreading of alternatives. In the effort justification experiment, participants who were (randomly assigned to) sitting upright and performed a difficult cognitive task evaluated the task incentive more positively than participants who were sitting upright and performed an easy cognitive task. This difference between conditions replicates the typical effort justification effect. In the supine body posture condition, however, participants did not show this effort justification effect (Harmon-Jones, Price, & Harmon-Jones, 2015).

7. QUESTIONS, IMPLICATIONS, AND CONCLUSIONS

The research we have reviewed suggests that bodily movements such as facial expressions (Coan et al., 2001; Ekman & Davidson, 1993), unilateral hand contractions (Harmon-Jones, 2006; Peterson et al., 2008), and whole body postures (Harmon-Jones & Peterson, 2009; E. Harmon-Jones et al., 2011; Price & Harmon-Jones, 2010a) influence relative left frontal cortical activity, presumably because these bodily movements influence approach motivation intensity. Indeed, evidence obtained with other measures supports this interpretation. In addition, the manipulated whole body posture going from supine to leaning forward influences subcortically driven emotive processes and event-related brain potentials related to motivated attention (Price et al., 2012). Thus, body manipulations along a continuum of approach motivation influence multiple psychophysiological processes.

One question that has arisen in our program of research on the whole body posture manipulation that goes from being supine to upright to leaning forward is whether it influences avoidance motivation. We have conducted one preliminary test of avoidance motivation and found that the body posture manipulation did not influence startle eyeblink and ERP reactions to arousing negative pictures (which evoke avoidance motivation).

Does the whole body posture manipulation influence arousal rather than approach motivation? In other words, does the supine posture exert its effects because it is simply reducing general arousal? The evidence collected so far suggests that approach motivation better explains the results than

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"general arousal." First, the experiment mentioned in the previous paragraph found no evidence that the whole body posture influences reactions to avoidance-related stimuli. If arousal explains the other results better than approach motivation, then this body posture should have influenced reactions to avoidance-related stimuli. Second, the supine posture has not been found to reduce startle responses during neutral stimuli. If the supine posture simply reduced general arousal, then it should reduce startle responses during neutral stimuli, because startle is an aversive response.

The program of research on whole body posture has at least one methodological implication. fMRI experiments often require individuals to be in a supine body posture. As suggested by the reviewed evidence, this posture may reduce approach motivational responses, and this may explain why some fMRI studies have not found a relationship between approach motivation variables and relative left frontal cortical activity (Tomarken & Zald, 2009). Other research methodologies, which used an upright body posture, have found a relationship between approach motivation variables and relative left frontal cortical activity (Carver & Harmon-Jones, 2009; van Honk & Schutter, 2006). Therefore, the supine posture used in most fMRI scanners may decrease, but not necessarily eliminate, neural activity associated with approach motivation.

We reviewed evidence that suggests that manipulated body postures and expressions influence approach motivational responses. These experiments illustrate the importance of motivation in several aspects of psychology and ultimately illustrate the importance of the action readiness of the body in motivation. We should consider the conceptual consequences of this research as we develop motivational theories.

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