ELECTROENCEPHALOGRAPHIC RESPONSE TO A BODY IMAGE EXPOSURE

By

Karen Storeshaw

BA (Hons.) Specialized Honours in Psychology, Lakehead University, 2009

THESIS SUBMITTED IN PARTIAL FULFULLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTER OF ARTS IN CLINICAL PSYCHOLOGY

Department of Psychology

Lakehead University

August, 2012

Abstract

Body and appearance dissatisfaction have been common topics of study in psychological research. Another area of research that may have implications for these topics is that of frontal asymmetry; the greater relative activity in either the right or left frontal lobe. Action-oriented mindsets have been associated with changes in frontal activity. This study examined the effect of an appearance-related, action-oriented mindset on frontal cortical asymmetry while males and females viewed pictures of themselves in two-dimensions (2D) and three-dimensions (3D). Ninety-seven male and female participants completed this study. During their initial lab visit, participants had their pictures taken. Participants returned to the lab to view the pictures and were fitted with an electroencephalogram (EEG) in order to record brain activity while undergoing either a no-mindset or an action-oriented mindset induction. Results indicated effects of mindset induction, dimensionality of picture presentation order, and dispositional body image satisfaction on frontal and parietal asymmetry. State changes in affect and body image satisfaction were also predicted by state changes in frontal and parietal asymmetry. For the findings pertaining to frontal asymmetry, results are discussed in terms of motivational direction. Findings pertaining to parietal asymmetry are explored with reference to arousal and emotional intensity, spatial attention, the processing of binocular disparity, and body image.

Table of Contents

List of Tables

List of Figures

List of Appendices

Electroencephalographic Response to a Body Image Exposure

Body and appearance dissatisfaction are common amongst individuals and are widely examined areas in psychological research. Another emerging area of study is that of frontal asymmetry; the pattern of cortical activity in the prefrontal lobes that has implications for affective valence and motivational direction. In addition, frontal activity has been manipulated using an action-oriented mindset. Based on our previous research on body image exposure and frontal asymmetry (Storeshaw & Davis, 2010), the present study seeks to manipulate frontal activity during body image exposure.

Body Image and Appearance Dissatisfaction

Early research in this area revealed that women indicated discrepancies between their own current figure and their conceptualization of the ideal and the most attractive female figures (Fallon & Rozin, 1985), a finding demonstrated across generations (Cohn et al., 1987; Rozin & Fallon, 1988). Twenty-five years later, these findings have remained relatively consistent. Women continue to express both body dissatisfaction and a desire for a thinner ideal figure and believe that men prefer thinner women (Bergstrom, Neighbors, & Lewis, 2004; Miller & Halberstadt, 2005). Although body image dissatisfaction has been less studied in men, studies have shown a changing trend in terms of male body image. Twenty-five years ago, adult men experienced relative body satisfaction (Fallon & Rozin, 1985) while the younger adolescent male cohort reported displeasure with their current figure (Cohn et al., 1987).

Dissatisfaction with weight is commonplace among women. One study found that when compared with males, women reported more dissatisfaction with their body weight and shape, despite the fact that the males in this sample were heavier and their prevalence of being overweight was higher (Neighbors & Sobal, 2007). The majority of women within the normal body mass index (BMI) weight range expressed an inclination to weigh less. Underweight women expressed the most body weight and shape satisfaction, while overweight women reported the most dissatisfaction with weight in the sample, but had the same amount of shape dissatisfaction as women in the normal BMI range (Neighbors & Sobal, 2007). Another study by Laliberte, Newton, McCabe, and Mills (2007) found that a nonclinical sample of young women preferred a body weight about 10% lower than their current weight.

While weight is a great source of body dissatisfaction for many women, the source of male body dissatisfaction is muscularity in which the ideal male figure is becoming increasingly muscular (e.g., Baghurst, Hollander, Nardella, & Haff, 2006). Indeed, both heterosexual and homosexual men express a desire to be more lean and muscular (Martins, Tiggemann, & Churchett, 2008; Tiggemann, Martins, & Churchett, 2008). In addition, Tiggemann, Martins, and Kirkbride (2007) found that both groups of men consider their ideal body to be thinner, and over 80% considered their ideal body more muscular compared to their current body figure. As a result of these findings, it has been proposed that a desire for muscularity has perhaps become normative among men (Tiggemann et al., 2007). This desire for muscularity has also been found in various countries (Pope et al., 2000). Moreover, the drive for muscularity is related to exposure to ideal male bodies (Morrison, Morrison, & Hopkins, 2003).

While body dissatisfaction plays a role in discontent with one’s physical self, appearance dissatisfaction is also a contributor to this discontent that is found among both sexes. Engeln-Maddox (2006) notes that, while there is an emphasis on thinness as a beauty ideal for women, there are a number of other attractiveness-related characteristics that play a role in what is considered ideally beautiful. Simple exposure to attractive individuals can produce an adverse effect on their overall appearance satisfaction among women (Want, Vickers, & Amos, 2009).

Appearance dissatisfaction can have a detrimental effect on self-esteem. There is a negative association between appearance dissatisfaction and self-esteem among the female college population (Kim & Lennon, 2007), although the effect of appearance dissatisfaction on self-esteem is not just limited to this population. Seidah and Bouffard (2007) found that 35% of adolescents report that their self-esteem is preceded and determined by the satisfaction they experience with their physical appearance. These adolescents experienced reduced satisfaction with how they look and believed that they were scholastically and socially less competent. Appearance is also important to how individuals believe their lives can be lived. Women believe that it would be likely that important, positive changes would occur in their lives if they achieved the media's beauty ideal (Engeln-Maddox, 2006).

The literature appears to be quite sparse in terms of male appearance dissatisfaction. According to male self-reports, however, the most important aspects of physical attractiveness were muscularity and body weight. These two aspects, as well as height and penis size, are also related to appearance self-esteem in men (Tiggemann et al., 2008). Furthermore, these men reported wanting to be leaner, to be more muscular, to be taller, to have more hair on their head, to have less hair on their bodies, and to have a larger penis.

Body Image Exposure

It is not surprising that exposure to one's own body can be an unpleasant experience for many people. A study by Shafran, Lee, Payne, and Fairburn (2007) investigated females as they underwent a body checking manipulation in which they were asked to attend to and analyze disliked body parts while looking in a mirror. These women underwent brief increases in body dissatisfaction and critical assessments regarding their body as well as their feelings of being fat. Another study found that both women with a diagnosis of bulimia nervosa and women without an eating disorder felt that exposure to their own body shape through video confrontation and imagery tasks was a negative experience (Tuschen-Caffier, Vögele, Bracht, & Hilbert, 2003). These exposures produced increases in self-reported negative emotions including anxiety and insecurity.

Jansen, Nederkoorn, and Mulkens (2005) investigated visual attention in eating symptomatic and normal control participants. Using eye movement registration (electrooculography) to assess visual attendance to particular body parts, participants looked at their own and others' bodies and rated various body parts as "beautiful" or "ugly" for each body presented. It was shown that those who were eating symptomatic averted their attention from "beautiful" body parts and focussed on "ugly" body parts when looking at the images of their own bodies, while they attended to "beautiful" parts on others' bodies. In contrast, the normal controls attended to "beautiful" body parts when looking at their own bodies, and attended to "ugly" body parts when looking at images of another's body (Jansen et al., 2005).

Similarly, Vocks, Legenbauer, Wachter, Wucherer, and Kosfelder (2007) investigated body image exposure among eating disordered women and a noneating disordered control group. During mirror exposure, it was found that women with eating disorders had a greater elevation of negative emotions compared to resting conditions than the group of normal controls. In addition, the group of eating disordered women experienced more self-deprecating thoughts compared to the control group.

The effects of body image exposure among males have been relatively unstudied. Most participants in a study of a group of men by Adams, Turner, and Bucks (2005) reported that something as simple as seeing oneself was a trigger for body dissatisfaction. Among the strategies used to deal with the emotional distress that results from body dissatisfaction, men described avoidant strategies such as withdrawal from difficult situations and distancing themselves from the unpleasant emotions. In addition, the men described a lack of control over what they perceived as flaws as a method of coping, which some men responded to with feelings of hopelessness due to the inability to change (Adams et al., 2005).

Stereopsis

It is possible that a body image exposure to one's own novel stereoscopic image may result in a different response. Stereopsis is a term that refers to binocular sense of depth. Wheatstone (1838) described this depth sense as one that is generated by retinal disparity of the human eye, with each eye producing a slightly different image from a slightly different perspective. A single image results from the ability of the brain to fuse these two very similar images together into a stereoscopic image that appears to be three-dimensional (3D).

Two-dimensional (2D) and 3D body images have recently been used in a body image exposure study. Roldan, Blanchette, & Davis (2009) used a mindfulness induction condition and a comparison condition of worry and rumination to determine subjective reports of body dissatisfaction and negative affect during body image exposure. Mindfulness techniques have been shown to produce improvements in attentional, perceptual, and cognitive processes (Ivanovski & Malhi, 2007). It was found that although female university participants as a whole experienced some discomfort during exposure to images of their bodies, negative affect was much more apparent among individuals who had a greater dispositional level of body dissatisfaction (Roldan et al., 2009). In addition, those in the worry and rumination condition who observed 3D photos of themselves expressed higher levels of negative affect and body dissatisfaction. This suggests that being in a particular mindset may have an influence on one's body image.

Frontal Asymmetry

One fascinating area of research in terms of brain activity which may have implications for body image exposure is frontal asymmetry. Frontal asymmetry is the term used to describe the amount of frontal lobe electroencephalographic (EEG) activity in one hemisphere relative to the other. Greater activity in one prefrontal lobe compared to the other has implications for what an individual is experiencing. Harmon-Jones (2003) reviewed three conceptual models regarding frontal asymmetry. The first is the valence model in which the experience and expression of positive and negative affect are associated with greater left and right frontal activity, respectively. Second, the motivational direction model proposes that approach and withdrawal motivations are related to greater left and right frontal activity. Third, the valenced motivational model suggests that positive approach emotions are related to left frontal activity, while negative withdrawal emotions are related to right frontal activity.

The valence model of frontal asymmetry describes the emotional tendencies of either side of the frontal cortex (e.g., Ahern & Schwartz, 1985; Gotlib, Ranganath, & Rosenfeld, 1998; Heller, 1990; Heller & Nitschke, 1998; Silberman & Weingartner, 1986). A number of studies have associated greater left frontal activity with positive affect and greater right frontal activity with negative affect (Davidson, Schwartz, Saron, Bennett, & Goleman, 1979; Jacobs & Snyder, 1996; Thibodeau, Jorgensen, & Kim, 2006). Responses to emotionally eliciting stimuli have also been predicted by frontal asymmetry at baseline such that greater right frontal activity predicts a response of greater negative affect when exposed to negative stimuli and greater left frontal activity predicts a response of more positive affect when exposed to positive stimuli (Wheeler, Davidson, & Tomarken, 1993). The intensity of the emotional experience of stimuli has also been associated with the expected lateral activity in the frontal lobes in a study of musically induced emotions (Schmidt & Trainor, 2001).

The motivational direction model of frontal asymmetry describes frontal activity in terms of motivation to approach and withdraw (Davidson, Jackson, & Kalin, 2000; Fox, 1991; Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997). Gray's (1972) behavioural activation system (BAS) and behavioural inhibition system (BIS) have been correlated with greater relative activity in the left and right frontal lobe, respectively (Coan & Allen, 2003; Sutton & Davidson, 1997). This evidence supports the idea that lateral differences in frontal cortical activity are implicated in dispositions to approach and withdraw (Sutton & Davidson, 1997). It is important to acknowledge that the psychometric scales tapping BAS and BIS systems may also predict affective outcomes, following from findings indicating that the BIS scale predicts nervousness in individuals when there is an expectation of a punishment, while the BAS scale predicts happiness when there is the expectation of a reward (Carver & White, 1994). However, more support for the motivational direction model has been found elsewhere. For example, other approach-related tendencies have been associated with greater left frontal activity such as sensation-seeking and exercise addiction (Gapin, Etnier, & Tucker, 2009; Santesso et al., 2008).

Furthermore, research has suggested discrepancies between self-reported affect and frontal asymmetry. Hietanen, Leppanen, Peltola, Linna-aho, and Ruuhiala (2008) found that receiving the direct or averted gaze of a live person, as opposed to a picture of a person’s face or an object, affected the neural system of approach and avoidance. Direct gaze from a live person was associated with greater left frontal activity thereby suggesting approach motivation while averted gaze from a live person was associated with greater right frontal activity thereby suggesting avoidance. According to subjective ratings of arousal, live faces were considered more arousing and direct gaze produced greater arousal compared to averted gaze. In addition, subjective reports of valence showed that direct gaze was rated as slightly positive but was not as pleasant or as positive as gaze that was averted. These subjective ratings of valence conflict with frontal asymmetry findings in which direct gaze was related to approach-related neural activity with less positive affect while averted gaze had the opposite effect.

Storeshaw and Davis (2010) also found discrepancies between self-reported affect and frontal activity. In a study examining exposure to 2D and 3D pictures of one’s own body and that of one’s romantic partner, brain activity was recorded with an EEG. Self-reported affect was not consistent with the anticipated frontal cortical responses of the valence model. That is, despite highly positive affective ratings of pictures of their partners, there was no observation of corresponding greater left frontal EEG activity. Participants also responded with more neutral affect to 3D pictures of themselves but exhibited greater right frontal activity which is suggestive of motivation to withdraw.

An argument can also be made for the third model, the valenced motivational model, with several studies finding that certain elicited positive and negative emotions are related to approach and withdrawal (Davidson, 1998; Tomarken & Keener, 1998). For example, the emotion of disgust produces negative affect in addition to withdrawal. Disgust has been linked to greater right frontal activity (Davidson, Ekman, Saron, Senulis, & Friesen, 1990). This study also found that left frontal activity was not significantly increased in a happy condition due to the failure of this condition to elicit an approach motivation from participants.

Despite support for all three conceptual models of frontal asymmetry, it appears that the motivational direction model may triumph (Harmon-Jones, 2003) given the multitude of studies supporting the model. For instance, anger is an approach-oriented, negatively-valenced emotion that is associated with greater left frontal activity (Harmon-Jones, 2003). This frontal activity pattern has been related to trait anger (Harmon-Jones, 2004b; Harmon-Jones & Allen, 1998). Stewart, Levin-Silton, Sass, Heller, and Miller (2008) found that those who had high trait anger demonstrated greater left frontal activity compared to those who had low trait anger regardless of their style of anger expression. Similarly, Hewig, Hagemann, Seifert, Naumann, and Bartussek (2004) found an association between greater left frontal activity and trait anger, particularly between greater left frontal activity and measures of physical and verbal aggression and hostility.

In addition, those who exhibited greater left frontal activity scored higher on a measure of aggressive expression of angry feelings and those with greater right frontal activity scored higher on a measure of active management of anger. This demonstrates a relationship between approach and greater left frontal activity and between withdrawal (active avoidance) and greater right frontal activity (Hewig et al., 2004).

The direct manipulation of frontal activity can also have an influence upon anger. d'Alfonso, van Honk, Hermans, Postma, and de Haan (2000) found that right prefrontal stimulation with slow repetitive transcranial magnetic stimulation (rTMS) (leading to greater left frontal activity) revealed selective attention to angry facial expressions while left prefrontal stimulation (leading to greater right frontal activity) revealed selective attention away from the angry expressions. This suggests that rTMS of the prefrontal cortex altered the motivational direction or goal-oriented behaviour. In addition, van Honk and Schutter (2006) had similar findings in which inhibiting activity in the left prefrontal cortex using rTMS led to decreases in processing anger. In contrast, Miskovic and Schmidt (2010) found that attention towards faces with angry expressions was related to greater right frontal activity. It is possible that this effect is due to the individual's desire to withdraw from threatening stimuli, whereas the studies using rTMS purposefully manipulated brain activity. Manipulations of left frontal activity through hand contractions have also led to more behavioural aggression when individuals were confronted with an anger provocation event (Peterson, Shackman, & Harmon-Jones, 2008).

Further investigation of anger has demonstrated that expectation to act is also associated with greater left frontal activity. Harmon-Jones and Sigelman (2001) demonstrated that participants who received an angering insult had greater left frontal activity than those who did not and exhibited greater aggression towards the individual who insulted them. In this study, insulted participants were not prohibited from taking action (Harmon-Jones & Sigelman, 2001). However, Harmon-Jones, Sigelman, Bohlig, and Harmon-Jones (2003) conducted a study in which participants were subjected to conditions in which they would be either able or unable to take action against increases in tuition, an angering situation for most students. Those who believed they had an opportunity to act against this angering situation exhibited greater left frontal activity compared to those who believed they were unable to take action. Among those who believed they were able to take action, greater left frontal activity was related to more self-reported anger and increased likelihood of engaging in behaviours in order to lessen the possibility that the angering situation would occur. Using the same paradigm of listening to arguments for increased tuition, Harmon-Jones et al. (2002) found that participants who were prone to symptoms of mania and hypomania exhibited greater approach motivation reflected by greater left frontal activity, while participants who were prone to symptoms of depression exhibited greater withdrawal motivation as reflected by greater right frontal activity. Harmon-Jones et al. (2002) deduced that proneness to these symptoms might predict approach and withdrawal motivational tendencies.

Anger is not the only negative emotion to promote the role of frontal activity and approach motivation. Amodio, Devine, and Harmon-Jones' (2007) study of racial prejudice found that there was a relationship between heightened guilt and reduced activity in the left frontal cortex. However, provided with an opportunity for reparation, guilt predicted a motivation to learn about behaviour to reduce prejudice that was associated with a shift to approach-oriented frontal activity patterns (Amodio et al., 2007). Defensiveness is another emotion that demands action and is related to greater left frontal activity in threatening situations (Crost, Pauls, & Wacker, 2008; Kline, Blackhart, & Joiner, 2002). Furthermore, two types of defensiveness, self-deceptive enhancement and impression management, have been associated with greater left frontal activity as well as positive affect (Pauls, Wacker, & Crost, 2005). Worrying, a negatively-valenced emotion that is approach-oriented, is also related to increased left frontal activity (Hofmann et al., 2005). These studies investigating the negative, yet approach-oriented, emotions of anger, guilt, defensiveness, and worry add to the mounting evidence supporting the motivational direction model of frontal asymmetry.

Frontal asymmetry and psychopathology. Frontal asymmetry has also been associated with different forms of psychopathology. Notably, two recent studies have implicated frontal asymmetry in depression and bipolar disorder. Nusslock et al. (2011) found that greater cognitive vulnerability to depression was related to decreased left frontal activity at resting baseline among individuals without a history of, or current, depression. Furthermore, cognitive vulnerability and frontal asymmetry were significant prospective predictors of the onset of one's first episode of depression.

Furthermore, Nusslock et al. (2012) investigated the role of frontal asymmetry as a neurophysiological marker in the prediction of conversion to bipolar I disorder among bipolar spectrum participants. Findings indicated that elevated left frontal activity at baseline predicted a greater probability of conversion to bipolar I disorder among individuals with cyclothymia or bipolar II disorder over a 4-year follow up. Since decreased left frontal activity is characteristic of unipolar depression while elevated left frontal activity suggests vulnerability to mania, Nusslock et al. concluded that pattern of frontal asymmetry may serve as a neurophysiological marker to differentiate between these disorders.

Frontal asymmetry and viewing pictures. In their review of frontal asymmetry and emotion, Harmon-Jones, Gable, and Peterson (2010) noted that previous studies using affective pictures failed to produce predicted effects on frontal cortical activity. For instance, Elgavish, Halpern, Dikman, and Allen (2003) found that exposure to stimuli from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthburt, 2008) did not produce state-related shifts in frontal asymmetry. Similarly, Hagemann, Naumann, Becker, Maier, and Bartussek (1998) found that exposure to positive and negative affective pictures did not elicit any significant frontal asymmetry, while Harmon-Jones (2007) demonstrated that affective pictures did not produce shifts in frontal activity. Another study investigated individual differences in terms of emotive tendencies and their effect on frontal activity in response to positive affective stimuli (Gable & Harmon-Jones, 2008). It was found that the emotive tendency of liking dessert and a longer period since having eaten was associated with greater left activity when participants viewed pictures of desserts compared to neutral pictures. However, the affective pictures themselves did not produce changes in frontal asymmetry when measured over the course of the experiment (Gable & Harmon-Jones, 2008).

The monoscopic or stereoscopic presentation - or dimensionality - of pictures has been shown to lead to differences in frontal asymmetry. With the use of slow cortical potentials and low resolution electromagnetic tomography (LORETA), Fischmeister and Bauer (2006) used stereoscopic images (a tree, building, and arcade) to examine the neural relationship of monocular cues and binocular cues. There was an increase in left frontal lobe activity while viewing the stereoscopic images that was not evident when individuals were exposed to the same monoscopic images. On the other hand, Storeshaw and Davis (2010) found that individuals experienced a reduction in left frontal asymmetry when viewing themselves in 3D compared to baseline that was not found when they viewed themselves in 2D.

Action-Oriented Mindsets

The action-based model of cognitive dissonance has also been investigated in terms of frontal asymmetry and approach-motivated behaviours. The model follows from Festinger's (1957) theory of cognitive dissonance in which inconsistent cognitions create an uncomfortable emotional-motivational state. As a result, an individual will engage in a method of discrepancy reduction in order to return to a comfortable state. For example, discomfort was found among those participants who had chosen to write a counter-attitudinal essay, and attitude change alleviated this discomfort through dissonance reduction (Elliot & Devine, 1994). There has been support for the conceptualization of cognitive dissonance as a basic motivational state (Elliot & Devine, 1994). Harmon-Jones (1999) proposed the action-based model to explain why negative emotions were produced by cognitive discrepancies and why there is a motivation to reduce these discrepancies. Harmon-Jones and Harmon-Jones (2008) suggested in their review that reduction of dissonance helps to assist effective action, as discomfort results from the inability to engage in effective action when cognitions conflict. The action-based model of cognitive dissonance states that when a person commits to an action, they will experience a motivation to pursue this commitment and will demonstrate enhanced tendencies towards approach motivation in order to facilitate their ability to act in such a manner that is effective and unconflicted with the commitment (Harmon-Jones, Gerdjikov, & Harmon-Jones, 2008).

The action-based model has been investigated in studies that use action-oriented mindsets. The action-oriented mindset is synonymous with Gollwitzer and Kinney's (1989) implemental mindset, which has been associated with an illusion of control and positive affect (Gollwitzer & Kinney, 1989; Taylor & Gollwitzer, 1995). In one study, Harmon-Jones and Harmon-Jones (2002) had participants rate a number of exercise tasks, and participants were either in an "easy" decision (choosing between a highly-rated exercise and a low-rated exercise) and a "difficult" decision (choosing between two similarly rated exercise tasks). Participants were inducted into either a neutral mindset or an action-oriented mindset before they performed the exercise. In the neutral mindset, participants listed a minimum of seven things they typically do in an ordinary day. The action-oriented mindset required participants to list a minimum of seven things they could do to improve their performance on the exercise task that they were assigned. It was found that when faced with a difficult decision that arouses dissonance, being in an action-oriented mindset enhances cognitive discrepancy reduction and thus promotes approach motivation to reduce the discrepancy.

In terms of cortical activity, action-oriented mindset studies have demonstrated interesting findings in accordance with approach motivational systems. The experience of dissonance has been found to be associated with activity in the anterior cingulate cortex (ACC), which is involved in detecting cognitive conflict (Carter et al., 1998; Gehring, Goss, Coles, Meyer, & Donchin, 1993). Furthermore, Harmon-Jones (2004a) suggested that dissonance is associated with activity in the ACC which then is associated with activity in the left frontal cortex in order to stimulate the approach motivation that may facilitate dissonance reduction. Several studies have supported this notion. For example, Harmon-Jones, Gerdjikov, et al. (2008) assigned participants to either a low choice condition in which they were asked to write arguments for a tuition increase or a high choice condition in which they were given the choice to write arguments for a tuition increase. Those in the high choice condition exhibited greater left frontal activity which suggests that reducing a cognitive discrepancy is related to greater left frontal activity.

Experimental manipulation of cortical activity has been used in studies of action-oriented mindsets. Harmon-Jones, Harmon-Jones, Fearn, Sigelman, and Johnson (2008) demonstrated that neurofeedback training led to reduced left frontal activity, which in turn decreased the spreading-of-alternatives effect in which evaluations of the chosen alternative become more positive while evaluations of the rejected alternative become more negative after a decision is made. A second experiment manipulated frontal cortical activity by using an action-oriented mindset induction. Participants had to rate their preferences of an experiment after reading its description, and then had to decide between two of the experiments which were positively rated and equally attractive. Participants then engaged in one of three mindset inductions. For the neutral mindset condition, participants considered an ordinary day in their life and wrote about it in detail. For the action-oriented mindset condition, participants thought about an intended project that had a goal that they aimed to accomplish one day and that they had decided to follow through on. They wrote about this complex project which could be realized within the following three months. In their writing, they had to list the project; five important steps to complete it; and specifically where, when, and how they would perform each step. For the positive non-action-oriented mindset condition, participants wrote about an event in which something occurred that made them feel good about themselves but was not the product of their own action. All participants were then asked to think about what they wrote about while EEG was recorded. It was found that only those in the action-oriented mindset condition demonstrated greater left frontal activity and spreading of alternatives. In addition, the action-oriented mindset and positive non-action-oriented mindset conditions produced increases in positive affect, suggesting that observed differences in frontal asymmetry were the result of approach motivation tendencies caused by the action-oriented mindset and not due to affective valence (Harmon-Jones, Harmon-Jones, et al., 2008).

The Present Study

We have previously demonstrated a shift from left to right frontal asymmetry in a small sample of participants undergoing a body image exposure when they viewed 3D pictorial images of themselves compared to a baseline viewing condition of common household objects (Storeshaw & Davis, 2010). From the valence perspective of emotion and frontal asymmetry (e.g., Ahern & Schwartz, 1985; Gotlib et al., 1998; Heller, 1990; Heller & Nitschke, 1998; Silberman & Weingartner, 1986), it is tempting to infer this cortical response reflects the aversive nature of a body image exposure. However, participants' ratings of subjective affect did not correspond to their cortical shift. Interestingly, this cortical response was not observed when participants viewed their 2D pictures.

The present study set out to expand upon these observations by asking two questions: First, what psychological process might be implemented to avert this cortical response in shifting frontal asymmetry during a body image exposure? An obvious candidate to test would be the action-oriented mindset induction that has documented effects upon cortical response (Harmon-Jones, Harmon-Jones, et al., 2008). We reckoned that an experimental induction that encourages participants to plan to make future changes to their appearance during a body image exposure would offer an effective and ecologically valid mindset induction that, theoretically, should produce the anticipated cortical response of a shift toward left frontal asymmetry. A specific prediction was that participants induced into an action-oriented mindset to change their appearance would demonstrate greater left frontal asymmetry during a body image exposure compared to a no-mindset condition.

Two potential moderators of this hypothesized mindset effect on cortical response were also examined in an exploratory manner without any specific predictions: (a) body image satisfaction (high vs. low) at baseline before the body image exposure (preexposure) and (b) order in which dimensionality of the images – 2D and 3D - were presented during the body image exposure: 2D for first exposure followed by 3D for second exposure or vice versa (2D/3D vs. 3D/2D).

Given that a body image exposure is a psychologically aversive experience for many people (Adams et al., 2005; Roldan et al., 2009; Shafran et al., 2007; Tuschen-Caffier et al., 2003; Vocks et al., 2007), the second question asked whether state changes in self-reported affect and body image over the course of a body image exposure could be predicted by state changes in cortical response over the same period. A specific prediction was that increases in left frontal EEG asymmetry during a body image exposure would predict subsequent increases in positive affect and body image satisfaction. This hypothesis was predicated upon the valence model (e.g., Ahern & Schwartz, 1985; Gotlib et al., 1998; Heller, 1990; Heller & Nitschke, 1998; Silberman & Weingartner, 1986) which associates left frontal asymmetry with positive affect.

Method

Participants

Male and female participants were recruited from Psychology undergraduate courses at Lakehead University via classroom announcements and email. They were directed to an online testing battery on SurveyMonkey which, upon completion, allowed interested individuals to schedule a laboratory appointment to have their pictures taken. A total of 108 participants completed the online testing battery and subsequently scheduled an appointment. Eight participants did not attend their appointment for their pictures to be taken, and an additional three participants failed to attend their second appointment for viewing the pictures. A statement on the demographic composition of the sample is warranted. The final sample consisted of 97 participants (71 females). Their mean age was 21.23 years (*SD* = 6.66). The majority reported their ethnicity to be Caucasian (84.6%) followed by Native-Canadian (7.2%), Asian (5.2%), "other" (1%), and 2.1% failed to report their ethnicity. Most participants were single (95.9%) and enrolled in full-time studies (95.9%). Over half (59.8%) of the participants reported never having viewed any photograph in 3D. Importantly, all but two participants (97.9%) had never viewed their own pictorial image in 3D which underscores this experiment's high degree of novelty for participants.

Questionnaires

Positive and Negative Affect Schedule. (PANAS; Watson, Clark, & Tellegen, 1988; Appendix A). The state version of this measure consists of 20 items assessing both positive (10 items) and negative (10 items) affect, rated on a 5-point scale (1 = *very slightly or not at all* and 5 = *extremely*). The Positive Affect and Negative Affect scales demonstrate internal consistency coefficients of .89 and .85, respectively, and appropriate convergent and discriminant validity correlations on related regression-based factor scores (Watson et al, 1988). The PANAS has also been found to be correlated with anxiety and depression measures in the adult population at large and has had its construct validity supported (Crawford & Henry, 2004). As well, the two scales are robust to differences in a number of demographic variables (Mackinnon et al., 1999).

Body Image States Scale. (BISS; Cash, Fleming, Alindogan, Steadman, & Whitehead, 2002; Appendix B). This scale measures an individual's evaluative/affective body-image states, assessing domains such as physical appearance, body size and shape, weight, attractiveness, and looks. It is composed of six items on a 9-point scale in which high scores indicate positive state body image. Internal consistency for women and men was .77 and .72, respectively, and elsewhere has been found to be higher (α = .85) in a sample of women (Vocks, Hechler, Rohrig, & Legenbauer, 2009). Test-retest reliability for women and men was .69 and .68, respectively. The stability is lower due to the fact that the scale measures state body image. The BISS demonstrates construct validity as assessed by an experiment on reactivity to information regarding appearance and body image investment, as well as convergent validity by correlating with a number of trait body image measures (Cash et al., 2002).

Edinburgh Handedness Inventory. (EHI; Oldfield, 1971; Appendix C). This inventory consists of 10 items to quantitatively assess handedness. Items inquire about strength of hand preference for completing certain activities such as writing and throwing. A laterality quotient is produced by using the following equation in which RH is the total number of right hand endorsements and LH is the total number of left hand endorsements: [(RH − LH)/(RH + LH)] x 100. A score of less than -40 indicates left handedness, a score between -40 and +40 indicates ambidexterity, and a score above +40 indicates right handedness. According to this classification scheme, the majority of current sample was right-handed (75.3%) followed by ambidexterous (23.7%) and left-handed (1%).

Stereo Fly Test: Stereotest Circles (SFT). The Stereo Fly Test: Stereotest Circles is a sequence of nine graded presentations that become increasingly difficult in order to test fine differences in depth perception. Each presentation contains four circles and, for individuals who have normal stereo fusion, one circle out of the four will appear to come out of the plane of reference (Stereo Optical Company, Inc., 1994). Normal depth perception is indicated by the ability to read all of the nine presentations correctly with the aid of polarized glasses, while the ability to answer up to five presentations correctly is considered acceptable depth perception (Stereo Optical Company, Inc., n.d.). The SFT was used in the current study to determine participants' fine depth discrimination ability. Participants were asked upon each presentation which of the four circles appeared to come out closer to them. Participants were administered all nine presentations and their number of correct responses was tallied. All participants were able to form at least two correct 3D images with the majority (70%) obtaining a perfect score on the nine presentations; $M = 8.22$ ($SD = 1.63$).

Procedure

Participants were recruited through announcements in Psychology courses at Lakehead University. Interested participants were directed to a link that provided the potential participant with information regarding the study (Appendix D) which they were required to read and indicate their consent in order to continue and participate in the study. This was followed by a battery of questionnaires that included the EHI (Appendix C), a basic demographic questionnaire (Appendix E), the PANAS (Appendix A), the BISS (Appendix B), questions assessing previous 3D viewing experiences, and questionnaires related to a separate study. Upon completion of the online questionnaire battery, participants were invited to sign up for two laboratory appointments on Experiment Manager, one in which to have their photographs taken and the second for viewing the photographs. Upon arrival at the laboratory for the first appointment, participants were administered the SFT. Twenty-four photos were then taken in a different pose and at a different angle with the participant maintaining a neutral facial expression. The three poses were a full portrait pose of the entire body, a seated portrait pose of the entire body, and a head and shoulder portrait pose. Each pose was taken from eight angles: 0°, 45°, 90°, 135°, 180°, 225°, 270°, and 315°. A Fuji Real 3D W3 camera mounted onto a tripod was used to take participants' photographs. The photographs were downloaded using MyFinePix Studio software onto an IBM® IntelliStation M Pro workstation computer and prepared for presentation to participants.

At the second 1-hr lab visit, participants underwent a number of activities (see Figure 1). Measurements of the participant's head were taken for the purposes of fitting the participant with an EEG cap. Participants also wore Real D CrystalEyes®, a pair of shutter glasses in order to view the 3D pictures. The researcher then retreated into a back room to attend to the computers controlling the EEG recordings and the picture presentations. The pictures were presented in a slideshow format using Stereoscopic Player (Version 1.7.8). All of the pictures in the presentation were projected onto a 72-in diagonal wide Samsung DLP 3D-enabled television for the participants' viewing.

Participants were randomly assigned to one of two conditions. The first condition was a no-mindset induction in which participants were simply asked to view the pictures with no further instruction (see Appendix F). The second condition was an action-

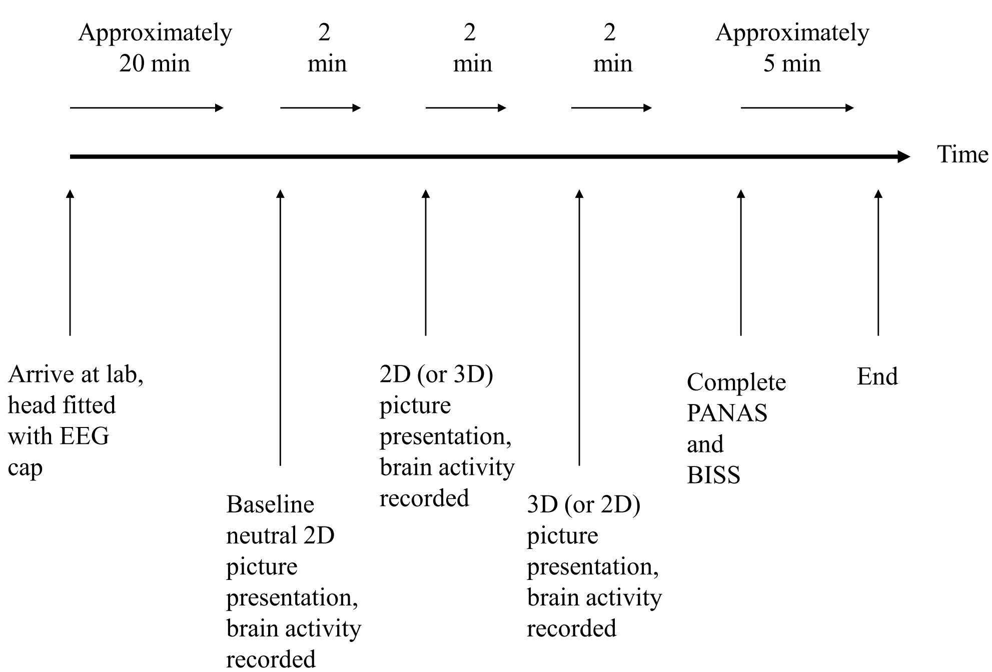


Figure 1. Timeline of activities during second lab visit.

oriented mindset induction. This experimental condition required that participants view the pictures of themselves with instruction to think of an appearance-related change that they could accomplish within the next three months. Specifically, they were instructed to think of the five most important steps to bring about that change and to think of when, where, and how those steps would be implemented while viewing the pictures (see Appendix G). These instructions were modelled on those of previous investigations on mindset (Harmon-Jones, Harmon-Jones, et al., 2008; Taylor & Gollwitzer, 1995).

Participants in each condition began by viewing a series of 24 emotionally neutral 2D images selected from the International Affective Picture System (IAPS; Lang et al., 2008). Each image was projected on the monitor for 5 s, totaling 2 min of baseline acclimatization to the experimental setting. Prior to viewing their own pictures, the participants were given oral instructions for the mindset induction via Skype. Thereafter, participants viewed a 2D image presentation block and a 3D image presentation block of themselves in a counterbalanced order across participants. Each presentation consisted of 24 body image photos, with each image presented for 5 s, totaling to 2 min of body image exposure. When all of the picture presentations were finished, the participants completed the PANAS (Appendix A) and the BISS (Appendix B). The participants subsequently continued with another unrelated experimental protocol and then were debriefed, thanked, and dismissed. Participants were awarded two bonus points toward their final Psychology course grade for their participation.

Recording of the Electroencephalogram (EEG)

This study used an EEG to measure participants' frontal asymmetry in alpha power (square volts = μV^2) during the picture presentations. EEG methodology for this study followed that of Hofmann (2007). The electrode placements complied with the International Electrode Placement System, using the following electrodes; left and right parietal (P3 and P4), left and right frontal (F3 and F4), left and right mastoid (A1 and A2), and midline central (Cz). Participants were fitted with a 128-channel Active Shield cap with electrodes fed through a 72-channel amplifier and into a computer with acquisition software to record the signals (all EEG apparatus was supplied by Advanced Neuro Technology, Enschede, the Netherlands). Using ElectroGel, efforts were made to bring impedance values below 10 kΩ. Cortical activity was continuously sampled during each of the three picture presentations for 2 min at 1024 Hz. Electro-oculogram channels were placed above, below, and on each side of the left eye to detect, and subsequently correct, EEG eye-movement artifacts.

The EEG recordings were prepared for statistical analysis following Hofmann (2007)'s procedure, which is consistent with established practices of calculating cortical asymmetry (Allen, Coan, & Nazarian, 2004). Artifacts resulting from eye blinks, movements, or muscle activity as identified by electro-oculogram electrodes were removed with the use of Advanced Neuro Technology software (Enschede, Netherlands). Analysis of the EEG data used a high-pass filter and a low cut-off frequency of 1 Hz, and the interval between epochs was 0.5 s. To extract alpha-band activity, a filter was used to reflect only the data encompassed within 8 – 13 Hz. A Hanning Window was used to extract epochs. To reduce data loss resulting from windowing, a Fast Fourier Transformation (FFT) partitioned the data into windows of 1 s duration with a 50% overlap. By taking the square of the FFT algorithm results, the calculation of a μV^2 value was made for each of the 1 s 50% overlapping windows. Next, the μV^2 values were averaged across epochs for each recording window. To account for the problem of positive skew typically found in these data, separate natural log (LN) transformations of the raw EEG alpha μV^2 output for left and right frontal and parietal hemispheres were conducted. As noted in Silva, Pizzagalli, Larson, Jackson, and Davidson (2002) and observed by Sutton and Davidson (1997) and Wheeler et al. (1993), the midfrontal F3/F4 electrode sites bear the greatest association with frontal dimensions of approach and avoidance while the parietal P3/P4 electrode sites do not. For this study, the P3/P4 sites served as control sites in order to test the hypotheses of the recordings from the F3/F4 sites. Calculations of difference scores for the homologous frontal (LN F4 − LN F3) and parietal (LN P4 − LN P3) electrodes were conducted by subtracting left from right recordings (LN (Right) − LN (Left)). In the interpretation of this metric, the assumption is made that alpha μV^2 is the inverse of cortical activity, thus decreases in μV^2 reflect increases in cortical activation. In this case, positive asymmetry difference scores indicate relatively greater left-sided cortical activation, zero difference represents symmetrical activity, and negative difference scores reflect greater right-sided activity (Allen et al., 2004). Means and standard deviations of the logarithmically transformed alpha μV^2 values for the EEG recordings of the three picture presentations are displayed in Table 1. These values are comparable to those of Hofmann (2007). In addition, Table 1 also contains the averaged logarithmically transformed frontal (F4 − F3) and parietal (P4 − P3) asymmetry scores for each recording.

Results

Data Preparation

Data were entered in SPSS v. 19 and inspected for missing responses. Regarding

Table 1

Means and Standard Deviations of EEG Recording Values Across Phases of the Experimental Procedure

	Order of picture presentation					
	2D/3D[a]			3D/2D[b]		
EEG sites	Baseline	1st exposure	2nd exposure	Baseline	1st exposure	2nd exposure
F3	2.15 (0.70)	2.14 (0.78)	2.16 (0.89)	2.51 (1.49)	2.29 (1.20)	2.51 (1.66)
F4	2.18 (0.68)	2.15 (0.75)	2.21 (0.86)	2.54 (1.48)	2.33 (1.19)	2.55 (1.65)
P3	2.30 (0.85)	2.16 (0.94)	2.24 (1.03)	2.61 (1.53)	2.24 (1.25)	2.52 (1.70)
P4	2.29 (0.86)	2.15 (0.92)	2.20 (1.03)	2.57 (1.51)	2.20 (1.22)	2.47 (1.67)
F4-F3	0.04 (0.10)	0.01 (0.11)	0.04 (0.12)	0.02 (0.11)	0.04 (0.08)	0.04 (0.09)
P4-P3	-0.01 (0.22)	-0.01 (0.20)	-0.04 (0.19)	-0.04 (0.18)	-0.04 (0.21)	-0.05 (0.21)

Note. The table shows means and standard deviations of logarithmically transformed EEG alpha power (μV^2) in the left and right frontal (F3, F4) and the left and right parietal (P3, P4) electrode sites, and the averaged logarithmically transformed frontal (F4 – F3) and parietal (P4 – P3) asymmetry scores during baseline, 1st exposure and 2nd exposure recordings during the experimental procedure.
[a] $n = 52$. [b] $n = 45$

self-report measures collected at preexposure, the BISS was missing one item from one individual and a total of nine items were missing from eight individuals on the PANAS. For measures collected at postexposure, two individuals each contributed two missing responses on the BISS and a total of 14 responses were missing across 12 individuals on the PANAS. Missing responses were replaced with prorated scores of each participant's mean on that particular BISS scale or PANAS subscale. One participant was unable to complete the postexposure PANAS and this participant's preexposure responses were brought forward as their postexposure responses.

Among EEG recordings, outliers were discovered in two parietal asymmetry scores from two separate individuals and two frontal asymmetry scores from one individual. Outliers were defined as *z* scores equivalent to or exceeding +3.29 or -3.29 (Field, 2009). These outliers were replaced by the next highest nonoutlier EEG value (Tabachnick & Fidell, 2001).

Questionnaire Data

Descriptive information regarding the psychometric variables at preexposure and postexposure are reported in Table 2. All of the psychometric variables exhibited good internal consistency as evidenced by Cronbach's $\alpha > .8$.

Analytic Strategy

The first hypothesis was investigated through profile analysis involving a multivariate approach to repeated measures (Tabachnick & Fidell, 2001) that employed a mixed model ANOVA run separately for the two EEG asymmetry indices of frontal asymmetry (FA) and parietal asymmetry (PA). Three between variables were as follows:

Table 2

Reliability Coefficients and Descriptive Statistics of the Psychometric Variables at Preexposure and Postexposure

Variables	Preexposure				Postexposure			
	M	*SD*	α	z_{Skewness}	*M*	*SD*	α	z_{Skewness}
BISS	5.45	1.35	.81	-1.46	5.50	1.43	.83	-2.03
PANAS-NA	16.22	5.33	.80	4.02	14.95	4.70	.80	5.09
PANAS-PA	29.59	7.29	.87	-1.43	28.89	6.20	.82	-0.35

Note. N = 97. BISS = Body Image States Scale; PANAS-NA = Positive and Negative Affect Schedule-Negative Affect; PANAS-PA = Positive and Negative Affect Schedule-Positive Affect.

(a) mindset (action-oriented vs. no-mindset), (b) order (2D/3D vs. 3D/2D), and (c) BISS (low vs. high by splitting the sample at *Mdn* = 5.34). The within factor was experimental phase (baseline, 1st exposure, 2nd exposure). Significant omnibus effects were followed up with simple effects and contrasts analyses.

The second hypothesis was examined using a moderated multiple regression analytic strategy that relied on the PROCESS macro for SPSS (Hayes, 2012). PROCESS utilizes an ordinary least squares path analytic framework to estimate conditional main effects (i.e., unstandardized regression coefficients) of variable X on Y, potential moderator effects for M and W, and associated tests of potential two-way (X*M, X*W, M*W) and three-way (X*M*W) interaction effects. The specific moderated moderation model tested in the present study is depicted in Figure 2. Consistent with recommended guidelines (Hayes, 2012), moderator variables were dichotomously coded as 0 and 1 and all predictors were mean centered before creating the interaction terms. Three separate blocks of regressions were run: one for each of three criterion Y variables, each

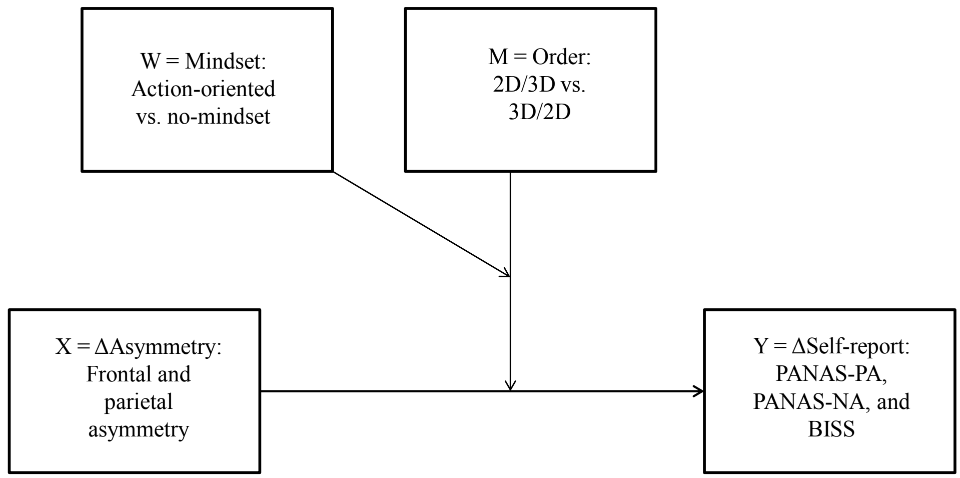


Figure 2. Moderated moderation model of the effects of EEG ΔAsymmetry upon ΔSelf-report as moderated by picture presentation order and mindset. M and W = moderator effects; X = predictor variable; Y = criterion variable; ΔAsymmetry = change in cortical asymmetry; ΔSelf-report = change score on self-reported variable (postexposure – preexposure); PANAS-PA = Positive and Negative Affect Schedule – Positive Affect; PANAS-NA = Positive and Negative Affect Schedule – Negative Affect; BISS = Body Image States Scale. Adapted from "PROCESS: A Versatile Computational Tool For Observed Variable Mediation, Moderation, and Conditional Process Modeling," by A.F. Hayes, 2012, retrieved from http://www.afhayes.com/public/process2012.pdf, p. 61.

representing change scores on self-report variables defined as postexposure − preexposure (ΔBISS, ΔPANAS-PA, ΔPANAS-NA) with the preexposure baseline value serving as the covariate in each case. Higher Δ scores reflect greater increases on the variable over the course of the body image exposure. Within each block, four separate regressions were run for each of two predictor X variables comprising change scores in EEG asymmetry indices PA and FA defined as (a) ΔAsymmetry at 1st exposure (1st

exposure − baseline) and (b) ΔAsymmetry at 2nd exposure (2nd exposure − 1st exposure). In total, 12 such regressions were run. In order to maintain experiment-wise type I error rate at $\alpha = .05$, the per-comparison error rate was Bonferroni adjusted such that the statistical significance level for each overall regression model was set at $\alpha/12 = .0042$.

Hypothesis 1

It was predicted that mindset would produce differential FA responses to the body image exposure. The three-between, one-within ANOVA failed to produce any significant between-groups effect. However, a statistical trend was observed for the Mindset*BISS interaction, $F(1, 89) = 3.60$, $p = .061$, $\eta^2 = .039$, which is depicted in Figure 3. The a priori contrast revealed that, collapsed across the three experimental phases, participants induced into an action-oriented mindset with low-BISS at preexposure exhibited a trend toward higher FA compared to their high-BISS counterparts, $F(1, 48) = 3.96$, $p = .052$, $\eta^2 = .076$.

The ANOVA on FA also produced only one within-subjects effect which involved the Order*Phase interaction, Wilks' $\Lambda = .92$, $F(2, 88) = 4.02$, $p = .021$, $\eta^2 = .08$, which is depicted in Figure 4. The results of two separate simple effects analyses revealed the FA response did not change over the body image exposure in the 3D/2D condition, Wilks' $\Lambda = .98$, $F(2, 43) = 0.41$, $p = .670$, $\eta^2 = .01$,whereas it did in the 2D/3D condition, Wilks' $\Lambda = .80$, $F(2, 50) = 6.08$, $p = .004$, $\eta^2 = .20$. Further, Bonferroni multiple comparisons revealed that FA decreased significantly ($p = .037$) during 1st exposure to 2D body pictures relative to baseline, which rebounded ($p = .011$) during the 2nd exposure involving 3D body pictures.

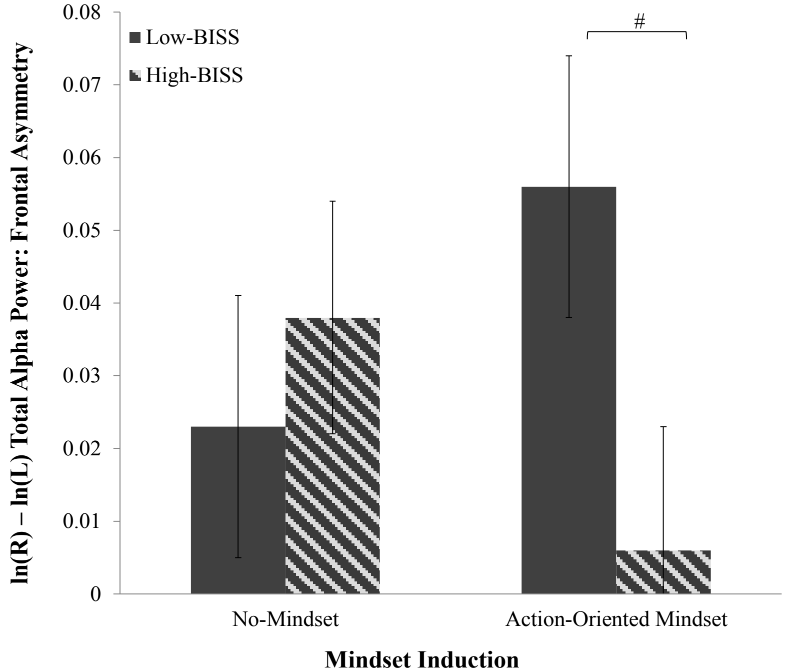


Figure 3. Frontal alpha asymmetry scores (8-13 Hz at F4-F3) plotted as a function of mindset induction and preexposure BISS score. Error bars represent standard errors. # $p = .052$.

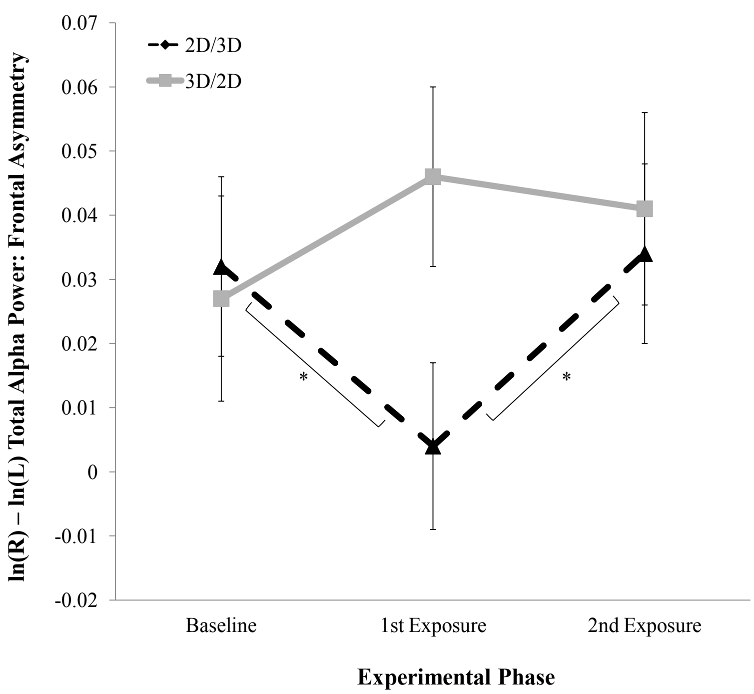


Figure 4. Frontal alpha asymmetry scores (8-13 Hz at F4-F3) plotted as a function of experimental phase and picture presentation order. Error bars represent standard errors. * $p < .05$.

The same ANOVA conducted on PA response revealed no statistically significant within-subjects effect. The only between-subjects effect to emerge was the Mindset*Order interaction, $F(1, 89) = 6.38$, $p = .013$, $\eta^2 = .07$, which is displayed in Figure 5. Simple effects analyses revealed the action-oriented mindset induction produced greater PA compared to the no-mindset induction among participants exposed to the 2D/3D order, $F(1, 50) = 9.59$, $p = .003$, $\eta^2 = .16$, but no difference in the 3D/2D order, $F(1, 43) = 0.44$, $p = .51$, $\eta^2 = .01$.

In sum, these analyses yielded various findings for cortical responses to the body image exposures. When induced into an appearance-related action-oriented mindset, individuals with poorer dispositional body image exhibited a tendency towards greater

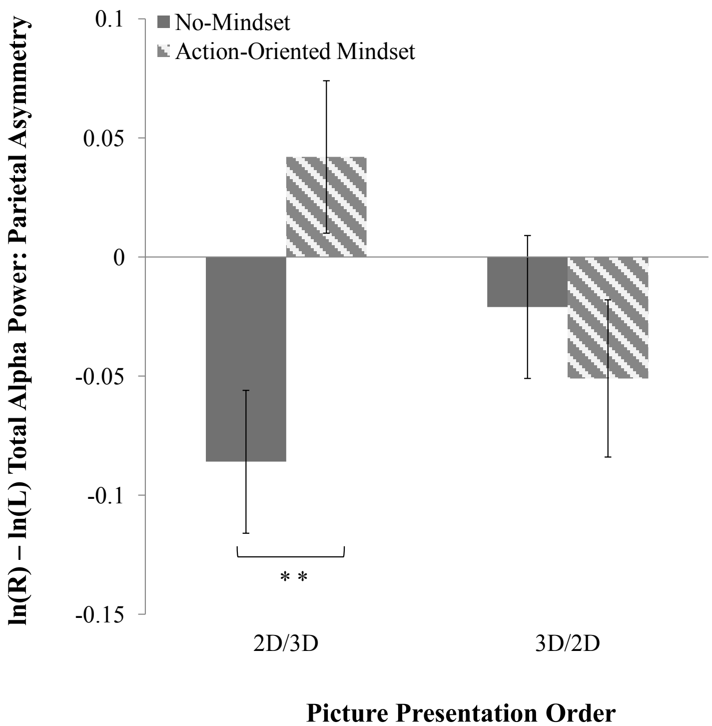


Figure 5. Parietal alpha asymmetry scores (8-13 Hz at P4-P3) plotted as a function of mindset induction and picture presentation order. Error bars represent standard errors. * * $p < .01$.

left frontal activity. In addition, frontal asymmetry was affected by picture presentation order. That is, individuals who viewed 2D pictures of themselves immediately following baseline experienced reductions in left frontal cortical activity which subsequently rebounded upon viewing the 3D pictures. Similar effects were not found when individuals viewed themselves in 3D prior to 2D. An unanticipated effect on parietal asymmetry also occurred. Individuals induced into an action-oriented mindset experienced greater left parietal activity compared to those in the no-mindset induction, but only when viewing 2D images followed by 3D images of themselves.

Hypothesis 2

Descriptive statistics for the change (Δ) scores on all three self-report and four EEG variables are displayed in Table 3. A two-between (order, mindset) one-within (experimental phase) ANOVA was run separately for each of the self-report variables. A main effect for experimental phase was observed in the analysis of ΔPANAS-NA, $F(1, 93) = 5.15$, $p = .026$, $\eta^2 = .052$. Participants reduced in PANAS-NA from pre- to postexposure; *M*s = 16.22 (*SD* = 5.33) versus 14.95 (*SD* = 4.70), respectively. No other significant effects emerged in any of the analyses of the self-report variables.

Note the wide range in variability on the change scores displayed in Table 3, indicative of the fact that as many participants increased as decreased on the variables over the course of the experiment. It was specifically predicted that increases in frontal asymmetry during the body image exposure would predict subsequent increases in positive affect and body image satisfaction. This hypothesis was evaluated using moderated multiple regression to predict each self-report measure in turn as depicted in Figure 2.

Table 3

Descriptive Statistics of Change (Δ) Scores

Variable	*M*	*SD*	Minimum	Maximum	z_{Skewness}
ΔBISS	0.06	1.21	-3.00	3.50	0.02
ΔPANAS-PA	-0.70	6.85	-19.00	17.00	-1.14
ΔPANAS-NA	-1.27*	5.48	-17.00	12.00	-0.81
Frontal asymmetry					
Δ1st exposure	-0.01	0.10	-0.30	0.32	0.74
Δ2nd exposure	0.01*	0.07	-0.17	0.17	-0.54
Parietal asymmetry					
Δ1st exposure	-0.00	0.19	-0.65	0.44	-1.12
Δ2nd exposure	-0.01	0.25	-0.68	0.70	1.28

Note. *N* = 97. BISS = Body Image States Scale; PANAS-PA = Positive and Negative Affect Schedule-Positive Affect; PANAS-NA = Positive and Negative Affect Schedule-Negative Affect; Δ = current – previous value; Δ1st exposure = 1st exposure – baseline; Δ2nd exposure = 2nd exposure – 1st exposure.
$* p < .05$.

Positive affect. Table 4 displays the results of the first block of four separate regression analyses predicting ΔPANAS-PA. The overall model of each analysis was statistically significant (*p*s < .0042) in each instance wherein the preexposure PANAS-PA was a significant covariate (*p*s < .001). Concerning the two models that tested the prediction of ΔAsymmetry at 1st exposure on ΔPANAS-PA, the only additional significant result was a main effect for ΔAsymmetry in parietal EEG, $t = 2.02$, $p = .046$, $r = .219$, $p = .031$. Increases in parietal asymmetry during first exposure were associated

Table 4

Moderated Multiple Regression Coefficients (Standard Error) for Predicting Change in PANAS-PA from Change in Hemispheric EEG Asymmetry (ΔAsymmetry) at Frontal and Parietal Regions

	1st exposure		2nd exposure	
Effect (X)	Frontal	Parietal	Frontal	Parietal
ΔAsymmetry	1.38 (6.70)	6.38 (3.15)*	16.23 (8.13)*	-0.70 (2.55)
Order	-0.96 (1.20)	-1.27 (1.14)	-0.36 (1.12)	-1.25 (1.13)
Mindset	0.11 (1.18)	0.41 (1.13)	0.44 (1.10)	-0.11 (1.11)
ΔAsymmetry*Order	5.20 (12.74)	0.73 (6.37)	-12.95 (16.03)	-2.16 (4.93)
ΔAsymmetry*Mindset	-0.49 (13.07)	1.14 (6.27)	-35.08 (16.15)*	-6.50 (5.15)
Order*Mindset	-1.08 (2.35)	-1.44 (2.26)	-2.36 (2.21)	-1.11 (2.23)
ΔAsymmetry*Order*Mindset	-13.81 (25.58)	-15.38 (12.76)	69.40 (32.42)*	22.86 (10.17)*
Preexposure covariate	-0.57 (0.08)***	-0.55 (0.08)***	-0.57 (0.08)***	-0.52 (0.08)***
Overall model				
R^2	.39	.42	.45	.42
$F(8, 88)$	7.10***	8.08***	9.13***	8.08***

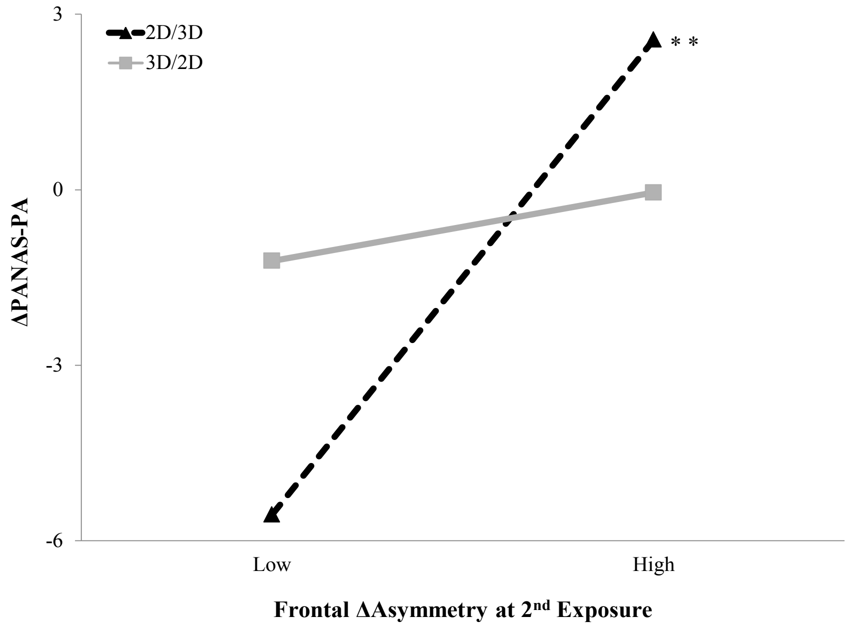
Note. PANAS-PA = Positive and Negative Affect Schedule – Positive Affect.
* $p < .05$. *** $p < .0042$.

with increases in positive affect over the course of the entire body image exposure regardless of mindset or order conditions.

With respect to the 2nd exposure, a significant main effect for ΔAsymmetry in frontal EEG was observed, $t = 2.00$, $p = .049$, qualified by its two-way interaction with mindset, $t = -2.17$, $p = .033$, which was further qualified by the three-way interaction of ΔAsymmetry*Mindset*Order, $t = 2.14$, $p = .035$, $\Delta R^2 = .029$, as depicted in Figure 6. Tests of the two conditional effects of the ΔAsymmetry*Order two-way interaction at each level of the mindset variable revealed it was significant for the no-mindset induction, β = -48.72 (*SE* = 23.13), $t = -2.11$, $p = .038$, but not for the action-oriented mindset induction, β = 20.68 (*SE* = 22.48), $t = 0.92$, $p = .360$. Simple effects analysis revealed only one significant slope for participants in the 2D/3D no-mindset condition, β = 56.91 (*SE* = 18.52), $t = 3.07$, $p = .002$, the scatterplot for which is displayed in Figure 7. Within this experimental condition, the increases in left frontal asymmetry that occurred while participants viewed themselves in 3D relative to the previous 2D exposure was positively associated with increases in PANAS-PA at postexposure relative to preexposure. In short, increased left frontal EEG was associated with increased positive affect only among participants transitioning from 2D to3D pictorial images of themselves unencumbered by any experimenter instruction to engage in an action-oriented mindset to alter their appearance (see Figure 6, top panel).

The same three-way interaction of ΔAsymmetry*Mindset*Order was significant for parietal EEG at 2nd exposure, $t = 2.25$, $p = .027$, $\Delta R^2 = .033$. However, neither of the two-way ΔAsymmetry*Order interactions at each level of mindset, nor any of the four simple slopes, proved to be significant, *p*s > .05. Nevertheless, the trajectories of the

No-Mindset Induction



Action-Oriented Mindset Induction

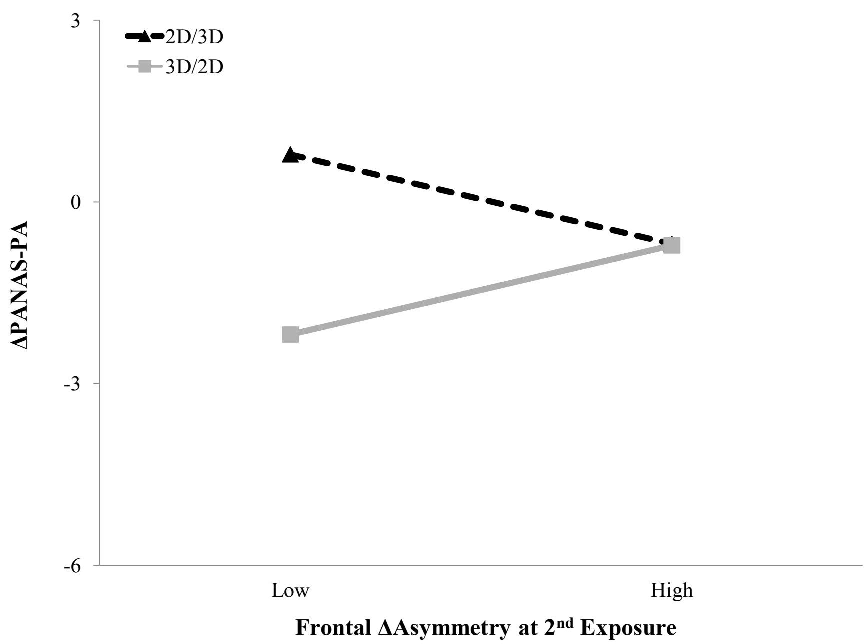


Figure 6. ΔPANAS-PA plotted as a function of picture presentation order and frontal ΔAsymmetry at 2nd exposure for the no-mindset (top panel) and action-oriented mindset (bottom panel) inductions.
* * $p < .01$.

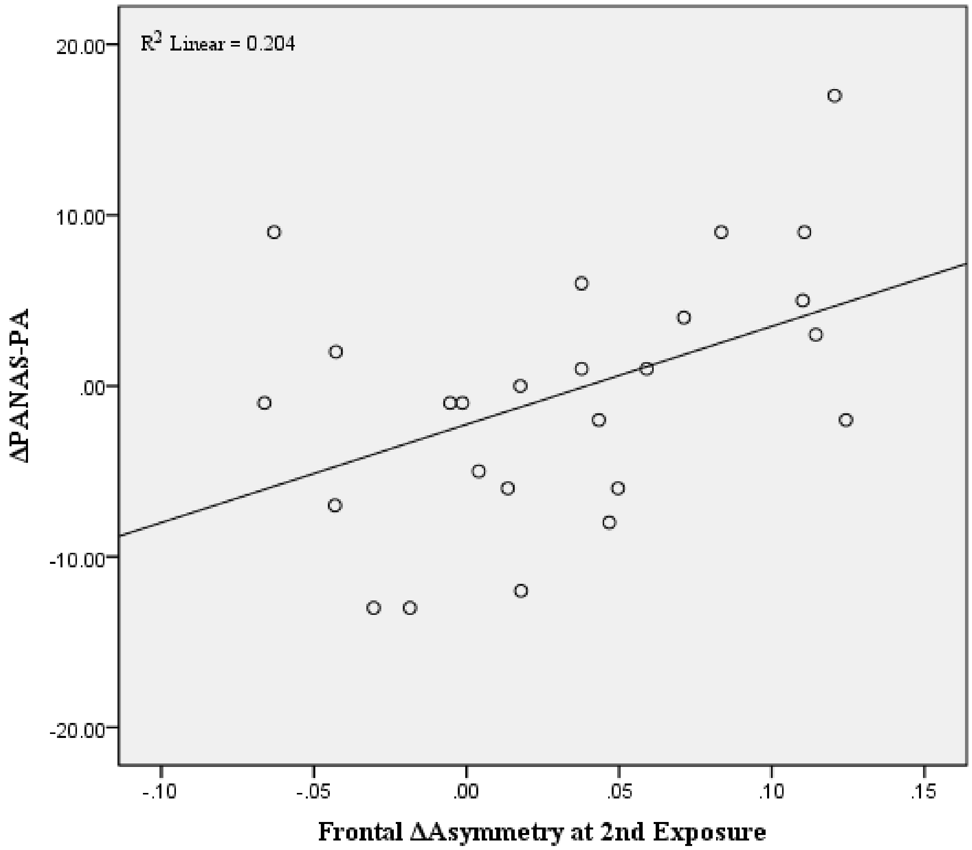
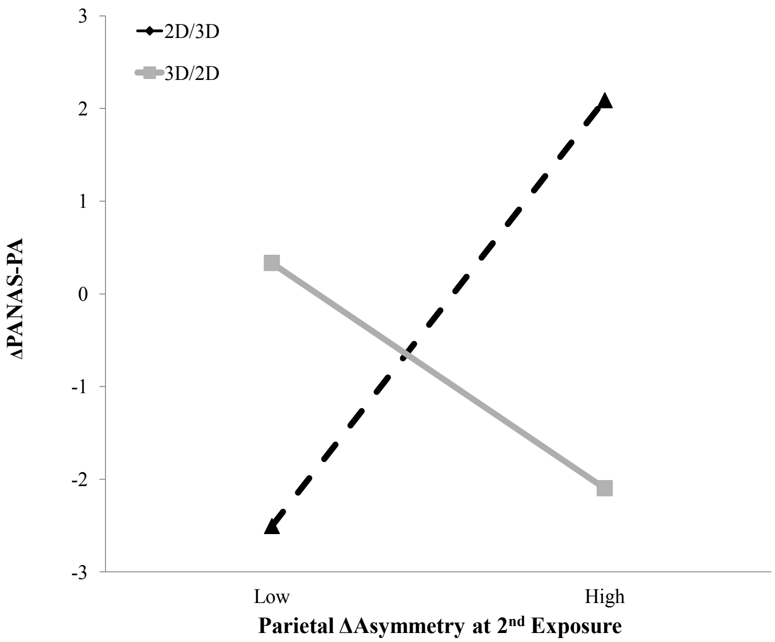


Figure 7. Scatterplot of ΔPANAS-PA as a function of frontal ΔAsymmetry at 2^{nd} exposure among participants in the 2D/3D no-mindset condition.

slopes mirrored that of the Figure 6 (see Figure 8).

Negative affect. Table 5 displays the regression results for predicting ΔPANAS-NA. As with positive affect, the overall regression model was significant (*p*s < .0042) as was the preexposure PANAS-NA covariate in each of the four regressions, *p*s < .05. In addition, two of the regressions revealed the same ΔAsymmetry*Mindset interaction term to be significant for parietal EEG at 1^{st} exposure, $t = -2.08$, $p = .041$, and at 2^{nd} exposure,

No-Mindset Induction



Action-Oriented Mindset Induction

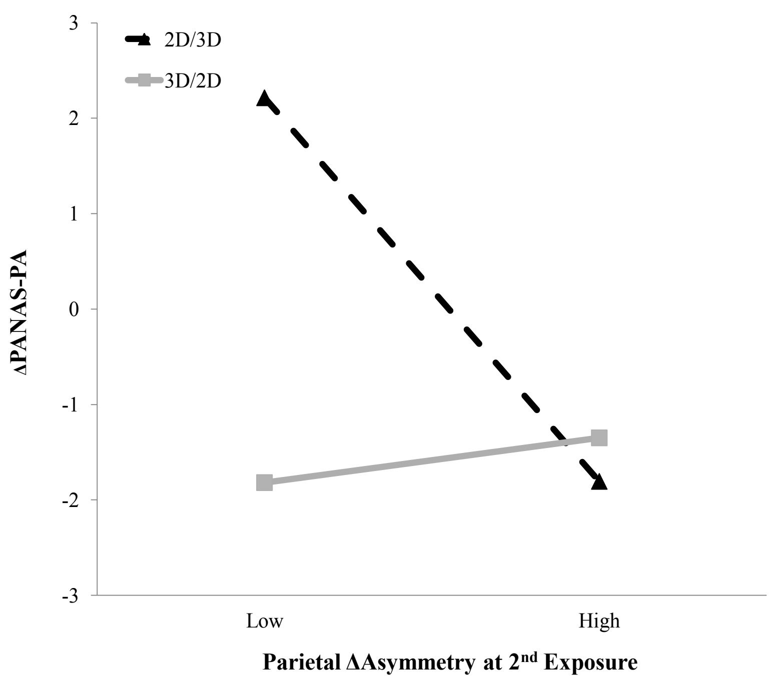


Figure 8. ΔPANAS-PA plotted as a function of picture presentation order and parietal ΔAsymmetry at 2nd exposure for the no-mindset (top panel) and action-oriented mindset (bottom panel) inductions.

Table 5

Moderated Multiple Regression Coefficients (Standard Error) for Predicting Change in PANAS-NA from Change in Hemispheric EEG Asymmetry (ΔAsymmetry) at Frontal and Parietal Regions

	1st exposure		2nd exposure	
Effect (X)	Frontal	Parietal	Frontal	Parietal
ΔAsymmetry	-6.12 (5.13)	1.94 (2.48)	-5.65 (6.74)	-0.03 (2.01)
Order	0.16 (0.92)	0.08 (0.88)	-0.31 (0.92)	-0.02 (0.88)
Mindset	1.12 (0.92)	1.08 (0.88)	0.94 (0.92)	0.94 (0.88)
ΔAsymmetry*Order	4.83 (9.93)	-4.28 (5.01)	-12.23 (13.53)	3.01 (3.89)
ΔAsymmetry*Mindset	7.89 (10.22)	-10.17 (4.90)*	-6.33 (13.42)	9.46 (4.05)*
Order*Mindset	-1.82 (1.85)	-1.68 (1.77)	-1.30 (1.84)	-1.54 (1.76)
ΔAsymmetry*Order*Mindset	-15.34 (19.90)	7.36 (9.99)	-3.98 (26.68)	-6.26 (7.80)
Preexposure covariate	-0.63 (0.08)***	-0.64 (0.08)***	-0.64 (0.09)***	-0.68 (0.08)***
Overall model				
R^2	.41	.45	.41	.44
$F(8, 88)$	7.73***	8.97***	7.67***	8.58***

Note. PANAS-NA = Positive and Negative Affect Schedule – Negative Affect.
* $p < .05$. *** $p < .0042$.

$t = 2.33$, $p = .022$. Given that these two-way interactions were not qualified by a three-way interaction with order, the latter variable was dropped in a rerun version of the regression model in order to further explore the two simple slopes comprised within these two-way interactions. Concerning ΔAsymmetry for parietal EEG at 1st exposure, the ΔAsymmetry*Mindset interaction again was significant, $t = -2.42$, $p = .018$, $\Delta R^2 = .036$, which is displayed in Figure 9. The slope was significant for participants in the no-mindset induction, β = 8.27 (*SE* = 3.36), $t = 2.46$, $p = .016$, but not for counterparts in the action-oriented mindset induction, β = -3.07 (*SE* = 3.31), $t = -0.93$, $p = .357$. Increases in ΔAsymmetry for parietal EEG at 1st exposure is associated with increases in negative affect in the no-mindset induction.

With respect to ΔAsymmetry for parietal EEG at 2nd exposure, the rerun regression with order dropped again produced a significant ΔAsymmetry*Mindset interaction, $t = 2.20$, $p = .030$, $\Delta R^2 = .030$, which is displayed in Figure 10. The slope was marginally significant for participants in the action-oriented mindset induction, β = 4.55 (*SE* = 2.37), $t = 1.92$, $p = .058$, but not for counterparts in the no-mindset induction, β = -3.11 (*SE* = 2.56), $t = -1.22$, $p = .227$. This time, increases in ΔAsymmetry for parietal EEG at 2nd exposure was associated with increases in negative affect in the action-oriented mindset induction.

Body image satisfaction. Table 6 displays the results of the four regressions predicting ΔBISS. The only analysis to produce significant effects beyond the preexposure BISS covariate effect was the ΔAsymmetry for parietal EEG at 2nd exposure; specifically, a three-way interaction of ΔAsymmetry*Mindset*Order, $t = 2.69$, $p = .009$, $\Delta R^2 = .062$, as depicted in Figure 11. Tests of the two conditional effects of the

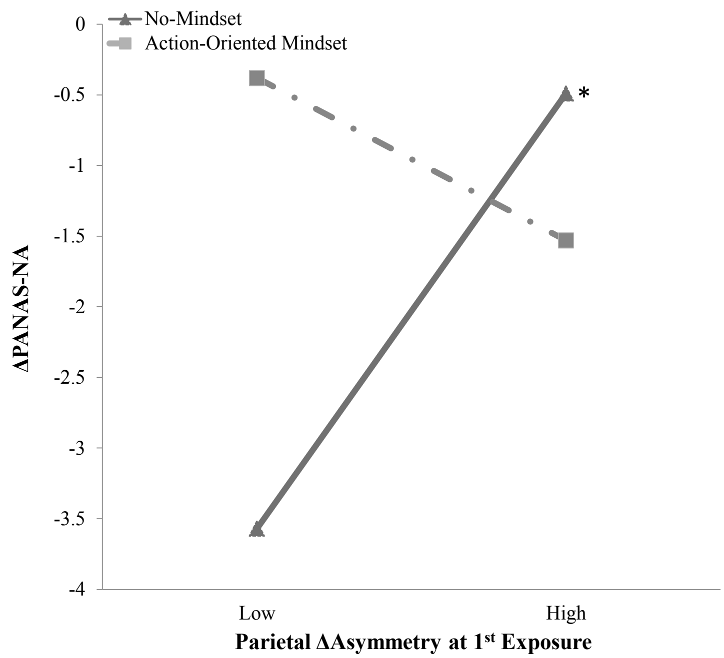


Figure 9. ΔPANAS-NA plotted as a function of mindset induction and parietal ΔAsymmetry at 1st exposure.
* $p < .05$.

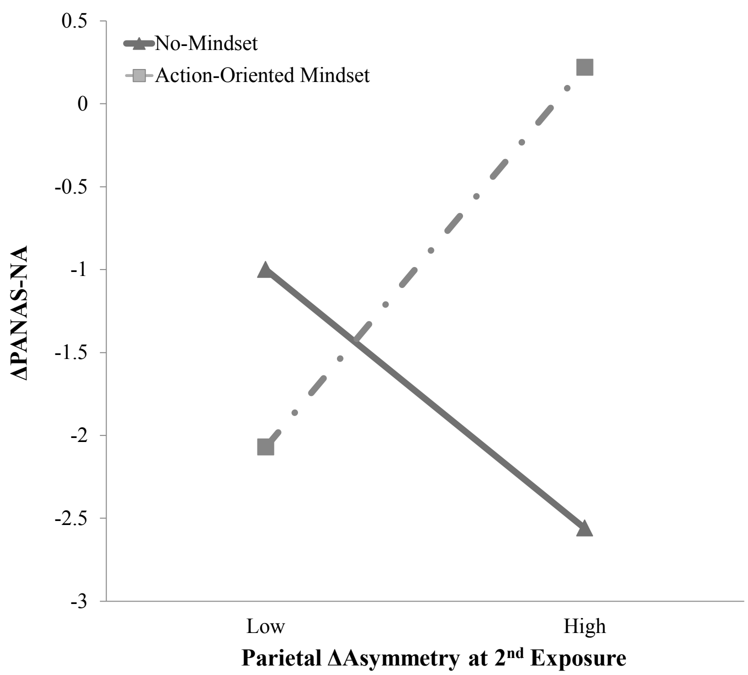


Figure 10. ΔPANAS-NA plotted as a function of mindset induction and parietal ΔAsymmetry at 2nd exposure.
× $p = .058$.

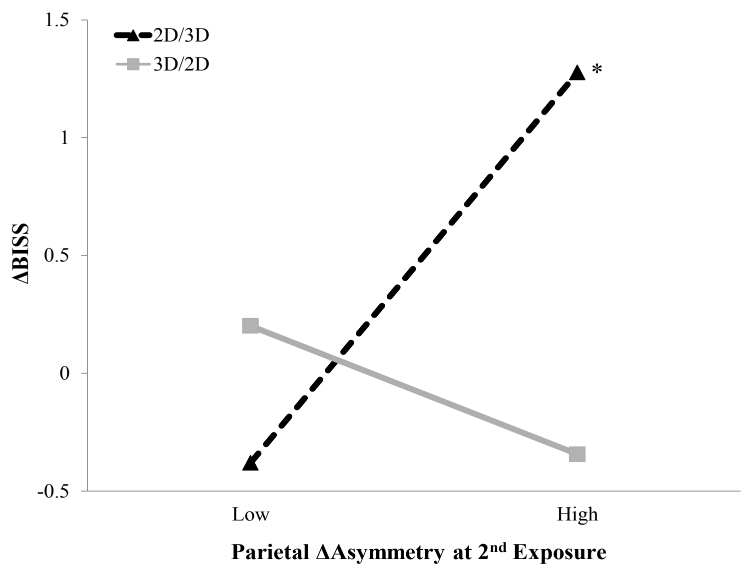
Table 6

Moderated Multiple Regression Coefficients (Standard Error) for Predicting Change in BISS from Change in Hemispheric EEG Asymmetry (ΔAsymmetry) at Frontal and Parietal Regions

	1st exposure		2nd exposure	
Effect (X)	Frontal	Parietal	Frontal	Parietal
ΔAsymmetry	0.79 (1.31)	-0.23 (0.66)	-0.80 (1.77)	0.09 (0.52)
Order	-0.26 (0.24)	-0.23 (0.24)	-0.24 (0.24)	-0.31 (0.23)
Mindset	-0.26 (0.24)	-0.22 (0.24)	-0.12 (0.24)	-0.21 (0.22)
ΔAsymmetry*Order	2.98 (2.53)	1.49 (1.34)	-2.55 (3.47)	-1.55 (1.00)
ΔAsymmetry*Mindset	0.31 (2.60)	1.26 (1.34)	-2.51 (3.50)	-2.27 (1.05)*
Order*Mindset	0.34 (0.47)	0.45 (0.48)	0.33 (0.48)	0.41 (0.45)
ΔAsymmetry*Order*Mindset	8.26 (5.10)	0.63 (2.68)	5.42 (6.95)	5.48 (2.04)**
Preexposure covariate	-0.35 (0.09)***	-0.32 (0.09)***	-0.34 (0.09)***	-0.29 (0.09)***
Overall model				
R^2	.22	.19	.18	.25
$F(8, 88)$	3.10***	2.57*	2.47*	3.73***

Note. BISS = Body Image States Scale.
* $p < .05$. ** $p < .01$. *** $p < .0042$.

No-Mindset Induction



Action-Oriented Mindset Induction

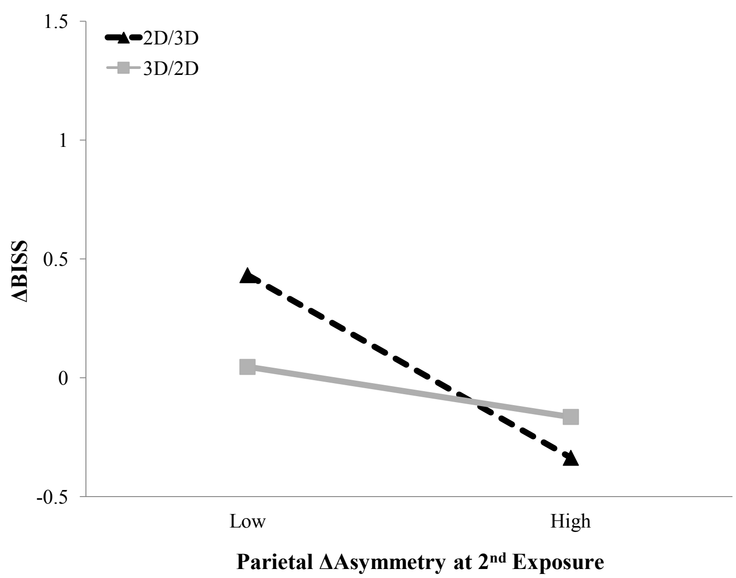


Figure 11. ΔBISS plotted as a function of picture presentation order and parietal ΔAsymmetry at 2nd exposure for the no-mindset (top panel) and action-oriented mindset (bottom panel) inductions.
* $p < .05$.

ΔAsymmetry*Order two-way interaction at each level of the mindset variable revealed it was significant for the no-mindset induction, β = -4.37 (*SE* = 1.54), *t* = -2.83, *p* = .006, but not for the action-oriented mindset induction, β = 1.11 (*SE* = 1.30), *t* = 0.85, *p* = .397. Simple effects analysis revealed only one significant slope, that for participants in the 2D/3D no-mindset condition, β = 3.29 (*SE* = 1.35), *t* = 2.44, *p* = .017, the scatterplot for which is depicted in Figure 12. Within this condition, the increases in left parietal asymmetry that occurred while participants viewed themselves in 3D relative to the

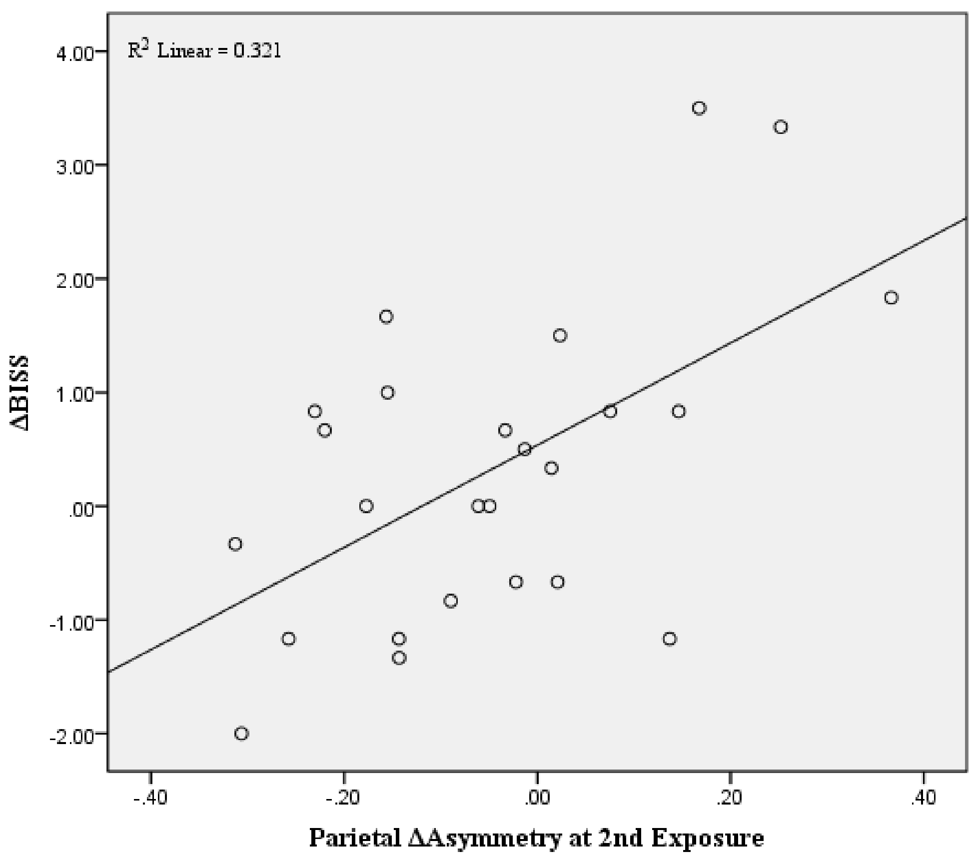


Figure 12. Scatterplot for ΔBISS as a function of parietal ΔAsymmetry at 2nd exposure among participants in the 2D/3D no-mindset condition.

previous 2D exposure was positively associated with increases in BISS at postexposure relative to preexposure. In short, increased left parietal EEG was associated with increased body image satisfaction only among participants transitioning from 2D to 3D pictorial images of themselves unencumbered by any experimenter instruction to engage in an action-oriented mindset to alter their appearance (see Figure 11, top panel).

Discussion

The main purpose of this study was to investigate the ability of an appearance-related action-oriented mindset induction to shift cortical activity towards greater left hemispheric activation in the frontal lobe and to examine the possibility of body image satisfaction and the order of picture presentation dimensionality as moderators of such an effect. Also of interest was the prediction of state changes in affect and body image satisfaction from state changes in cortical activity during a body image exposure. These investigations follow from previous observations of a shift towards greater right frontal activity when viewing 3D images of oneself compared to baseline that was not found during 2D body image exposures (Storeshaw & Davis, 2010). Discussion of this study's findings will be partitioned into two sections. First, the findings pertaining to frontal asymmetry will be examined. Second, the findings pertaining to parietal asymmetry will be discussed, beginning with a brief review of the literature on parietal activity in order to provide potential explanations for the present results.

Frontal Asymmetry

The hypothesized effect of mindset induction on cortical activity was found, but it was moderated by body image satisfaction. The action-oriented mindset induction only affected those participants with poor dispositional body image wherein they demonstrated a tendency towards greater left frontal asymmetry over the course of the entire body image exposure compared to those who had better body image (see Figure 3). Since greater left frontal activity is suggestive of approach motivation, the effect of the action-oriented mindset induction may be interpreted as an increased motivation to change one's appearance among individuals who experience greater body dissatisfaction. These individuals are primed by their negative body image to desire change the most and, thus, most susceptible to this personally relevant experimental induction.

Personal relevance of a stimulus and brain activity has previously been investigated in terms of action and picture viewing (Harmon-Jones, Lueck, Fearn, & Harmon-Jones, 2006). When a particular stimulus is personally relevant to an individual along with an expectation that an individual could act, they will exhibit greater left frontal activity. For example, one study showed that those opposed to racism had greater left frontal activity when exposed to pictures depicting racism (Harmon-Jones et al., 2006). The present study produced findings in which participants with negative body image, upon being induced into a state of mind that promoted action on a personally relevant topic, evidenced greater left frontal activity. In addition, in a study of dispositional defensiveness and anxiety, findings suggested that there is a relationship between asymmetry and personality traits that is only evident in personality-trait relevant situations (Crost et al., 2008). Along this line of thought, it can be reasoned that the appearance-related action-oriented mindset induction would provide a personally relevant situation to those who are predisposed to negative body image.

Further support of the effect of an action-oriented mindset induction on cortical activity among those with a negative body image comes from other studies of brain activity and body image exposures. In a study by Uher et al. (2005), fMRI was used to look at brain activity. When viewing images of various overweight, normal, and underweight body shapes, there was a positive correlation between aversion ratings of the images and right medial apical prefrontal activity in eating disordered patients, a population susceptible to negative body image. These body image exposures, however, were not their own bodies. Another study found that when exposed to video images of their own bodies, patients with anorexia nervosa experienced a hyperactivation of the right frontal area (Beato-Fernández et al., 2009). In these studies, a population characterized by negative body image exhibited greater right frontal activity during body image exposures. In contrast, our study demonstrated an association of greater left frontal activity among those with negative body image when induced into an action-oriented mindset. Due to these differences in patterns of brain activity across studies among individuals with negative body image, it is possible that the greater left, as opposed to right, frontal activity in our study can be attributed to the action-oriented mindset induction.

It was hypothesized that the effect of mindset induction on frontal asymmetry would be moderated by picture presentation dimensionality. Results indicated, however, that picture presentation order affected frontal asymmetry regardless of mindset induction. That is, individuals who viewed 2D pictures of themselves immediately following baseline experienced reductions in left frontal cortical activity that subsequently rebounded upon viewing the 3D pictures. Similar effects were not found when individuals viewed themselves in 3D prior to 2D. It is possible that this reflects a shift in cortical activity as a consequence of a successive contrast effect that occurs upon viewing oneself in a novel fashion (3D) after having previously viewed oneself in a familiar fashion (2D). A contrast effect occurs when the judgment that is made of one stimulus acts as a frame of reference to a subsequent stimulus (Novemsky & Ratner, 2003). A comparison is made between the two stimuli and, in general, it has been found that people typically prefer a sequence of experiences that improves (e.g., becomes more pleasurable) over time as opposed to those that decline (e.g., become less pleasurable; Loewenstein & Prelec, 1993). Furthermore, this improving sequence of contrast produces more favourable evaluations (Tversky & Griffin, 1991). This preference may have implications for picture presentation order dimensionality of 2D/3D versus 3D/2D presentation, with the 2D/3D presentation order representing the sequence of improving experience. The 3D presentation would be considered the more pleasurable of the two presentations due to its novelty. In the present study, the novelty of the 3D body image exposures is particularly noteworthy in light of the fact that 97% of the sample had never seen 3D pictorial images of themselves. This element of novelty might naturally impel individuals to approach such stimuli, as evidenced by rebounding greater left frontal activity observed in the present study.

Partial support was provided for the hypothesis that increases in frontal asymmetry would predict increases in positive affect. Among those who did not undergo the mindset induction, greater increases in left frontal activity when transitioning from 2D to 3D pictures of themselves predicted subsequent increases in positive affect. This finding can be understood from the vantage point of both the valence model and the motivational model of frontal asymmetry. The valence model asserts that greater left frontal activity is associated with positive affect. It is possible that the improving sequence of the contrast effect (from familiar 2D to novel 3D) promoted increased positive affect. On the other hand, Harmon-Jones, Harmon-Jones, Abramson, and Peterson (2009) suggested that PANAS-PA assesses approach motivation, or positive activation, in addition to positive affect, and this approach motivation is present even in negative circumstances. In addition, it is possible that the novelty of the 3D image demonstrates increased approach motivation as evidenced by increased left frontal activity among this group which would theoretically experience less approach motivation overall due to the lack of an induced action-oriented mindset.

Parietal Asymmetry

Prior to discussion of the unanticipated findings of the present study that pertain to parietal asymmetry, a brief review of the literature on parietal activity is warranted.

Parietal asymmetry is typically investigated alongside frontal asymmetry in studies of emotion (e.g., Davidson et al., 1979). Heller (1993) claims that the right parietal area is implicated in autonomic and behavioural arousal modulation, in which a greater amount of right parieto-temporal activity is related to greater arousal and emotional intensity and, conversely, a lower amount of right parieto-temporal activity indicating lower arousal levels. Stewart, Towers, Coan, and Allen (2011) also noted that greater right parietal activity depends on state arousal. Another study found that regardless of emotional valence, those who exhibited greater right parietal asymmetry compared to those with greater left parietal asymmetry experienced more intense positive and negative affect in response to pictures that were positive and negative in nature (Hagemann et al., 1998). In terms of asymmetrical parietal activity, Heller, Nitschke, Etienne, and Miller (1997) noted that it might be the relative hemispheric activation that is responsible for anxious arousal as opposed to only the level of right parietal activity, with Stewart et al. echoing this observation. These findings may have implication for mindset induction in terms of behavioural arousal and affect.

The right hemisphere has also been implicated in spatial attention and processing, especially in response to sensory stimuli in the environment (Culham, Cavina-Pratesi, & Singhal, 2006; Heller, 1993). Furthermore, Schmidt and Trainor (2001) suggested that parietal effects might only occur when maintaining an external focus of attention to external stimuli as opposed to an internal focus. Findings by Weissman and Woldorff (2005) indicated that the right and left parieto-temporal areas were respectively implicated in wide and narrow attentional spotlights. This study also noted that greater activity in the left parieto-temporal region was associated with local as opposed to global processing. Furthermore, Bardi, Kanai, and Walsh (2010) also found differential hemispheric asymmetry in which the left parietal lobe was associated with local elements, and the right parietal lobe was associated with global forms, of complex visual stimuli. It was also found that attention to stimuli of low salience was associated with left parietal activity, whereas attention to stimuli of high salience was associated with right parietal activity.

These aspects of parietal activity and their role in spatial attention and processing may have implications for the mindset inductions of the current study; specifically, the action-oriented mindset induction required that participants focus on a particular part of the body while the no-mindset induction did not. As a result, those in the no-mindset induction may have experienced a more external and global focus of attention on the entire body with less salience while those in the action-oriented mindset induction may have experienced a more internal and local focus of attention on a particular body part with greater salience of the stimuli due to instruction to attend to that part.

Parietal activity has also been implicated in processing binocular disparity. Fischmeister and Bauer (2006) found that when transitioning from monoscopic to stereoscopic images, greater activity in Brodmann area 7 of the parietal cortex was observed, particularly in the left hemisphere. These authors noted that this area serves an important function while integrating cues of binocular disparity. This finding may have implications for the present study's discoveries of the role of parietal activity in picture presentation order dimensionality.

Unfortunately, a review of the literature on brain activity and body image exposures did not unearth any studies among nonclinical populations. As a result, the reviewed literature of body image and brain activity is confined to examinations of individuals with eating disorders, a population who characteristically experience body image disturbance. Ehrsson, Kito, Sadato, Passingham, and Naito (2005) found left parietal lobe activity during manipulation of illusory perception of parts of one's body, suggesting that body image is processed in the brain through integration of somatosensory system signals. Hyperactivation of the left parietal region when exposed to an image of one's own body has been documented among women with anorexia nervosa (Beato-Fernández et al., 2009). It was also found that changes in body distortion among these women during exposure were associated with an increase in left parietal activity. In contrast, reduced activity was found in the left parietal region among women with anorexia nervosa in a study by Vocks et al., (2010), which was attributed to avoidance behaviour during body exposure. These findings serve as a basis in order to examine the effect of parietal activity on body image satisfaction.

In the present study, an unexpected effect of mindset induction and picture presentation order was observed in parietal lobe asymmetry (see Figure 5). While viewing 2D followed by 3D images of themselves, greater left parietal activity was observed among those induced into an action-oriented mindset compared to those without a mindset induction. There are a number of potential explanations of this effect, as parietal activity has been associated with order of dimensional image presentation, behavioural arousal, and attentional processing. The involvement of parietal activity, especially in the left hemisphere, when transitioning from 2D to 3D images has been previously documented (Fischmeister & Bauer, 2006). Greater left parietal activity, however, has only been found in the present study among those induced into an action-oriented mindset who viewed the 2D presentation followed by the 3D presentation. It is possible that the effect found here may be due to the fact that the action-oriented mindset elicited a narrow attentional spotlight and a more local focus on a particular body part, producing greater left parietal activity (Bardi et al., 2010; Weissman & Woldorff, 2005), while processing binocular disparity further produced left parietal activity (Fischmeister & Bauer, 2006). These two factors may have interacted to produce the finding for a significantly greater amount of activity in the left parietal lobe in this condition.

This study also explored state changes in cortical activity as a predictor of state changes in affect and body image satisfaction. These analyses produced a number of parietal asymmetry findings. In terms of affect, greater increases in left parietal asymmetry upon viewing the first picture presentation of oneself predicted increased positive affect among all individuals. In addition, changes in negative affect were also predicted by changes in parietal activity. Among those in the no-mindset induction, greater increases in left parietal asymmetry upon viewing the first body image exposure were associated with increases in negative affect. On the other hand, among those induced into an action-oriented mindset, greater increases in left parietal asymmetry upon the second body exposure were associated with increases in negative affect. These findings are contrary to what is known about affect and parietal activity. Previous research posits that parietal activity is involved in emotional intensity, in which greater right parietal activity is associated with greater emotional intensity (Hagemann et al., 1998; Heller, 1993). While the present findings demonstrate that parietal activity is unrelated to the particular valence of emotion (as with Hagemann et al., 1998), the pattern of left parietal asymmetry suggests increased intensity of the emotion in question as opposed to a pattern of greater right asymmetry as would be expected. One possible explanation for this discrepancy may be that the PANAS assesses the extent to which an individual is experiencing a particular mood dimension of positive and negative affect as opposed to a particular emotion (Watson et al., 1988).

The prediction of changes in negative affect in regards to changes in parietal asymmetry are also intriguing: It appears that an action-oriented mindset induction somehow delays a parietal shift towards greater left activity which predicts negative affect while a no-mindset induction does not delay this cortical shift while still predicting negative affect. In terms of behavioural arousal, greater left parietal activity would suggest lack of arousal. Perhaps both experimental groups experienced negative affect of a low arousal nature which was delayed in those induced into an action-oriented mindset that needed to maintain a mindset towards behavioural arousal, but became fatigued after the first presentation. It is possible that viewing the same pictures a second time, although in a different dimension, would cause those planning changes to simply view the pictures and give up making plans. These explanations, however, are only speculations at present.

It was also hypothesized that increases in left frontal activity would be associated with increases in body image satisfaction. This finding was not supported. It was, however, found that increases in body image satisfaction was predicted by increases in left parietal activity only when individuals without a mindset induction were transitioning from 2D to 3D pictures of themselves. This finding appears contradictory to previous research in which greater left parietal activity was documented amongst a population that is characterized by poor body image (Beato-Fernández et al., 2009; Vocks et al., 2010). However, those findings may not be directly generalizable to the present sample due to the possibility of structural differences in the brain among the clinical population that may contribute to the observed parietal effect. Perhaps it is the combination of lower behavioural arousal among individuals in the no-mindset induction as well as the integration of binocular disparity cues that are associated with left parietal activity. In turn, it is possible that the improving contrast effect sequence of transitioning from a traditional 2D to a novel 3D picture allowed these participants to focus more on the enjoyment of the novel 3D image, leading to improved body image evaluations (e.g., Tversky & Griffin, 1991). Perhaps the focus on an appearance-related change detracted from such enjoyment among those in the action-oriented mindset induction. Alternatively, Vocks et al., (2010) attributed reduced left parietal activity to avoidance behaviour during a body image exposure. It is possible that those in a no-mindset induction, who are not instructed to attend vigilantly to their image, found that a transition to a 3D image intensified their body image satisfaction or dissatisfaction. These changes in body image satisfaction may have led to their attendance or avoidance of the image which would be reflected by the changes in parietal asymmetry.

Limitations

There are a few limitations to this study. Although those in the action-oriented mindset induction were asked to plan changes to their appearance, it was not verified if they actually engaged in this process or if they maintained the mindset induction throughout the totaled four min of body image exposure. It may have been useful to include a thought sampling aspect to the study in order to assess adherence to the experimental protocol.

The present study also failed to replicate the findings regarding frontal asymmetry and 3D picture viewing than those found by Storeshaw and Davis (2010). Based on the previous results, the present study should have observed greater right frontal asymmetry when exposed to 3D body images among those in the no-mindset induction. This may be due to several methodological factors. First, the present study included dimensionality of picture presentation order as a variable in the analysis whereas Storeshaw and Davis did not. Furthermore, Storeshaw and Davis only used a small sample of participants, and participants were viewing pictures of their romantic partners in addition to their own. As a result, the two studies cannot be directly compared.

Future Directions

With 3D technology becoming increasingly common and available, the study of the effect of 3D images on cortical activity, body image, and affect is a worthwhile pursuit. A mindset induction could be a powerful tool in understanding the effect of cognition and motivation on body image satisfaction and affect. Furthermore, the change in brain activity could be used as an additional and objective indicator if it proves predictive of changes in body satisfaction and affect. It may also be of interest to investigate the effect of alternative mindset inductions on cortical activity, body image satisfaction, and affect. An example of such a mindset induction may be an induction in which individuals are asked to attend to a particular quality about their appearance that they like. It is possible that this frame of mind may assist in improving body image dissatisfaction during body image exposures while undergoing such a positive and accepting mindset induction.

At present, this study has provided evidence for the effect of mindset induction on cortical activity as moderated by dimensionality of picture presentation order and body image satisfaction. In addition, it has provided intriguing findings for state changes in cortical asymmetry as a predictor of state changes in body image satisfaction and affect.

References

Adams, G., Turner, H., & Bucks, R. (2005). The experience of body dissatisfaction in men. *Body Image, 2,* 271-283. doi:10.1016/j.bodyim.2005.05.004

Ahern, G. L., & Schwartz, G. E. (1985). Differential lateralization for positive and negative emotion in the human brain: EEG spectral analysis. *Neuropsychologia, 23*, 745–755.

Allen, J.B., Coan, J.A., & Nazarian, M. (2004). Issues and assumptions on the road from raw signals to metrics of frontal EEG asymmetry in emotion. *Biological Psychology*, *67*, 183-218. doi: 10.1016/j.biopsycho.2004.03.007

Amodio, D.M., Devine, P.G., & Harmon-Jones, E. (2007). A dynamic model of guilt: Implications for motivation and self-regulation in the context of prejudice. *Psychological Science, 18,* 524-530. doi: 10.1111/j.1467-9280.2007.01933.x

Baghurst, T., Hollander, D.B., Nardella, B., & Haff, G.G. (2006). Change in sociocultural ideal male physique: An examination of past and present action figures. *Body Image, 3,* 87-91. doi:10.1016/j.bodyim.2005.11.001

Bardi, L., Kanai, R., & Walsh, V. (2010). Parietal asymmetry in local/global and salience-based selection: A tDCS study. *Neuropsychological Trends, 8*, 107-110. Retrieved from http://ezproxy.lakeheadu.ca/login?url=http://search.proquest.com/docview/857125264?accountid=11956

Beato-Fernández, L., Rodríguez-Cano, T., García-Vilches, I., García-Vicente, A., Poblete-García, V., Castrejon, A. S., & Toro, J. (2009). Changes in regional cerebral blood flow after body image exposure in eating disorders. *Psychiatry Research: Neuroimaging, 171*, 129-137. doi:10.1016/j.pscychresns.2008.01.001

Bergstrom, R.L., Neighbors, C., & Lewis, M.A. (2004). Do men find "bony" women attractive?: Consequences of misperceiving opposite sex perceptions of attractive body image. *Body Image, 1,* 183-191. doi:10.1016/S1740-1445(03)00025-1

Carter, C.S., Braver, T.S., Barch, D.M., Botvinick, M.M., Noll, D., & Cohen, J.D. (1998). Anterior cingulate cortex, error detection, and the online monitoring of performance. *Science, 280,* 747-749. doi: 10.1126/science.280.5364.747

Carver, C.S., & White, T.L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology, 67,* 319-333. doi: 10.1037/0022-3514.67.2.319

Cash, T.F., Fleming, E.C., Alindogan, J., Steadman, L., & Whitehead, A. (2002). Beyond body image as a trait: The development and validation of the Body Image States Scale. *Eating Disorders, 10,* 103-113. doi: 10.1080/10640260290081678

Coan, J.A., & Allen, J.J.B. (2003). Frontal EEG asymmetry and the behavioral activation and inhibition systems. *Psychophysiology, 40,* 106-114. doi: 10.1111/1469-8986.00011

Cohn, L.D., Adler, N.E., Irwin, C.E., Jr., Millstein, S.G., Kegeles, S.M., & Stone, G. (1987). Body-figure preferences in male and female adolescents. *Journal of Abnormal Psychology, 96,* 276-279. doi: 10.1037/0021-843X .96.3.276.

Crawford, J.R., & Henry, J.D. (2004). The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 43,* 245-265. doi: 10.1348 /0144665031752934.

Crost, N.W., Pauls, C.A., & Wacker, J. (2008). Defensiveness and anxiety predict frontal EEG asymmetry only in specific situational contexts. *Biological Psychology, 78*, 43-52. doi:10.1016/j.biopsycho.2007.12.008

Culham, J.C., Cavina-Pratesi, C., & Singhal, A. (2006). The role of parietal cortex in visuomotor control: What have we learned from neuroimaging? *Neuropsychologia, 44,* 2668 - 2684. doi: 10.1016/j.neuropsychologia.2005.11.003

d'Alfonso, A.A.L., van Honk, J., Hermans, E., Postma, A., & de Haan, E.H.F. (2000). Laterality effects in selective attention to threat after repetitive transcranial magnetic stimulation at the prefrontal cortex in female subjects. *Neuroscience Letters, 280,* 195-198. Retrieved from http://www.elsevier.com/locate/neulet

Dalley, S.E., & Buunk, A.P. (2009). "Thinspiration" vs. "fear of fat". Using prototypes to predict frequent weight-loss dieting in females. *Appetite, 52,* 217-221. doi:10.1016/j.appet.2008.09.019

Davidson, R. J. (1998). Anterior electrophysiological asymmetries, emotion, and depression: Conceptual and methodological conundrums. *Psychophysiology, 35*, 607-614. doi:10.1017/S0048577298000134

Davidson, R.J., Ekman, P., Saron, C.D., Senulis, J.A., & Friesen, W.V. (1990). Approach-withdrawal and cerebral asymmetry: Emotional expression and brain physiology I. *Journal of Personality and Social Psychology, 58,* 330-341. doi: 10.1037//0022-3514 .58.2.330

Davidson, R. J., Jackson, D. C., & Kalin, N. H. (2000). Emotion, plasticity, context, and regulation: Perspectives from affective neuroscience. *Psychological Bulletin, 126,* 890–909. doi: 10.1037//0033-2909.126.6.890

Davidson, R.J., Schwartz, G.E., Saron, C., Bennett, J., & Goleman, D. (1979). Frontal versus parietal EEG asymmetry during positive and negative affect. *Psychophysiology, 16,* 202–203.

Ehrsson, H.H., Kito, T., Sadato, N., Passingham, R.E., & Naito, E. (2005). Neural substrate of body size: Illusory feeling of shrinking of the waist. *PLoS Biology, 3,* 2200 – 2207. doi: 10.1371/journal.pbio.0030412

Elgavish, E., Halpern, D., Dikman, Z., & Allen, J.J.B. (2003). Does frontal EEG asymmetry moderate or mediate responses to the International Affective Picture System (IAPS)? *Psychophysiology, 40*, S38. doi: 10.1111/1469-8986.40.s1.1

Elliot, A.J., & Devine, P.G. (1994). On the motivational nature of cognitive dissonance: Dissonance as psychological discomfort. *Journal of Personality and Social Psychology, 67,* 382-394. doi: 10.1037/0022-3514.67.3.382

Engeln-Maddox, R. (2006). Buying a beauty standard or dreaming of a new life? Expectations associated with media ideals. *Psychology of Women Quarterly, 30,* 258-266. doi: 10.1111/j.1471-6402.2006.00294.x

Fallon, A.E., & Rozin, P. (1985). Sex differences in perceptions of desirable body shape. *Journal of Abnormal Psychology, 94,* 102-105. doi: 10.1037//0021-843X .94.1.102

Festinger, L. (1957). *A theory of cognitive dissonance*. Stanford, CA: Stanford University Press.

Field, A. (2009). *Discovering Statistics Using SPSS (3rd Editon).* Washington DC: Sage.

Fischmeister, F.Ph.S., & Bauer, H. (2006). Neural correlates of monocular and binocular depth cues based on natural images: A LORETA analysis. *Vision Research, 46,* 3373-3380. doi:10.1016/j.visres.2006.04.026

Fox, N. A. (1991). If it's not left, it's right: Electroencephalograph asymmetry and the development of emotion. *American Psychologist, 46,* 863–872.

Gable, P., & Harmon-Jones, E. (2008). Relative left frontal activation to appetitive stimuli: Considering the role of individual differences. *Psychophysiology, 45,* 275-278. doi: 10.1111/j.1469-8986.2007.00627.x

Gapin, J., Etnier, J.L., & Tucker, D. (2009). The relationship between frontal brain asymmetry and exercise addiction. *Journal of Psychophysiology, 23,* 135-142. doi: 10.1027/0269-8803.23.3.135

Gehring, W.J., Goss, B., Coles, M.G.H., Meyer, D.E., & Donchin, E. (1993). A neural system for error detection and compensation. *Psychological Science, 4,* 385-390. doi: 10.1111/j.1467-9280.1993.tb00586.x

Gollwitzer, P.M., & Kinney, R.F. (1989). Effects of deliberative and implemental mind-sets on illusion of control. *Journal of Personality and Social Psychology, 56,* 531-542. doi: 10.1037/0022-3514.56.4.531

Gotlib, I. H., Ranganath, C., & Rosenfeld, J. P. (1998). Frontal EEG alpha asymmetry, depression, and cognitive functioning. *Cognition and Emotion, 12,* 449–478. doi: 10.1080/026999398379673

Gray, J. A. (1972). The psychophysiological basis of introversion – extra-version: A modification of Eysenck's theory. In V. D. Nebylitsyn & J. A. Gray (Eds.). *The biological basis of individual behavior* (pp. 182 – 205). San Diego, CA: Academic Press.

Hagemann, D., Naumann, E., Becker, G., Maier, S., & Bartussek, D. (1998). Frontal brain asymmetry and affective style: A conceptual replication. *Psychophysiology, 35,* 372-388. doi: 10.1017/S0048577298970755

Harmon-Jones, E. (1999). Toward an understanding of the motivation underlying dissonance effects: Is the production of aversive consequences necessary to cause dissonance? In E. Harmon-Jones & J. Mills (Eds.), *Cognitive Dissonance: Progress on a Pivotal Theory in Social Psychology* (pp. 71–99). Washington, DC: American Psychological Association.

Harmon-Jones, E. (2003). Clarifying the emotive functions of asymmetrical frontal cortical activity. *Psychophysiology, 40,* 838-848. doi: 10.1111/1469-8986.00121

Harmon-Jones, E. (2004a). Contributions from research on anger and cognitive dissonance to understanding the motivational functions of asymmetrical frontal brain activity. *Biological Psychology, 67*, 51-76. doi: 10.1016/j.biopsycho.2004.03.003

Harmon-Jones, E. (2004b). On the relationship of frontal brain activity and anger: Examining the role of attitude toward anger. *Cognition and Emotion, 18,* 337-361. doi: 10.1080/02699930341000059

Harmon-Jones, E. (2007). Trait anger predicts relative left frontal cortical activation to anger-inducing stimuli. *International Journal of Psychophysiology, 66,* 154-160. doi: 10.1016/j.ijpsycho.2007.03.020

Harmon-Jones, E., & Allen, J. J. B. (1997). Behavioral activation sensitivity and resting frontal EEG asymmetry: Covariation of putative indicators related to risk for mood disorders. *Journal of Abnormal Psychology, 106*, 159-163. doi:10.1037/0021-843X.106.1.159

Harmon-Jones, E., & Allen, J.J.B. (1998). Anger and frontal brain activity: EEG asymmetry consistent with approach motivation despite negative affective valence. *Journal of Personality and Social Psychology, 74,* 1310-1316. doi: 10.1037/0022-3514 .74.5.1310

Harmon-Jones, E., Gable, P.A., & Peterson, C.K. (2010). The role of asymmetric frontal cortical activity in emotion-related phenomena: A review and update. *Biological Psychology, 84,* 451-462. doi: 10.1016/j.biopsycho.2009.08.010

Harmon-Jones, E., Gerdjikov, T., & Harmon-Jones, C. (2008). The effect of induced compliance on relative left frontal cortical activity: A test of the action-based model of dissonance. *European Journal of Social Psychology, 38,* 35-45. doi: 10.1002/ejsp.399

Harmon-Jones, E., & Harmon-Jones, C. (2002). Testing the action-based model of cognitive dissonance: The effect of action orientation on postdecisional attitudes.

Personality and Social Psychology Bulletin, 28, 711-723. doi: 10.1177/0146167202289001

Harmon-Jones, E., & Harmon-Jones, C. (2008). Action-based model of dissonance: A review of behavioral, anterior cingulate, and prefrontal cortical mechanisms. *Social and Personality Psychology Compass, 2,* 1518-1538. doi: 10.1111/j.1751-9004.2008.00110.x

Harmon-Jones, E., Harmon-Jones, C., Abramson, L., & Peterson, C.K. (2009). PANAS positive activation is associated with anger. *Emotion, 9,* 183-196. doi: 10.1037/a0014959

Harmon-Jones, E., Harmon-Jones, C., Fearn, M., Sigelman, J.D., & Johnson, P. (2008). Left frontal cortical activation and spreading of alternatives: Tests of the action-based model of dissonance. *Journal of Personality and Social Psychology, 94,* 1-15. doi: 10.1037/0022-3514.94.1.1

Harmon-Jones, E., Lueck, L., Fearn, M., & Harmon-Jones, C. (2006). The effect of personal relevance and approach-related action expectation on relative left frontal cortical activity. *Psychological Science, 17,* 434-440. doi: 10.1111/j.1467-9280 .2006.01724.x

Harmon-Jones, E., & Sigelman, J. (2001). State anger and prefrontal brain activity: Evidence that insult-related relative left-prefrontal activation is associated with experienced anger and aggression. *Journal of Personality and Social Psychology, 80,* 797-803. doi: 10.1037//0022-3514.80.5.797

Harmon-Jones, E., Sigelman, J.D., Bohlig, A., & Harmon-Jones, C. (2003). Anger, coping, and frontal cortical activity: The effect of coping potential on anger-induced left frontal activity. *Cognition and Emotion, 17,* 1-24. doi: 10.1080/02699930143000635

Hayes, A.F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling [White paper]. Retrieved from http://www.afhayes.com/public/process2012.pdf

Heller, W. (1990). The neuropsychology of emotion: Developmental patterns and implications for psychopathology. In N. L. Stein, B. Leventhal, & T. Trabasso (Eds.), *Psychological and biological approaches to emotion* (pp. 167–211). Hillsdale, NJ: Lawrence Erlbaum Associates.

Heller, W. (1993). Neuropsychological mechanisms of individual differences in emotion, personality, and arousal. *Neuropsychology, 7,* 476 – 489. doi: 10.1037/0894-4105.7.4.476

Heller, W., & Nitschke, J. B. (1998). The puzzle of regional brain activity in depression and anxiety: The importance of subtypes and comorbidity. *Cognition and Emotion, 12,* 421–447. doi: 10.1080/026999398379664

Heller, W., Nitschke, J. B., Etienne, M. A., & Miller, G. A. (1997). Patterns of regional brain activity differentiate types of anxiety. *Journal of Abnormal Psychology, 106*, 376-385. doi:10.1037/0021-843X.106.3.376

Hewig, J., Hagemann, D., Seifert, J., Naumann, E., & Bartussek, D. (2004). On the selective relation of frontal cortical asymmetry and anger-out versus anger-control. *Journal of Personality and Social Psychology, 87,* 926-939. doi: 10.1037/0022-3514.87.6.926

Hietanen, J.K., Leppanen, J.M., Peltola, M.J., Linna-aho, K., & Ruuhiala, H.J. (2008). Seeing direct and averted gaze activates the approach-avoidance motivational brain systems. *Neuropsychologia, 46,* 2423-2430. doi:10.1016/j.neuropsychologia.2008.02.029

Hofmann, S.G. (2007). Trait affect moderates cortical activation in response to state affect. *International Journal of Psychophysiology, 63,* 258 – 264. doi:10.1016/j.ijpsycho.2006.11.003

Hofmann, S.G., Moscovitch, D.A., Litz, B.T., Kim, H., Davis, L.L., & Pizzagalli, D.A. (2005). The worried mind: Autonomic and prefrontal activation during worrying. *Emotion, 5,* 464-475. doi: 10.1037/1528-3542.5.4.464

Ivanovski, B., & Malhi, G.S. (2007). The psychological and neurophysiological concomitants of mindfulness forms of meditation. *Acta Neuropsychiatrica, 19*, 76–91. doi: 10.1111/j.1601-5215.2007.00175.x

Jacobs, G.D., & Snyder, D. (1996). Frontal brain asymmetry predicts affective style in men. *Behavioral Neuroscience, 110,* 3-6. doi: 10.1037/0735-7044 .110.1.3

Jansen, A., Nederkoorn, C., & Mulkens, S. (2005). Selective visual attention for ugly and beautiful body parts in eating disorders. *Behaviour Research and Therapy, 43,* 183-196. doi:10.1016/j.brat.2004.01.003

Kim, J.-H., & Lennon, S.J. (2007). Mass media and self-esteem, body image, and eating disorder tendencies. *Clothing & Textiles Research Journal, 25,* 3-23. doi: 10.1177/0887302X06296873

Kline, J.P., Blackhart, G.C., & Joiner, T.E. (2002). Sex, lie scales, and electrode caps: An interpersonal context for defensiveness and anterior electroencephalographic asymmetry. *Personality and Individual Differences, 33,* 459-478. doi: 10.1016/S0191-8869 (01)00167-2

Laliberte, M., Newton, M., McCabe, R., & Mills, J.S. (2007). Controlling your weight versus controlling your lifestyle: How beliefs about weight control affect risk for disordered eating, body dissatisfaction, and self-esteem. *Cognitive Therapy Research, 31,* 853-869. doi: 10.1007/s10608-006-9104-z

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8.* University of Florida, Gainesville, FL.

Loewenstein, G. F., & Prelec, D. (1993). Preferences for sequences of outcomes. *Psychological Review, 100*, 91-108. doi:10.1037/0033-295X.100.1.91

Mackinnon, A., Jorm, A.F., Christensen, H., Korten, A.E., Jacomb, P.A., & Rodgers, B. (1999). A short form of the Positive and Negative Affect Schedule: Evaluation of factorial validity and invariance across demographic variables in a community sample. *Personality and Individual Differences, 27,* 405-416. doi: 10.1016/S0191-8869 (98)00251-7

Martins, Y., Tiggemann, M., & Churchett, L. (2008). The shape of things to come: Gay men's satisfaction with specific body parts. *Psychology of Men & Masculinity, 9,* 248-256. doi: 10.1037/a0012473

Miller, E., & Halberstadt, J. (2005). Media consumption, body image and thin ideals in New Zealand men and women. *New Zealand Journal of Psychology, 34(3),* 189-195. Retrieved from http://www.psychology.org.nz/NZ_Journal

Miskovic, V., & Schmidt, L.A. (2010). Frontal brain electrical asymmetry and cardiac vagal tone predict biased attention to social threat. *International Journal of Psychophysiology, 75,* 332-338. doi:10.1016/j.ijpsycho.2009.12.015

Morrison, T.G., Morrison, M.A., & Hopkins, C. (2003). Striving for bodily perfection? An exploration of the drive for muscularity in Canadian men. *Psychology of Men & Masculinity, 4,* 111-120. doi: 10.1037/1524-9220.4.2.111

Neighbors, L.A., & Sobal, J. (2007). Prevalence and magnitude of body weight and shape dissatisfaction among university students. Eating Behaviours, 8, 429-439. doi:10.1016/j.eatbeh.2007.03.003

Novemsky, N., & Ratner, R. K. (2003). The time course and impact of consumers' erroneous beliefs about hedonic contrast effects. *Journal of Consumer Research, 29*, 507-516. doi:10.1086/346246

Nusslock, R., Harmon-Jones, E., Alloy, L. B., Urosevic, S., Goldstein, K., & Abramson, L. Y. (2012). Elevated left mid-frontal cortical activity prospectively predicts conversion to bipolar I disorder. *Journal of Abnormal Psychology*. Advance online publication. doi: 10.1037/a0028973

Nusslock, R., Shackman, A. J., Harmon-Jones, E., Alloy, L. B., Coan, J. A., & Abramson, L. Y. (2011). Cognitive vulnerability and frontal brain asymmetry: Common predictors of first prospective depressive episode. *Journal of Abnormal Psychology, 120*, 497-503. doi:10.1037/a0022940

Oldfield, R.C. (1971). The assessment and analysis of handedness: The Edinburgh Inventory. *Neuropsychologia, 9,* 97-113.

Pauls, C.A., Wacker, J., & Crost, N.W. (2005). The two components of social desirability and their relations to resting frontal brain asymmetry. *Journal of Individual Differences, 26,* 29-42. doi: 10.1027/1614-0001.26.1.29

Peterson, C.K., Shackman, A.J., & Harmon-Jones, E. (2008). The role of asymmetrical frontal cortical activity in aggression. *Psychophysiology, 45,* 86-92. doi: 10.1111/j.1469-8986.2007.00597.x

Pope, H.G., Jr., Gruber, A.J., Mangweth, B., Bureau, B., deCol, C., Jouvent, R., & Hudson, J.I. (2000). Body image perception among men in three countries. *American Journal of Psychiatry, 157,* 1297-1301. doi: 0.1176/appi.ajp .157.8.1297

Roldan, O. E., Blanchette, L., & Davis, R. (2009, June). *Body dissatisfaction and affect: The effects of mode of mind induction and three dimensional body shape exposure*. Poster session presented at the annual meeting of the Canadian Psychological Association, Montreal, QC.

Rozin, P., & Fallon, A. (1988). Body image, attitudes to weight, and misperceptions of figure preferences of the opposite sex: A comparison of men and women in two generations. *Journal of Abnormal Psychology, 97,* 342-345. doi: 10.1037/0021-843X .97.3.342

Santesso, D.L., Segalowitz, S.J., Ashbaugh, A.R., Antony, M.M., McCabe, R.E., & Schmidt, L.A. (2008). Frontal EEG asymmetry and sensation seeking in young adults. *Biological Psychology, 78,* 164-172. doi:10.1016/j.biopsycho.2008.02.003

Schmidt, L. A., & Trainor, L. J. (2001). Frontal brain electrical activity (EEG) distinguishes valence and intensity of musical emotions. *Cognition and Emotion, 15*, 487-500. doi:10.1080/0269993004200187

Seidah, A., & Bouffard, T. (2007). Being proud of oneself as a person or being proud of one's physical appearance: What matters for feeling well in adolescence? *Social Behavior and Personality, 35,* 255-268. doi: 10.2224/sbp.2007.35.2.255

Shafran, R., Lee, M., Payne, E., & Fairburn, C.G. (2007). An experimental analysis of body checking. *Behaviour Research and Therapy, 45,* 113-121. doi:10.1016/j.brat.2006.01.015

Silberman, E. K., & Weingartner, H. (1986). Hemispheric lateralization of functions related to emotion. *Brain and Cognition, 5*, 322-353. doi:10.1016/0278-2626(86)90035-7

Silva, J. R., Pizzagalli, D. A., Larson, C. L., Jackson, D. C., & Davidson, R. J. (2002). Frontal brain asymmetry in restrained eaters. *Journal of Abnormal Psychology, 111*, 676-681. doi:10.1037/0021-843X.111.4.676

Stereo Optical Company, Inc., (n.d.). *Stereo Optical Company Vision Tester Slide Package* [Brochure].

Stereo Optical Company, Inc. (1994). *Stereo Fly Test* [Brochure].

Stewart, J.L., Levin-Silton, R., Sass, S.M., Heller, W., & Miller, G.A. (2008). Anger style, psychopathology, and regional brain activity. *Emotion, 8,* 701-713. doi: 10.1037/a0013447

Stewart, J.L., Towers, D.N., Coan, J.A., & Allen, J.J.B. (2011). The oft-neglected role of parietal EEG asymmetry and risk for major depressive disorder. *Psychophysiology, 48,* 82 – 95. doi: 10.1111/j.1469-8986.2010.01035.x

Storeshaw, K. & Davis, R. (2010, June). *Electroencephalographic response to body image exposure.* Poster session presented at the meeting of the Canadian Psychological Association's 71st Annual Convention, Winnipeg, MB.

Sutton, S.K., & Davidson, R.J. (1997). Prefrontal brain asymmetry: A biological substrate of the behavioral approach and inhibition systems. *Psychological Science, 8,* 204-210. doi: 10.1111/j.1467-9280 .1997.tb00413.x

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (4th ed.). Needham Heights, MA: Allyn & Bacon.

Taylor, S.E., & Gollwitzer, P.M. (1995). Effects of mindset on positive illusions. *Journal of Personality and Social Psychology, 69,* 213-226. doi: 10.1037/0022-3514.69.2.213

Thibodeau, R., Jorgensen, R.S., & Kim, S. (2006). Depression, anxiety, and resting frontal EEG asymmetry: A meta-analytic review. *Journal of Abnormal Psychology, 115,* 715-729. doi: 10.1037/0021-843X.115.4.715

Tiggemann, M., Martins, Y., & Churchett, L. (2008). Beyond muscles: Unexplored parts of men's body image. *Journal of Health Psychology, 13,* 1163-1172. doi: 10.1177/1359105308095971

Tiggemann, M., Martins, Y., & Kirkbride, A. (2007). Oh to be lean and muscular: Body image ideals in gay and heterosexual men. *Psychology of Men & Masculinity, 8,* 15-24. doi: 10.1037/1524-9220.8.1.15

Tomarken, A. J., & Keener, A. D. (1998). Frontal brain asymmetry and depression: A self-regulatory perspective. *Cognition and Emotion, 12*, 387-420. doi:10.1080/026999398379655

Tuschen-Caffier, B., Vögele, C., Bracht, S., & Hilbert, A. (2003). Psychological responses to body shape exposure in patients with bulimia nervosa. *Behaviour Research and Therapy, 41*, 573-586. doi:10.1016/S0005-7967(02)00030-X

Tversky, A., & Griffin, D. (1991). Endowment and contrast in judgments of well-being. In F. Strack, M. Argyle, & M. Schwarz (Eds.), *Subjective well-being* (pp. 101 – 118). New York: Pergamon.

Uher, R., Murphy, T., Friederich, H.-C., Dalgleish, T., Brammer, M.J., Giampietro, V., … Treasure, J. (2005). Functional neuroanatomy of body shape perception in healthy and eating-disordered women. *Biological Psychiatry, 58,* 990-997. doi:10.1016/j.biopsych.2005.06.001

van Honk, J., & Schutter, D.J.L.G. (2006). From affective valence to motivational direction: The frontal asymmetry of emotion revised. *Psychological Science, 17,* 963-965. doi: 10.1111/j.1467-9280 .2006.01813.x

Vocks, S., Busch., M., Grönemeyer, D., Schulte, D., Herpertz, S., & Suchan, B. (2010). Neural correlates of viewing photographs of one's own body and another woman's body in anorexia and bulimia nervosa: an fMRI study. *Journal of Psychiatry and Neuroscience, 35,* 163 – 176. doi: 10.1503/jpn.090048

Vocks, S., Hechler, T., Rohrig, S., & Legenbauer, T. (2009). Effects of a physical exercise session on state body image: The influence of pre-experimental body dissatisfaction and concerns about weight and shape. *Psychology and Health, 24,* 713-728. doi: 10.1080/08870440801998988

Vocks, S., Legenbauer, T., Wachter, A., Wucherer, M., & Kosfelder, J. (2007). What happens in the course of body exposure? Emotional, cognitive, and physiological reactions to mirror confrontation in eating disorders. *Journal of Psychosomatic Research, 62,* 231-239. doi:10.1016/j.jpsychores.2006.08.007

Want, S.C., Vickers, K., & Amos, J. (2009). The influence of television programs on appearance satisfaction: Making and mitigating social comparisons to “Friends”. *Sex Roles, 60,* 642-655. doi: 10.1007/s11199-008-9563-7

Watson, D., Clark, L.A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54,* 1063-1070. doi: 10.1037/0022-3514.54.6.1063

Weissman, D. H., & Woldorff, M. G. (2005). Hemispheric asymmetries for different components of global/local attention occur in distinct temporo-parietal loci. *Cerebral Cortex, 15*, 870-876. doi:10.1093/cercor/bhh187

Wheatstone, C. (1838). Contributions to the physiology of vision. – Part the first. On some remarkable, and hitherto unobserved, phenomena of binocular vision. *Philosophical Transactions of the Royal Society of London*, *128,* 371 – 394.

Wheeler, R. E., Davidson, R. J., & Tomarken, A. J. (1993). Frontal brain asymmetry and emotional reactivity: A biological substrate of affective style. *Psychophysiology, 30*, 82-89. doi:10.1111/j.1469-8986.1993.tb03207.x

Appendix A

Positive and Negative Affect Schedule (PANAS)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way right now, that is, at the present moment. Use the following scale to record your answers.

1 = very slightly or not at all
2 = a little
3 = moderately
4 = quite a bit
5 = extremely

___ interested
___ distressed
___ excited
___ upset
___ strong
___ guilty
___ scared
___ hostile
___ enthusiastic
___ proud
___ irritable
___ alert
___ ashamed
___ inspired
___ nervous
___ determined
___ attentive
___ jittery
___ active
___ afraid

Appendix B

Body Image States Scale (BISS)

For each of the items below, check the box beside the one statement that best describes how you feel **RIGHT NOW, AT THIS VERY MOMENT**. Read the items carefully to be sure the statement you choose accurately and honestly describes how you feel right now.

1. Right now I feel…

☐ ***Extremely dissatisfied*** with my physical appearance

☐ ***Mostly dissatisfied*** with my physical appearance

☐ ***Moderately dissatisfied*** with my physical appearance

☐ ***Slightly dissatisfied*** with my physical appearance

☐ ***Neither dissatisfied nor satisfied*** with my physical appearance

☐ ***Slightly satisfied*** with my physical appearance

☐ ***Moderately satisfied*** with my physical appearance

☐ ***Mostly satisfied*** with my physical appearance

☐ ***Extremely satisfied*** with my physical appearance

2. Right now I feel…

☐ ***Extremely satisfied*** with my body size and shape

☐ ***Mostly satisfied*** with my body size and shape

☐ ***Moderately satisfied*** with my body size and shape

☐ ***Slightly satisfied*** with my body size and shape

☐ ***Neither dissatisfied nor satisfied*** with my body size and shape

☐ ***Slightly dissatisfied*** with my body size and shape

☐ ***Moderately dissatisfied*** with my body size and shape

☐ ***Mostly dissatisfied*** with my body size and shape

☐ ***Extremely dissatisfied*** with my body size and shape

3. Right now I feel…

☐ ***Extremely dissatisfied*** with my weight

☐ ***Mostly dissatisfied*** with my weight

☐ ***Moderately dissatisfied*** with my weight

☐ ***Slightly dissatisfied*** with my weight

☐ ***Neither dissatisfied nor satisfied*** with my weight

☐ ***Slightly satisfied*** with my weight

☐ ***Moderately satisfied*** with my weight

☐ ***Mostly satisfied*** with my weight

☐ ***Extremely satisfied*** with my weight

4. Right now I feel…

☐ ***Extremely*** physically ***attractive***

☐ ***Very*** physically ***attractive***

☐ ***Moderately*** physically ***attractive***

☐ ***Slightly*** physically ***attractive***

☐ ***Neither attractive nor unattractive***

☐ ***Slightly*** physically ***unattractive***

☐ ***Moderately*** physically ***unattractive***

☐ ***Very*** physically ***unattractive***

☐ ***Extremely*** physically ***unattractive***

5. Right now I feel…

☐ ***A great deal worse*** about my looks than I usually feel

☐ ***Much worse*** about my looks than I usually feel

☐ ***Somewhat worse*** about my looks than I usually feel

☐ ***Just slightly worse*** about my looks than I usually feel

☐ ***About the same*** about my looks as usual

☐ ***Just slightly better*** about my looks than I usually feel

☐ ***Somewhat better*** about my looks than I usually feel

☐ ***Much better*** about my looks than I usually feel

☐ ***A great deal better*** about my looks than I usually feel

6. Right now I feel that I look…

☐ ***A great deal better*** than the average person looks

☐ ***Much better*** than the average person looks

☐ ***Somewhat better*** than the average person looks

☐ ***Just slightly better*** than the average person looks

☐ ***About the same*** as the average person looks

☐ ***Just slightly worse*** than the average person looks

☐ ***Somewhat worse*** than the average person looks

☐ ***Much worse*** than the average person looks

☐ ***A great deal worse*** than the average person looks

Appendix C

Edinburgh Handedness Inventory

Please indicate your preferences in the use of hands in the following activities *by putting a check in the appropriate column*. Where the preference is so strong that you would never try to use the other hand, unless absolutely forced to, *put 2 checks*. If in any case you are really indifferent, *put a check in both columns*.

Some of the activities listed below require the use of both hands. In these cases, the part of the task, or object, for which hand preference is wanted is indicated in parentheses.

Please try and answer all of the questions, and only leave a blank if you have no experience at all with the object or task.

	Left	Right
1. Writing	☐ ☐	☐ ☐
2. Drawing	☐ ☐	☐ ☐
3. Throwing	☐ ☐	☐ ☐
4. Scissors	☐ ☐	☐ ☐
5. Toothbrush	☐ ☐	☐ ☐
6. Knife (without fork)	☐ ☐	☐ ☐
7. Spoon	☐ ☐	☐ ☐
8. Broom (upper hand)	☐ ☐	☐ ☐
9. Striking Match (match)	☐ ☐	☐ ☐
10. Opening box (lid)	☐ ☐	☐ ☐

Appendix D

Participant Information Sheet

Dear Potential Participant,

Thank you for your interest in participating in our study on brain and cardiac activity, titled "Cortical frontal asymmetry during body exposure and chocolate consumption." This research is being conducted by Karen Storeshaw for her MA degree in Psychology under the supervision of Dr. Ron Davis in the Department of Psychology at Lakehead University in Thunder Bay, Ontario, Canada.

If you agree to participate in this study, you will attend two laboratory meetings with the researcher. During the first meeting, you will have your pictures taken, which will take approximately 15 minutes. During the second meeting, you will have two electrodes attached to your clavicle in order to record your heart rate and be fitted with an EEG cap to record brain activity while you view pictures of yourself in 2D and 3D and while you consume a quantity of chocolate. This will take approximately 1 hour and 15 minutes of your time.

Your participation in this study is completely voluntary and you may withdraw from it at any time without penalty. All information that you provide will be kept completely confidential. Only Dr. Ron Davis, Karen Storeshaw, and research assistant Chantal Poirier will be permitted to view your information. Your name will only be used to ensure that you receive 2 bonus marks towards your final grade in your course. All of the information that you provide will be assigned a code and will be securely stored at Lakehead University for 5 years, as per University regulations. In addition, your identifying information will be kept completely confidential in reports of results and publications.

A risk associated with your participation in this study is the possibility that thinking about personal issues while completing the questionnaires (e.g., self-esteem, body image) may arouse a degree of distress as might normally occur when you think about such issues. You may choose not to answer any question asked in the questionnaires without penalty or consequence. If at any point during or after this study you have any concerns, feel free to contact the Student Health and Counseling Centre at 343-8361 (UC 1007). Also, feel free to contact myself and/or Dr. Ron Davis with any questions that you might have.

The Research Ethics Board (REB), which is located in the Office of Research at Lakehead University, has approved this study. If you have any questions regarding this research, feel free to contact the REB at (807) 343-8283.

Thank you again for your interest in our research.

Sincerely,

Karen Storeshaw, B.A. (Hons.), M.A. Clinical Psychology Candidate. Lakehead University, Thunder Bay, ON. Email: kstoresh@lakeheadu.ca, Phone: (807) 622-1991

Dr. Ron Davis, Associate Professor of Psychology. Lakehead University, Thunder Bay, ON, Email: ron.davis@lakeheadu.ca, Phone: (807) 343-8646

○ I have read and understood the information above. Click this button to consent to participating in this study and to fill out the following questionnaires.

Appendix E

Demographic Questionnaire

What is your sex:

What is your age:

Marital status:

Married/common law □ Engaged □ Long-term Relationship □ Single □

Divorced/separated □

What is your ethnic background?

Caucasian □ South Asian □ Hispanic □ African-Canadian □ European □

Native-Canadian □ East Asian □ Other (please specify):________________

School Enrolment:

Full time student □ Part time student □

What academic program(s) are you in?_________________________________

Do you wear glasses or contact lenses? YES NO (circle one)

What is your height in feet and inches (guess if you don’t know):

What is your weight in pounds (guess if you don’t know):

Appendix F

No-Mindset Induction Script

Script for Neutral Pictures

You will be viewing some pictures of common household objects for the next 2 minutes while we record your brain and heart activity. Please remain as still as possible during the viewing.

Say "begin" when you are ready.

Script for First Picture Presentation

You will be viewing some pictures yourself in (2D/3D) for the next 2 minutes. Please remain as still as possible during the viewing.

Say "begin" when you are ready.

Script for Second Picture Presentation

Now you will be viewing pictures of yourself in (3D/2D) for the next two minutes. Remember to remain as still as possible during the viewing.

Say "begin" when you are ready.

Appendix G

Action-Oriented Mindset Induction Script

Script for Neutral Pictures

You will be viewing some pictures of common household objects for the next 2 minutes while we record your brain and heart activity. Please remain as still as possible during the viewing.

Say "begin" when you are ready.

Script for First Picture Presentation

You will be viewing some pictures of yourself in (2D/3D) for the next two minutes. While doing so, we would like you to think of something about your appearance that you would like to change and imagine that you are able to make this change within the next 3 months. Please think of the five most important steps to bring this change about, as well as when, where, and how you will perform each step. Please think about this while you are viewing the pictures. Please remain as still as possible during the viewing.

Say "begin" when you are ready.

Script for Second Picture Presentation

Now you will be viewing pictures of yourself in (3D/2D) for the next two minutes. Please continue to think about the change that you would like to make to your appearance while viewing the pictures. Remember to remain as still as possible during the viewing.

Say "begin" when you are ready.