A Neurophysiological Approach to Differentiate Core Disgust and Moral Disgust

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ABSTRACT

The association between core disgust and moral disgust has been a particularly contentious issue within the emotion literature. Preliminary neurophysiological evidence appeared to support a hybrid theory of the relation between core disgust and moral disgust, suggesting reactivity to bodily moral disgust stimuli is similar to core disgust reaction patterns and reactivity to non-bodily moral disgust stimuli is similar to that of anger. The aim of this project was to test this theory. In Study 1, participants viewed and rated emotion video clips to ensure the video clips shown in Study 2 elicited the intended emotions. In Study 2, the selected video clips were shown while EEG and ECG data were collected. It was hypothesized that there would be similar cerebral asymmetry, heart rate, and heart rate variability patterns between contamination-related core disgust and bodily moral disgust and between anger and non-bodily moral disgust. Although the results of this study did not fully support these hypotheses, preliminary evidence was found to support the hybrid theory of disgust. Based on the participant ratings and observed frontal asymmetry scores, similarities were found amongst contamination-related core disgust and bodily moral disgust and with non-bodily moral disgust and anger. These results warrant further investigation into the disgust construct in order to continue to explore the validity of the hybrid theory of disgust.

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The belief that emotions are innate, universal constructs has generally been accepted within the psychological community. This idea suggests that six basic emotions, anger, disgust, fear, happiness, sadness, and surprise, are hardwired within the human psyche and are seen throughout human cultures (Ekman & Friesen, 1971). These emotions influence our behaviors, help us make decisions, and allow us to communicate with others. They have developed over time with specific evolutionary purposes (Darwin, 1872). Disgust, for example, likely evolved as a biological adaptation to allow humans to avoid ingesting contaminated food. Recently, this basic emotions model has drawn criticism from researchers who suggest that there is not enough empirical support to confirm the belief that emotions are natural kinds (Barrett, 2006).

Barrett (2006) argues that the basic emotions model is based on assumptions that lack empirical support, the main offender being that the six basic emotions are innate. This model also suggests that the basic emotions are associated with universal behavioral and physiological reactions. However, critics point to the lack of cohesion on subjective experiences, facial expressions, autonomic responses, and neuroimaging within studies when arguing against the natural-kinds view of emotion. In other words, although participants may report feeling angry, facial reactivity and neuroimaging measures may not corroborate their reports. Due to this lack of empirical support for the basic emotions model, Barrett suggests that emotion researchers should quit operating under the assumptions of this model.

However, other researchers support the continued use of the basic emotions theory. Izard (2007) presents several arguments to support the idea that emotions are natural kinds. Some of his most compelling arguments are that the neural circuitry involved in experiencing basic emotions is present at birth and very early in childhood, emotion influences and regulates

cognitions and actions, and critics misuse emotion terminology such as *basic emotion* and *emotional schemas*. Clearly, viewing emotions as natural kinds is a controversial topic in the emotion literature that remains unresolved.

Interestingly, not only is there a taxonomy problem within the general emotion literature (as noted by Izard, 2007), but, as we will see, there is also a taxonomy issue within the disgust literature. Specifically, there is not consensus among researchers on what core disgust and moral disgust are and thus it is likely that conclusions about the relations between the two are not meaningful. Perhaps the discrepancy within studies noted by Barrett (2006) is an artifact of a taxonomy problem related to the specific emotions, rather than an incorrect assumption about the innate characteristics of emotion as a whole. The purpose of this dissertation project is to explore the psychophysiological indicators of core disgust and moral disgust in an attempt to distinguish the two types of disgust physiologically.

Within the disgust literature base, the nature of the association between core disgust and moral disgust has been a contentious issue. Some researchers suggest that core disgust and moral disgust are related emotions in the disgust construct. Others argue that core disgust and moral disgust are not related; rather, moral disgust is more closely related to anger. In order to properly explore this relation, it is important to have a good understanding of what core disgust and moral disgust are and how to accurately measure them.

Core Disgust

Disgust literally means bad taste. Although it is believed disgust evolved as an aid to identify contaminated foods, Darwin (1872) suggests that disgust also enables humans to avoid mutilation-related stimuli as well as other types of contamination through various sensory

modalities. This shows that disgust has evolved from its original purpose and still holds a relevant biological advantage for humans.

When disgust arises due to stimuli related to contamination or mutilation, it is said to be core disgust. Core disgust is an interesting emotion because it develops over time and elicitors of core disgust vary greatly by culture and from one individual to another. With the exception of gustatory-related stimuli, the experience of disgust is not observed until children are approximately 3 years of age (Bloom, 2004; Stevenson, Oaten, Case, Repacholi, & Wagland, 2010). Bloom likens the development of the ability to feel disgust with the ability to conceive children: these abilities develop later in life and it is evolutionarily advantageous to develop these abilities years after birth. On the other hand, Stevenson et al. suggest that children learn to feel disgust through social learning processes. They argue that children mimic their parents' reactions in disgusting situations.

The disgust experience is associated with a distinct facial expression that is characterized by wrinkling the nose, gaping the mouth, protruding the tongue, raising the upper lip, and closing the eyes. (Chapman, Kim, Susskind, & Anderson, 2009; de Jong, Peters, & Vanderhallen, 2002; Olatunji, Haidt, McKay, & David, 2008; Rozin, Lowery, & Ebert, 1994; Vrana, 1993). These reactions serve to distance oneself from the disgusting stimuli. Olfactory information is restricted from passing through the nasal passage when the nose is wrinkled. The mouth gape, tongue extension, and lip raise allow one to rid the disgusting contents from the mouth. Finally, closing the eyes reduces the input of disgusting visual information. As Darwin (1872) suggested, the disgust reaction results in ridding the body of oral contamination and well as avoiding other disgusting sensory input (visual and olfactory).

Although core disgust has been associated with a distinct facial expression, there have been varying reports on the physiological response to core disgust. Although some studies report parasympathetic autonomic activation, such as decreased heart rate (Levenson, Ekman, & Friesen, 1990; Rohrmann, Hopp, & Quirin, 2008), others have reported a sympathetic autonomic response to core disgust, including nausea (Royzman & Sabini, 2001; Rozin & Fallon, 1987). Kreibig (2010) reviewed several studies that measured psychophysiological emotional responses and determined that the differences in autonomic responding to disgust were due to the type of disgust elicitor. More specifically, contamination-related core disgust is characterized by increased respiration rate, heart rate acceleration (or no change from baseline), increased heart rate variability, and unchanged (or decreased) electrodermal activity whereas mutilation-related core disgust is associated with sympathetic cardiac deactivation, heart rate deceleration, increased electrodermal activity, and increased respiration. Additionally, core disgust has been non-differentially associated with increased systolic blood pressure (SBP) and diastolic blood pressure (DBP), decreased facial blood flow, increased skin conductance response, and decreased cardiac output. Kreibig goes on to point out that this decrease in cardiac output is particularly interesting because the other negative emotions are associated with an increase in cardiac output.

Other researchers have looked to brain activity to define core disgust. Using brain imaging techniques, researchers have begun to explore the patterns of activity that are common among healthy participants when experiencing disgust (Borg, Lieberman, & Kiehl, 2008; Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Lane, Reiman, Ahem, Schwartz, & Davidson, 1997; Moll et al., 2002; Phillips et al., 1997; Schäfer, Schienle, & Vaitl, 2005; Schienle, Schäfer, Stark, Walter, & Vaitl, 2005; Schienle, Schäfer, & Vaitl, 2008; Wright, He,

Shapira, Goodman, & Liu, 2004) and among participants with various neurological insults (Calder, Keane, Manes, Antoun, & Young, 2000; Gray, Young, Barker, Curtis, & Gibson, 1997; Malhi et al., 2007). Between all these studies, numerous areas of the brain were implicated in experiencing (or inability to recognize) core disgust, such as the anterior insula, medial prefrontal cortex, and basal ganglia. However, the lack of cohesive results between the studies warrants closer inspection before a definitive answer can be given regarding the neurological underpinnings of core disgust. The type of disgust being elicited is of particular concern, as it is unclear whether contamination-related and mutilation-related core disgust would activate different brain areas. Considering the varying psychophysiological responses to core disgust stimuli, there is reason to believe there would be differential neurological activation as well.

Moral Disgust

This lack of cohesion is not unique to core disgust; the moral disgust literature is also quite unclear. Russell and Giner-Sorolla (2011) define moral disgust as "a context of disgust that arises from moral considerations and informs moral judgments" (p. 5-6). Moral disgust results from acts that involve socially inappropriate behaviors. Just as core disgust serves to protect the body from harm, moral disgust serves to protect the self from harm. In other words, whereas core disgust acts to protect us from personal contamination, moral disgust acts to protect us from interpersonal contamination (Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999). Like core disgust, there is not a universal elicitor of moral disgust. Examples of things that can elicit moral disgust include the following: incest, pedophilia, cruelty, bullying, homosexuality, homophobia, racism, torture, and sleaziness.

Several researchers have attempted to observe patterns of physiological activity when participants are experiencing moral disgust (Borg, Lieberman, & Kiehl, 2008; Chapman et al.,

2009; Moll et al., 2002; Moll et al., 2005; Royzman, Leeman, & Sabini, 2008; Sherman, Haidt, & Coan, 2007). Chapman et al. found that moral disgust elicits activation of the levator labii, which is a muscle that is also activated in response to core disgust. Interestingly, Royzman et al. found that moral disgust, like core disgust, was associated with oral inhibition. Decreased heart rate and throat tightness was associated with moral disgust in a study conducted by Sherman et al. Borg et al., Moll et al. (2002), and Moll et al. (2005) implicated a variety of anatomical locations such as the medial prefrontal cortex, anterior insula, medial orbitofrontal cortex, and lateral orbitofrontal cortex among other brain areas in the moral disgust response. Although there is decidedly a lack of cohesion among the brain activations reported between the studies, the areas listed were implicated in multiple studies. The lack of a consensus is believed to be due to the differences in methods used to elicit moral disgust. Further complicating matters is the overall lack of research conducted on the neurophysiological underpinnings of moral disgust.

A lack of cohesion appears to be a common theme amongst the disgust literature. In addition to the inconsistencies we see with core disgust and moral disgust, there are also discrepant theories about the relations between core disgust and moral disgust. It has been argued that core disgust and moral disgust are related only in name, that they are part of the same construct, and that they are related only under certain conditions.

Major Ideas on the Relations Between Core and Moral Disgust

Core disgust and moral disgust are separable. Bloom (2004) and Royzman and Sabini (2001) have suggested that moral disgust is simply a metaphor for the anger people feel when they think social norms have been violated, and therefore core disgust and moral disgust are not related. When people state they "feel disgusted," "feel grossed out," or "have a bad taste in my mouth" due to an immoral act, they are speaking figuratively. It would be more appropriate for

people to use descriptors such as “anger” or “hate” when describing an unjust politician or a person who preys on young children. While others (e.g., Haidt, Rozin) make a linguistic argument in favor of core disgust and moral disgust being related, that disgust is used to describe bodily and moral offenses in at least eight other languages, Royzman and Sabini point out that cross-linguistic metaphors are common and this is not sufficient evidence to support their claim. Whereas Bloom and Royzman and Sabini make logical arguments for their beliefs, Simpson, Carter, Anthony, and Overton (2006) provide empirical evidence to support this theory. They found that the self-report response pattern differed between core disgust and moral disgust stimuli. Their results showed that although participants rated core disgust and moral disgust stimuli equally on disgust, moral disgust stimuli also received high ratings of anger and sadness. Additionally, when asked to rate the same stimuli over time, the participants rated core disgust stimuli as less disgusting while the moral disgust stimuli were rated as more disgusting. Simpson et al. suggest that these results provide support for the idea that moral disgust is not part of the disgust construct.

If core disgust and moral disgust are not in fact related as some researchers suggest, we would expect to see differing neurophysiological reactions in response to core disgust and moral disgust elicitors. As previously mentioned, Kreibig (2010) found that contamination-related core disgust results in sympathetic autonomic activation, such as increased heart rate, increased heart rate variability, and increased respiration rate whereas mutilation-related core disgust is related to mixed sympathetic/parasympathetic activation such as decreased heart rate and increased respiration. Kreibig also looked at autonomic activity in response to anger and found that anger is associated with increased sympathetic activity such as increased heart rate, decreased heart

rate variability, increased SBP, and increased DBP. According to Kreibig, disgust and anger differ in their cardiovascular response patterns.

Furthermore, Coan, Allen, and Harmon-Jones (2001) showed that approach emotions, such as anger, produce greater left than right hemispheric activation whereas withdrawal emotions, such as disgust, produce greater right than left hemispheric activation. Indeed, using mutilation-related core disgust video clips, Davidson et al. (1990) found that core disgust is associated with increased alpha activation (i.e., lower alpha power values) in right frontal and anterior temporal regions whereas and Harmon-Jones (2007) found anger is associated with increased left frontal activation. If the theory that core disgust and moral disgust are not part of the same construct is true, and if Bloom (2004) and Royzman and Sabini (2001) are correct in their assertion that moral disgust is more closely related to anger than disgust, then we would expect to find that morally disgusting stimuli produce reactions characterized by increased heart rate, decreased heart rate variability, increased cardiac output, and increased left frontal hemisphere activity.

Unfortunately, the current literature has not tackled the question on what the complete psychophysiological response pattern of moral disgust looks like. However, we do have limited evidence to question the claim that core disgust and moral disgust are not related. As previously stated, Chapman and colleagues (2009) found that the facial electromyography (EMG) responses to gustatory, core, and moral disgust stimuli all involved raising the levator labii muscle, which is significantly more active during responses to disgust than to anger (Vrana, 1993). Sherman et al. (2007) found that moral disgust elicited self-reported feelings of disgust and anger, tightness in the throat, and decreased heart rate. This is particularly interesting because decreased heart rate is associated with disgust but not anger. Indeed, the authors reported that the throat tightness

and decreased heart rate were only significantly related to feeling disgusted. Participants who reported feeling more angry than disgusted did not have the same pattern of physiological responding.

Core disgust and moral disgust are related. Others suggest that core disgust and moral disgust are related. In various articles they have published, Haidt, Rozin, and colleagues present several arguments in support of core and moral disgust being of the same construct. The first argument, which was addressed by Royzman and Sabini (2001), suggests that the use of 'disgust' to describe morally offensive situations is not a metaphor of the English language, but a universally accepted descriptor (Haidt, Rozin, McCauley, & Imada, 1997). As previously stated, cross-linguistic metaphors are common and universality of the use of the word does not exclude it from being a metaphor. They also point out that research on neurological activation while experiencing core disgust and moral disgust has implicated both overlapping and independent areas of activation in brain activity, suggesting that core disgust and moral disgust are related and part of the same construct (Borg et al., 2008; Moll et al., 2005). Overlapping areas of activation include the medial prefrontal cortex (particularly the orbitofrontal cortex), left inferior frontal gyrus, medial superior frontal gyrus, left temporal lobe, amygdala, thalamus, and basal ganglia. Both Borg et al. and Moll et al. observed insular activation to moral disgust but not to core disgust. This is of particular interest because numerous other studies (Calder et al., 2000; Malhi et al., 2007; Moll et al., 2002; Phillips et al., 1997; Schäfer et al., 2005; Schienle et al., 2005; Schienle et al., 2008; Wright et al., 2004) have implicated the anterior insula in core disgust reactivity. It is also interesting to note that Borg et al. reported more activation in left frontal areas whereas Moll et al. (2005) reported more activation in right frontal areas. This is important

because Davidson et al. (1990) reported core disgust activated significantly more right than left frontal activity.

If core disgust and moral disgust are related, we would expect to see similar physiological responses. Although we do know that facial EMG and heart rate response patterns are similar for core disgust and moral disgust, and there are similar brain activation patterns, we still have much to learn about the psychophysiological reactions to each. Though we may lack the desired physiological data, we do have other evidence to support the theory that core disgust and moral disgust are related.

Of particular interest is a recent study that asked participants to rate how much anger, moral disgust, contempt, sadness, fear, and grossed out they felt after reading emotionally charged vignettes (Hutcherson & Gross, 2011). Researchers found that participants rated themselves highest on feeling grossed out and morally disgusted after reading morally disgusting vignettes. Their feelings of being grossed out and morally disgusted were significantly higher than their ratings of the other options, including anger. This supports the idea that core disgust and moral disgust are more closely related than moral disgust and anger. Further evidence of an association between core disgust and moral disgust comes from another recently published study by Eskine, Kacinik, and Prinz (2011). Participants who ingested a disgusting drink rated moral transgressions as more severe than participants who were not primed to feel disgusted. Finally, Royzman et al. (2008) found that moral disgust was related to self-reports of oral inhibition. As previously mentioned, it is believed that disgust evolved to prohibit ingestion of contaminated food and therefore these results provide further evidence that there is a relation between core disgust and moral disgust. However, we still lack enough research to say definitively that they are part of the same construct.

Hybrid theory of core disgust and moral disgust. More recently, researchers have begun to examine why there appear to be such discrepant results in the disgust literature. One proposed theory is a hybrid of the two aforementioned theories. That is, that the relation between core disgust and moral disgust is moderated by the type of moral disgust that is involved. Russell and Giner-Sorolla (2011) have suggested that there are two types of moral disgust: bodily and non-bodily. Bodily moral disgust involves violations to norms regarding the body whereas non-bodily moral disgust is defined "by ideas of harm, consent, contractual agreement and rights" (p. 14) that, as the name suggests, are not necessarily related to the body. Examples of bodily moral disgust include incest, cannibalism, and pedophilia. Examples of non-bodily moral disgust include cheating, inequality, and exploitation. Russell and Giner-Sorolla go on to suggest that bodily moral disgust is directly related to disgust, whereas non-bodily moral disgust is directly related to anger. They point out that these distinctions do not necessitate that bodily-moral disgust exists without any anger, nor is non-bodily moral disgust completely unrelated to disgust. Rather, that the dominant primary emotion elicited by bodily moral disgust is disgust, whereas the dominant primary emotion elicited by non-bodily moral disgust is anger.

If this hybrid theory is accurate, it could account for why there appears to be discrepancies within the existing literature. That is, if researchers are not specifying the type of disgust that they are attempting to measure and lump bodily and non-bodily moral disgust together into a single unitary moral disgust construct, researchers may lose important information and make inaccurate assumptions about the association between moral disgust and other variables. Additionally, if the hybrid theory is an accurate portrayal of the relations between core disgust and moral disgust, we would anticipate that bodily moral disgust would result in relative right hemisphere cortical activation, decreased cardiac output, increased heart

rate variability, and other psychophysiological responses associated with disgust. Alternatively, we would expect non-bodily moral disgust to elicit relative left hemisphere cortical activation, increased cardiac output, decreased heart rate variability, and other psychophysiological responses associated with anger.

It is important to keep these distinctions suggested by Russell and Giner-Sorolla (2011) in mind when reviewing the moral disgust literature. Borg et al. (2008) appear to have been keen to this distinction as they separated bodily moral disgust elicitors from non-bodily moral disgust elicitors. It appears that this was the first study to suggest that there are two different types of moral disgust. They made a distinction between core disgust, sexual moral disgust, and non-sexual moral disgust and their results showed that core disgust and incest were both rated highly disgusting whereas nonsexual immoral offenses were not. Additionally, they found that core disgust, sexual moral disgust, and non-sexual moral disgust all had overlapping and unique brain activation patterns. However, despite finding differences between sexual and non-sexual moral disgust, they combined them together in order to compare brain activity between moral disgust and core disgust. Therefore, conclusions cannot be made about the similarities between core disgust and sexual moral disgust nor between core disgust and nonsexual moral disgust.

In Royzman et al.'s (2008) study, in which they concluded that moral disgust is related to core disgust, the researchers used bodily moral disgust (incest) to elicit disgust. Hutcherson and Gross (2011) were specifically referring to bodily moral disgust (incest and sexual deviance) when they suggested that core disgust and moral disgust were related. When Simpson et al. (2006) concluded that core disgust and moral disgust have different response patterns and therefore were not related, non-bodily moral offenses (betrayal, racism, hypocrisy, and disloyalty) were used. Interestingly, participants reported feeling more anger to the moral

disgust stimuli than to the core disgust stimuli. Eskine et al. (2011) appear to have combined bodily and non-bodily moral disgust together when they concluded that core disgust and moral disgust are related.

However, in Chapman et al.'s (2009) facial EMG study, which found that moral disgust was related to core disgust, researchers used non-bodily moral disgust (unfairness) to elicit moral disgust. Also, Moll et al. (2005) measured non-bodily moral disgust when concluding that core disgust and moral disgust are related. Finally, Sherman et al. (2007) also used non-bodily moral disgust elicitors (racism and anti-Semitism) when they found that core disgust was related to moral disgust. At first glance, these studies do not appear to fit with the predictions of the hybrid theory model. However, Russell and Giner-Sorolla (2011) did not suggest that non-bodily moral disgust is completely independent from core disgust (nor did they suggest that bodily moral disgust is completely independent from anger), just that non-bodily moral disgust is more closely related to anger than disgust. Therefore, it is not too surprising that they found that there was a relation between core disgust and non-bodily moral disgust. Because Chapman et al. and Moll et al. (2005) did not control for anger, we do not know if their moral disgust elicitors would have correlated higher with anger than disgust. However, Sherman et al. did assess anger as well and found that although anger was associated with moral disgust, decreased heart rate and tightness of the throat were not significantly related to anger, only core disgust.

Overall, the literature seems to indicate that bodily moral disgust was consistently related to core disgust. The results for non-bodily moral disgust were not consistently related to anger though this is likely due to the fact that researchers do not always measure anger. That non-bodily moral disgust was often associated with core disgust does not discredit the hybrid theory, as Russell and Giner-Sorolla (2011) would have predicted there would be an association between

the variables. However, we do not know if the negative emotionality that was elicited in these studies would have been more closely related to anger than core disgust.

Statement of the Problem and Hypotheses

While some evidence appears to support the hybrid theory, it may be premature to draw a definitive conclusion about the association between core disgust and moral disgust. Obviously there is a dearth of evidence regarding the neurophysiology of bodily and non-bodily moral disgust. There appears to be more support for the idea that bodily moral disgust is related to core disgust than there is support for non-bodily moral disgust being related to anger. However, it would be prudent to explore these emotions more thoroughly before making any definitive statements about the relations between core disgust and moral disgust.

Further complicating the matter are the differences in neurophysiological responses between contamination-related core disgust and mutilation-related moral disgust. If we want to compare bodily and non-bodily moral disgust with core disgust, should we make the comparisons with the response pattern associated with contamination-related core disgust or mutilation-related moral disgust? In the studies presented in this manuscript, four only measured contamination-related core disgust (Borg et al., 2008; Lane et al., 2997; Moll et al., 2002; Schäfer et al., 2005), one only measured mutilation-related core disgust (Davidson et al., 1990), two measured both types of core disgust (Schienle et al., 2005; Wright et al., 2004), one induced disgust using facial expressions (Phillips et al., 1997), and in one study it is unclear whether the researchers only used contamination-related stimuli or both (Schienle et al., 2008). Though it is imperative for researchers to indicate the type of stimuli used to elicit core disgust, it may also be useful to determine the nature of the relations of contamination-related core disgust and mutilation-related core disgust individually with bodily and non-bodily moral disgust.

Despite the differences in autonomic nervous system responses, Kreibig (2010) suggests the hallmark of core disgust is decreased cardiac output, as other negative emotions tend to be associated with increased cardiac output. Currently there are not any studies that measure cardiac output in response to bodily or non-bodily moral disgust. The literature base is also lacking sufficient studies that look at cerebral asymmetries, heart rate, and heart rate variability associated with contamination and mutilation related core disgust and bodily and non-bodily moral disgust. Further evidence is needed in these areas before conclusions can be made about the nature of the relations between core disgust and moral disgust.

The aim of this study was to explore the cerebral asymmetry, heart rate, and heart rate variability patterns associated with contamination-related core disgust, mutilation-related core disgust, bodily moral disgust, and non-bodily moral disgust. The results of this project will allow researchers to make informed claims about the relations between core disgust and moral disgust. This could provide insight into the nature of disgust and, more generally, the nature of emotion. Based on the predictions of the hybrid theory, the following hypotheses were given for this study. Each physiological direction is relative to baseline. First, it was hypothesized that *contamination-related core disgust* would be associated with right frontal asymmetry (i.e., greater relative right than left frontal activity), increased heart rate, and increased respiratory sinus arrhythmia (RSA). It was predicted that *mutilation-related core disgust* would be associated with right frontal asymmetry, decreased heart rate, and decreased RSA. Assuming the hybrid theory is correct, it was hypothesized that *bodily moral disgust* elicitors would produce greater right frontal asymmetry, increased heart rate, and increased RSA. Similarly, if the hybrid theory is accurate, it was expected that both *non-bodily moral disgust* and *anger* would have

neurophysiological profiles with greater relative left frontal asymmetry, increased heart rate, and decreased RSA (Coan et al., 2001; Kreibig, 2010). These hypotheses are summarized in Table 1.

This project consisted of two studies. The purpose of Study 1 was to screen and select the emotion video clips to be used in Study 2. Study 2 was designed to test the hypotheses by using physiological and self-report measures.

Method (Study 1)

The purpose of Study 1 was to ensure that the videos used during the neurophysiological data collection are eliciting the expected emotional reactions. Twenty-seven video clips were viewed and rated by participants. Based on the patterns of these ratings, twelve video clips were selected to be used in Study 2.

Participants

One hundred sixty-four participants were recruited from 2000- and 3000-level psychology classes at Virginia Tech. Both men and women were recruited for this portion of the study. Responses were anonymous and no demographic information was collected. The participants were given 1 extra credit point for their participation.

General Procedure

The primary researcher attended undergraduate psychology classes and showed the video clips to the students who chose to participate. Study 1 was conducted in three phases. In the first phase, four video clips for each of the six emotion conditions (contamination-related core disgust, mutilation-related core disgust, bodily moral disgust, non-bodily moral disgust, anger, and neutral) were shown to twenty-six participants. In Phase 2, an additional mutilation-related core disgust video clip and bodily moral disgust video clip were shown along with the original 24 video clips. One hundred twenty eight additional participants watched and rated the video

clips. Finally, another anger video clip was identified, shown to, and rated by ten participants in Phase 3. In all three phases of Study 1, participants rated their emotional reactions on an emotional intensity rating scale after viewing each video clip. The presentation of the videos was randomized so two videos from the same category were not shown back-to-back.

Materials

Video clips. Twenty-seven video clips were shown to the participants during their regular classroom time (see Appendix A for a description of the video clips). The video clips were screened to create a set of 12 clips, two for each emotion, to be shown in Study 2. The video clips ranged from 32 seconds to 68 seconds in length. The types of video clips chosen to attempt to elicit contamination-related core disgust contained elements such as feces and vomit. Mutilation-related core disgust video clips included blood and internal organ exposure. Bodily moral disgust video clips involved elements such as pedophilia and incest, whereas non-bodily moral disgust clips involved elements such as racism and bullying. The video clips used to elicit anger involved fighting and disrespectful children. Finally, the four video clips intended to be neutral showed nature scenes. The neutral video clips were included to ensure the participants are watching the videos and to be used as a vanilla baseline comparison.

After Phase 1, the data were examined to determine whether the expected patterns were beginning to emerge. It appeared that the video clips for two of the emotion conditions were not being rated in the expected pattern. Therefore, for Phase 2, an additional mutilation-related core disgust video clip and bodily moral disgust video clip were shown along with the original 24 video clips from the first phase. Following Phase 2, at least two videos from each of the six emotion conditions were rated with the expected pattern with the exception of anger. Therefore,

a video clip previously used to elicit anger was shown to and rated by ten participants and was found to elicit the expected pattern of ratings (Stephens, Christie, & Friedman, 2010).

Video rating form. After each video was shown, participants were asked to complete an emotional intensity rating scale (see Appendix B for page one of the scale). Each rating form had a checkbox at the top of the first page for participants to indicate consent. The participants were asked to rate how each video clip made them feel on a 7-point Likert-type scale on anger, fearful, grossed out, happy, morally disgusted, and sad. This form is a modification of the form used by Hutcherson and Gross (2011). Hutcherson and Gross used two disgust-related descriptors (grossed out and moral disgust) to distinguish between what they describe as social and nonsocial feelings. Their work demonstrates that respondents understood the "grossed out" and "moral disgust" labels and used them to describe feelings as easily as they used more typical descriptors of anger, fear, happy, and sadness.

After each phase, the data were analyzed to determine which videos would be used for Study 2. Ratings that averaged 4 or higher were considered high; ratings that averaged 2.5 or less were considered low (Hutcherson & Gross, 2011). The contamination- and mutilation-related core disgust video clips were expected to elicit high ratings of grossed out and low ratings on all other emotions. Based on Russell and Giner-Sorolla's (2011) hypothesis, the bodily moral disgust video clips were expected to elicit high ratings of morally disgusted and low ratings on fearful and happy. Their hypothesis also suggests the non-bodily moral disgust video clips should elicit high ratings of morally disgusted and anger and low ratings on fearful, grossed out, and happy. The anger video clips were expected to have high ratings on anger and low ratings on all other emotions. Finally, the neutral video clips were expected to elicit low ratings on all emotions except happiness.

Results (Study 1)

Phase One

After the first group of 26 participants rated the video clips, the average rating for each emotion for each video clip was calculated (see Table 2 for the emotional ratings for all of the video clips in Phase 1). Several patterns emerged from the data. All of the contamination-related core disgust videos had high ratings on grossed out, as expected, but one of the videos also had high morally disgusted ratings. Two of the other video clips were neither rated high nor low on morally disgusted. The ratings for all other emotions were low.

Three of the mutilation-related core disgust video clips were rated high on grossed out. Of these three, two video clips did not have high ratings on any of the other emotions and one video clip was also high on fearful and sad. One video clip was rated neither high nor low on morally disgusted. The fourth video clip was high on sad, but not on grossed out. All other ratings were low.

The bodily moral disgust video clips were expected to be rated high on morally disgusted and low on fearful and happy. However, one of the bodily moral disgust video clips received low ratings on all six emotions. The other three bodily moral disgust video clips had high ratings on anger, grossed out, and morally disgusted, with two of the videos also having high sad ratings. One video clip was rated neither high nor low on fearful, while all other emotions were rated low.

The non-bodily moral disgust video clips were chosen to elicit high ratings of moral disgust and anger and low ratings on fearful, grossed out, and happy. Three of the non-bodily moral disgust video clips received high morally disgusted ratings, with two of these also receiving high anger ratings. One of the four video clips also had high sad ratings, while one

video clip did not have any high ratings. The fearful, grossed out, and happy ratings for all four video clips were low.

All four video clips that were expected to elicit anger were rated high on anger. However, all four clips were also rated high on morally disgusted and two were rated high on sad. One clip was also rated high on grossed out. Two videos were neither rated high nor low on fearful and sad. None of the videos had high happy ratings. Finally, two of the neutral video clips had high happy ratings, while two did not have any high ratings.

After reviewing these results, two video clips were added before proceeding with Study 1. An additional mutilation-related core disgust video clip and a bodily moral disgust video clip were included with the original 24 video clips and rated by Study 1 participants in Phase 2.

Phase Two

One hundred twenty eight participants rated the video clips in Phase 2. The video clip ratings in Phase 2 are similar to the patterns observed in Phase 1 (see Table 3 for the emotional ratings for all of the video clips in Phase 2). That is, after the average rating for each emotion for each video clip was calculated, the contamination-related core disgust video clips were all high on grossed out and none of the video clips had any other high ratings. Three of the video clips were neither rated high nor low on morally disgusted.

One of the five mutilation-related core disgust video clips was rated high on grossed out and low on all other emotions, while one clip was rated high on grossed out, neither high nor low on morally disgusted, and low on all other emotions. Two of the other video clips had high sad ratings and were not rated low on fearful, while one clip did not have any high ratings.

The bodily moral disgust video clip ratings in Phase 2 resulted in a similar pattern as in Phase 1. The clip that did not receive any high ratings in Phase 1 had low ratings for all six

emotions in Phase 2. The four other video clips were all rated high on anger, grossed out, and morally disgusted. Three of the videos were also rated high on sad and neither high nor low on fearful. The happy ratings were low for all five bodily moral disgust video clips.

Only two of the non-bodily moral disgust video clips in Phase 2 were rated high on anger and morally disgusted, as expected. These two videos were also rated high on sad. One other non-bodily moral disgust video was only rated high on sad and one video did not have any high ratings. All of the video clips had low fearful, grossed out, and happy ratings.

The four video clips that were expected to result in anger had a similar pattern as in Phase 1. All four anger video clips received high anger and morally disgusted ratings, with three also receiving high sad ratings. Two videos were rated neither high nor low on fearful, one was rated neither high nor low on grossed out, and one was rated neither high nor low on sad. All of the anger video clips were rated low on happy. Finally, only one neutral video clip maintained a high happy rating, while the other three did not have any high ratings.

Phase Three

An additional anger video was shown to and rated by ten additional participants (see Table 4 for the emotional ratings for this video clip). An extended version of this video clip was used in a previous study to elicit anger (Stephens et al., 2010). Anger received high ratings for this video clip and none of the other emotions had high ratings. Morally disgusted and sad received neither high nor low ratings for this clip.

Discussion (Study 1)

The purpose of Study 1 was to find two video clips for each emotion that were rated in the expected pattern. The results suggest that the video clips elicited complex emotional patterns in the participants. In order for a video to be chosen for Study 2, the highest rating for that video

must be for the expected emotion(s). For example, all five of the anger videos were rated high on anger; however, anger was the highest rated emotion for only two of the videos. Therefore, those two videos were chosen for Study 2. This was the primary criterion for choosing the Study 2 videos. If more than two videos met this criterion, the researchers analyzed the unique characteristics of the video clips to determine which videos would be shown in Study 2.

Contamination-Related Core Disgust

The contamination-related core disgust video clips were expected to elicit high ratings of grossed out and low ratings on all other emotions. Only one of the video clips, video D, resulted in the expected pattern. Videos A, B, and C had morally disgusted ratings between the low and high cutoffs. Contamination-related core disgust videos B and C were chosen for Study 2. Although video A had the highest grossed out rating of all the contamination-related core disgust videos, the researchers decided to eliminate it because it showed animal blood during a potion of the video clip. It is unclear whether the participants rated grossed out so high because the man drank blended mice or because they were exposed to blood. Video A also had the highest rating on morally disgusted. Videos B and C had the next highest ratings on grossed out, the target emotion. Video D was not chosen for Study 2 because it had the lowest grossed out rating for all of the contamination-related core disgust videos.

Mutilation-Related Core Disgust

The mutilation-related core disgust video clips were expected to have high ratings of grossed out and low ratings on all other emotions. One of the video clips, video E, conformed to this pattern and was chosen for Study 2. Video B was the only other mutilation-related core disgust video clip that was rated high on grossed out. Although it was also rated neither high nor low on morally disgusted, it did not have any other elevated ratings and was also chosen for

Study 2. Videos A, C, and D did not have high grossed out ratings and, therefore, were not chosen for Study 2.

Bodily Moral Disgust

Based on Russell and Giner-Sorolla's (2011) hypothesis, it was expected that the bodily moral disgust video clips would be associated with high ratings of morally disgusted and low ratings on fearful and happy. Russell and Giner-Sorolla suggested that anger is sometimes associated with bodily moral disgust, when a perceived injustice occurs (as in cases of pedophilia or incest). However, anger is considered a secondary emotion to disgust (as opposed to non-bodily moral disgust where anger is a primary emotion). Because the morally disgusted ratings for videos B and D were the highest for all of the bodily moral disgust video clips, and because morally disgusted was the highest rated emotion for videos B and D, these two clips were chosen for Study 2. These two video clips were also rated high on sadness. While this was not predicted, it is not unexpected that participants might report feeling saddened when viewing video clips that have pedophilic and incestual content.

Non-bodily Moral Disgust

The non-bodily moral disgust video clips were expected to elicit high ratings of morally disgusted and anger and low ratings on fearful, grossed out, and happy. Videos A and B conformed to this pattern and were chosen for Study 2. Similar to the bodily moral disgust videos, videos A and B also had high ratings on sadness. Again, it is not unexpected that participants would report feeling saddened when watching videos containing racism and bullying. It is important to note that, unlike the bodily moral disgust video clips, none of the non-bodily moral disgust videos had high ratings on grossed out, which is consistent with the hybrid theory.

Anger

The anger video clips were expected to have high ratings on anger and low ratings on all other emotions. However, none of the anger video clips conformed to this pattern. All of the videos elicited high anger ratings. However, anger was the highest rated emotion only for videos D and E. Therefore, these videos were chosen for Study 2.

Neutral

The neutral video clips were expected to have low ratings on all emotions with the exception of happy. It is important to note that these videos were not intended to elicit happiness; rather, it was acceptable if the happy rankings were not low. All four videos conformed to this pattern. Videos B and D were chosen for Study 2 because they had the lowest ratings on happy.

Method (Study 2)

The purpose of Study 2 was to test the hypotheses regarding cerebral asymmetry, heart rate, and RSA patterns associated with contamination-related core disgust, mutilation-related core disgust, bodily moral disgust, non-bodily moral disgust, and anger.

Participants

Three hundred six Virginia Tech students were screened for eligibility for Study 2. Participants completed an online questionnaire to ensure they met the eligibility criteria; that is, all participants in Study 2 were at least 18 years, right-handed, non-smokers, and had no history of head injury or psychiatric, cardiovascular, or substance use disorders. Both men and women participants were recruited. Participants were given 1 extra credit point for participating in the online screener. The 211 participants who were eligible for Study 2 were notified by email. Thirty-two women and twenty men elected to participate in Study 2. However, the physiological data for one woman was not collected due to difficulties with the electrophysiological equipment

(i.e., the researcher was unable to get the impedance below 5K ohms because the participant had synthetic hair) and another woman elected to discontinue the study. The results presented include data from the sample of the 50 participants who completed the study. The ages of the participants ranged from 18 to 35 (M = 20.5 years). Participants who required vision correction were asked to wear glasses (rather than contacts) during the session to lessen the impact of eyeblinks on the EEG recording. The participants were awarded 2 extra credit points for their participation in the lab-portion of Study 2.

General Procedure

Participants were recruited from an online participation system already in place within the Virginia Tech Psychology Department. The Sona system allows participants to sign up for studies and assign extra credit to their Psychology classes. People who were interested in participating were screened for eligibility (see Appendix C) via the Sona system. An individual appointment was offered to each person who met the eligibility criteria. All participants were asked to abstain from alcohol, nicotine, and caffeine use 24 hours prior to their appointments. When a participant arrived at the lab, he or she completed the Informed Consent form (see Appendix D) and Participant Information form (see Appendix E). If the participant was still eligible for the study (i.e., he or she had abstained from substance use), the EEG and ECG electrodes were applied and a baseline phase was completed. No participants were excused from the study based on their eligibility on the day of participation. The 4-minute baseline phase consisted of four 1-minute intervals alternating between eyes open and eyes closed. After the baseline phase was completed, two videos for each of the six conditions (contamination-related core disgust, mutilation-related core disgust, bodily moral disgust, non-bodily moral disgust, anger, and neutral) were presented while continuous EEG and ECG data were collected. The

video clips were shown on a 26 inch monitor in the lab, with participants sitting 7 feet from the monitor. The research assistant event marked the data as each video clip began and ended. After watching each video, the participant rated the video on an emotional intensity rating form. The researcher waited 30 seconds after the participant completed the form before starting the next video. This was done to all allow time for the emotion to abate. After all the videos were viewed and rated, the electrodes were removed, and the participant was thanked for his or her participation and excused from the study.

Psychophysiology

EEG. Continuous EEG was collected throughout the session. The EEG recorded at baseline was compared to the recordings made while the participants were exposed to emotional stimuli. A 32-channel cap using the 10/20 system was used, with Cz as the recording reference. Later off-line, the EEG was re-referenced using the average of all electrode sites. Using an average reference weighs all the electrode sites equally, thus eliminating the need for a noncephalic reference. Electrodes were also placed on the mastoids (for an alternate reference for future work on this dataset), as well as on the supra orbit and outer canthi of the left eye (for EOG). Omni-Prep abrasive gel was dispensed into the electrodes using a blunt tipped plastic syringe and abraded with a wooden Q-tip to prepare the scalp. Then Electro-Gel conductive gel was dispensed into each recording site. Each site was checked to ensure impedance was below 5K ohms. Instrumentation Bioamps (San Diego, CA) were used to collect data at 512 Hz to prevent aliasing. The high pass filter was set at 1 Hz while the low pass filter was set at 100 Hz with a gain of 5,000. An acquisition computer displayed the activity using Snapshot-Snapstream (HEM Data Corp.; Southfield, MI) and the raw data were stored for later analyses. The 8- to 13-Hz frequency band (i.e., the alpha band) was used for all analyses, as Ahern and Schwartz (1985)

have shown that alpha suppression is associated with emotional reactivity in frontal areas. Three frontal pairs, F3/F4, F7/F8, and Fp1/Fp2, were analyzed for frontal asymmetry comparisons. Although F3/F4 asymmetry is the standard in the adult emotion literature, studies have analyzed frontal asymmetry based on other frontal electrodes locations as well (e.g., Steiner & Coan, 2011).

The EEG data were analyzed using EEG Analysis software developed by the James Long Company (Caroga Lake, NY). An eye blink algorithm was used to mark and remove artifacts due to eye blinks recorded with the EOG electrodes and the data were artifact scored by hand for gross motor movements. All artifact data were eliminated from the analyses. A discrete Fourier transform (DFT) using a Hanning window of 1-s width and 50% overlap was used to analyze the data. The mean voltage was subtracted from each data point prior to analysis to eliminate any differences due to DC offset and power was calculated for the frequency band. After normalizing the distributions by transforming the power using the natural log (ln), the asymmetry score was computed by subtracting the left frontal EEG ln power values from the right frontal EEG ln power values (ln right – ln left = frontal asymmetry). In the EEG literature, brain activation is indicated by lower EEG power values in the alpha frequency band (Coan & Allen, 2004; Lindsley, 1936). Thus, greater relative left than right frontal activation is indicated by a positive asymmetry score, and greater relative right than left frontal activation is indicated by a negative asymmetry score.

ECG. Cardiac electrical activity was also measured during the baseline and task phases. Disposable electrodes were placed at the right collarbone and lower left rib, grounded at the scalp near electrode site Fz. The SA Instrumentation Bioamp was used to amplify the electrical activity with a bandpass filter of .01-1000 Hz. The electrical activity was displayed on the

acquisition computer monitor along with the EEG data, and the cardiac signal was digitized at 512 samples per second. Snapshot-Snapstream (HEM Data Corp.) was used to acquire the data, and the raw data were stored for later analyses.

The ECG data were examined and analyzed using IBI Analysis System software (developed by James Long Company). Artifact-scored epochs were removed from all cardiac calculations. Artifact-free R waves were then detected and converted to interbeat intervals (IBIs) and resampled into equal time intervals of 125 ms. Heart rate was calculated as beats per minute (bpm). In order to measure RSA, prorated IBIs were analyzed for processing of respiratory sinus arrhythmia (RSA), which is the high frequency component of RSA. A fast Fourier transform (FFT) analysis was used within the 0.12-0.4 Hz bandwidth and the distributions were normalized by transforming the power using the natural log (ln) prior to analyses.

Materials

Video clips. Twelve video clips were chosen based on the results of Study 1. Two video clips for each condition, contamination-related core disgust, mutilation-related core disgust, bodily moral disgust, non-bodily moral disgust, anger, and neutral were shown in a randomized order (see Appendix F for a description of the video clips).

Video rating form. After each video was shown, participants were asked to complete the same emotional intensity rating scale that was used in Study 1 (see Appendix G for page one of the scale). The participants were asked to rate how each video clip made them feel on a 7-point Likert-type scale on anger, fearful, grossed out, happy, morally disgusted, and sad.

Data Analysis

The data were examined for outliers before any analyses were run and a manipulation check was run on the video ratings to ensure the intended emotions were being elicited. The

same process and criteria that were used in Study 1 were used in this study as well, with ratings that average 4 or higher considered high ratings and ratings that average 2.5 or less considered low ratings. A repeated measures MANOVA was run on each pair of videos for each of the six emotion conditions to determine if there was a difference between ratings on the two videos chosen to represent each specific emotion. For conditions that did not have differences, the EEG and ECG data for both videos for the specific emotion condition were averaged for the remaining analyses. For conditions that had different ratings, the EEG and ECG data were analyzed separately for each pair of videos for that specific emotion condition.

The five hypotheses were focused on changes in frontal EEG asymmetry, heart rate, and RSA during the emotion videos relative to baseline. The vanilla baseline was used rather than the eyes open baseline task because it is believed to be more similar to the task demands of the emotion conditions and is believed to be a better estimate of baseline functioning than the eyes open task, particularly when collecting autonomic data (Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992). Thus, the electrophysiological data were analyzed for each emotion, resulting in five analyses. Repeated measures MANOVAs were used to test these hypotheses. The within subjects variables were condition (baseline, video) and physiology type (i.e., frontal asymmetry, heart rate, RSA). The dependent variables were the frontal EEG asymmetry (F3/F4, F7/F8, and Fp1/Fp2), heart rate, and RSA values. It was predicted that there would be a main effect for condition; that is, that all five physiological variables will differ from baseline. When a main effect was present, baseline and video condition means were examined to determine if the changes were in the hypothesized directions. Full support for the hypotheses occurred if each of the five physiological variables during the video differed from baseline in the proposed directions.

When an interaction between condition and physiology was present, paired samples t-tests were used to test baseline and task differences separately for each of the physiology variables in order to determine which physiological variables were contributing to the interaction. Partial support for the hypotheses occurred when one-four of the physiological variables differed from baseline in the proposed direction(s). No interaction between condition and physiology suggested that there was no support for the hypotheses because there were no differences in any of the physiological variables between baseline and video. A main effect for physiology (differences in the values of frontal asymmetry, heart rate, and RSA averaged across baseline and video) would not be meaningful for this study, and therefore was not interpreted.

Results (Study 2)

Emotion Ratings

After all the data were collected, the average rating for each emotion for each video clip was calculated (see Table 5 for the average emotional ratings for all of the video clips in Study 2). The ratings for the Study 2 videos follow a similar pattern to those for Study 1, Phase 2. That is, both contamination-related core disgust video clips were rated high on grossed out and did not have any other high ratings. One of the video clips was rated neither high nor low on fearful and all other ratings were low. Similarly, both mutilation-related core disgust video clips were also rated high on grossed out and did not have any other high ratings. One of the video clips was also rated neither high nor low on fearful and all other ratings were low.

Both of the bodily moral disgust videos were rated high on anger, grossed out, morally disgusted, and sad. One of the videos was rated neither high nor low on fearful. Morally disgusted had the highest ratings of all the emotions, with grossed out being the second highest rated emotion for both videos. Both of the non-bodily moral disgust video clips were rated high

on anger, morally disgusted, and sad, with one video also receiving a neither high nor low rating on fearful. No other emotions had high ratings and morally disgusted was the highest rated emotion for both non-bodily moral disgust video clips.

Only one of the video clips designed to elicit anger was rated high on anger. The other video clip (Anger B) did not have any high ratings and was rated neither high nor low on anger (though it is worth mentioning that it was 0.06 too low to receive a high rating). Both videos were rated neither high nor low on morally disgusted and sad, and one video was also rated neither high nor low on fearful. One of the neutral video clips was rated high on happy, while the other was rated neither high nor low on happy. All other ratings were low. Overall, the patterns of the emotional ratings for the videos used in Study 2 were consistent with those in Study 1.

Can the Data for Men and Women be Combined?

In order to determine whether the data for men and women should be combined or separated for the analyses, repeated measures MANOVAs were run, with emotion (Video A and Video B) and physiological reactions (F3/F4 asymmetry, F7/F8 asymmetry, Fp1/Fp2 asymmetry, heart rate, and RSA) as the within-subjects factors and gender as the between-subjects factor (see Table 6 for MANOVA results). The results showed that there were no differences in physiological reactions between men and women. Therefore, the data were combined and analyzed together.

Did Both Videos for Each Emotion Produce Similar Physiological Reactions?

A repeated measures MANOVA was run on each pair of video clips for each emotion in order to determine if there was a difference between the physiological reactions for each emotion condition (see Table 7 for descriptive statistics for all physiological variables; see Table 8 for MANOVA results).

Contamination-related core disgust. There was a condition main effect (i.e., video A vs. video B for CRCD) [Wilks' Λ = .841, $F(1, 38) = 7.178$, $p = .011$, $\eta_p^2 = .159$]; there was no condition x physiology interaction [Wilks' Λ = .813, $F(4, 35) = 2.011$, $p = .114$, $\eta_p^2 = .187$]. The results suggest that the contamination-related core disgust video clips differed from one another. Therefore, the data for these video clips were not averaged and all further analyses considered the contamination-related core disgust video clips separately (i.e., CRCD A, CRCD B).

Mutilation-related core disgust. There was no condition main effect [Wilks' Λ = 1.000, $F(1, 44) = .005$, $p = .945$, $\eta_p^2 = .000$] and no interaction between condition and physiology [Wilks' Λ = .812, $F(4, 41) = 2.378$, $p = .067$, $\eta_p^2 = .188$]. Therefore, the data for the mutilation-related core disgust video clips were averaged for all further analyses. The averaged mutilation-related core disgust physiological data will henceforth be referred to as "MRCD."

Bodily moral disgust. There was no condition main effect [Wilks' Λ = .934, $F(1, 36)$ = 2.537, $p = .120$, $\eta_p^2 = .066$], nor was there an interaction between condition and physiology [Wilks' Λ = .799, $F(4, 33) = 2.072$, $p = .107$, $\eta_p^2 = .201$]. Therefore, the data for the bodily moral disgust video clips were averaged and used for all further analyses. The averaged bodily moral disgust physiological data will henceforth be referred to as "BMD."

Non-bodily moral disgust. There was no main effect of condition [Wilks' Λ = .964, $F(1, 43) = 1.590$, $p = .214$, $\eta_p^2 = .036$], nor was there a condition x physiology interaction [Wilks' Λ = .846, $F(4, 40) = 1.822$, $p = .144$, $\eta_p^2 = .154$]. Therefore, the data for the non-bodily moral disgust video clips were averaged and used for all further analyses. The averaged non-bodily moral disgust physiological data will henceforth be referred to as "NBMD."

Anger. There was a condition main effect [Wilks' Λ = .810, $F(1, 43) = 10.085$, $p = .003$, $\eta_p^2 = .190$] and an interaction between condition and physiology [Wilks' Λ = .725, $F(4, 40)$ =

3.784, $p = .011$, $\eta_p^2 = .275$]. Therefore, the data for these video clips were not averaged and all further analyses considered the anger video clips separately (i.e., Anger A, Anger B).

Neutral. There was a main effect for condition [Wilks' $\Lambda = .707$, $F(1, 43) = 17.779$, $p < .001$, $\eta_p^2 = .293$] and a condition x physiology interaction [Wilks' $\Lambda = .654$, $F(4, 40) = 5.279$, $p = .002$, $\eta_p^2 = .346$]. Therefore, the data for these video clips were not averaged and the researcher was unable to use their averaged data for the vanilla baseline. Neutral video A was chosen as the vanilla baseline because it did not have any high ratings on the emotional intensity form and therefore is believed to represent a more neutral video.

Did the Emotion Videos Differ from Baseline?

In order to test the hypotheses and determine whether the video clips differed from the vanilla baseline, repeated measures MANOVAs were run, with condition (baseline and emotion) and physiological reactions (F3/F4 asymmetry, F7/F8 asymmetry, Fp1/Fp2 asymmetry, heart rate, and RSA) as within-subjects factors (see Table 9 for MANOVA results). When an interaction between condition and physiology occurred, paired t-tests were run to determine which physiological variables were contributing to the significant findings (see Table 10 for t-test results).

CRCD. There was no main effect for condition for CRCD A [Wilks' $\Lambda = .944$, $F(1, 42) = 2.513$, $p = .120$, $\eta_p^2 = .056$]. However, there was a condition x physiology interaction [Wilks' $\Lambda = .733$, $F(4, 39) = 3.545$, $p = .015$, $\eta_p^2 = .267$]. The paired t-test showed there was an increase in heart rate [$t(48) = -2.147$, $p = .037$] and decrease in RSA [$t(47) = 3.011$, $p = .004$] from baseline. For CRCD B, there was a main effect for condition [Wilks' $\Lambda = .688$, $F(1, 39) = 17.675$, $p < .001$, $\eta_p^2 = .312$] as well as an interaction between condition and physiology [Wilks' $\Lambda = .482$, $F(4, 36) = 9.691$, $p < .001$, $\eta_p^2 = .518$]. Follow-up t-tests revealed that there was an

increase in heart rate [t(47) = -4.256, $p < .001$] and decrease in RSA [t(46) = 2.081, $p = .043$] from baseline.

MRCD. There was no main effect for condition [Wilks' $\Lambda = .984$, $F(1, 43) = .702$, $p = .407$, $\eta_p^2 = .016$], nor was there an interaction between condition and physiology [Wilks' $\Lambda = .849$, $F(4, 40) = 1.784$, $p = .151$, $\eta_p^2 = .151$].

BMD. There was no main effect for condition [Wilks' $\Lambda = .963$, $F(1, 35) = 1.357$, $p = .252$, $\eta_p^2 = .037$]. There was a condition x physiology interaction for BMD [Wilks' $\Lambda = .653$, $F(4, 32) = 4.253$, $p = .007$, $\eta_p^2 = .347$].The BMD data showed an increase in F8/F7 left frontal asymmetry [t(44) = -2.572, $p = .014$] and decrease in RSA [t(46) = 3.133, $p = .003$] from baseline.

NBMD. There was a main effect for condition [Wilks' $\Lambda = .734$, $F(1, 43) = 15.622$, $p < .001$, $\eta_p^2 = .266$] as well as an interaction between condition and physiology [Wilks' $\Lambda = .453$, $F(4, 40) = 12.095$, $p < .001$, $\eta_p^2 = .547$]. For NBMD, an increase in heart rate [t(48) = -4.967, $p < .001$] and decrease in RSA [t(47) = 4.267, $p < .001$] were observed.

Anger. There was no main effect for condition [Wilks' $\Lambda = .950$, $F(1, 43) = 2.252$, $p = .141$, $\eta_p^2 = .050$] but there was an interaction between condition and physiology for Anger A [Wilks' $\Lambda = .685$, $F(4, 40) = 4.606$, $p = .004$, $\eta_p^2 = .315$]. Three physiological differences emerged when comparing Anger video A to baseline, as there was an increase in F4/F3 left frontal asymmetry [t(47) = -2.349, $p = .023$], an increase in heart rate [t(48) = -2.131, $p = .038$], and a decrease in RSA [t(47) = 2.431, $p = .019$]. Similarly, there was no main effect for condition [Wilks' $\Lambda = .955$, $F(1, 42) = 1.998$, $p = .165$, $\eta_p^2 = .045$], but a condition x physiology interaction for Anger B [Wilks' $\Lambda = .538$, $F(4, 39) = 8.385$, $p < .001$, $\eta_p^2 = .462$]. Only the RSA decreased for Anger B [t(47) = 3.673, $p = .001$].

Was the Hybrid Theory Supported?

Emotion conditions were compared with each other in order to test the hybrid theory. If the hybrid theory is accurate, the psychophysiological profile of BMD should be similar to that of CRCD, while the psychophysiological profile of NBMD should resemble that of anger. Repeated measures MANOVAs were used to test these predictions (see Table 11 for a comparison of all emotion conditions).

BMD and NBMD. When comparing BMD and NBMD, a main effect for condition [Wilks' Λ = .748, $F(1, 35) = 11.806$, $p = .002$, $\eta_p^2 = .252$] and an interaction between condition and physiology [Wilks' Λ = .580, $F(4, 32) = 5.797$, $p = .001$, $\eta_p^2 = .420$] were observed, suggesting that the physiological responses to these videos differed from one another.

BMD and CRCD. There was no main effect for condition [Wilks' Λ = .989, $F(1, 36) = .419$, $p = .522$, $\eta_p^2 = .011$] nor a condition x physiology interaction [Wilks' Λ = .895, $F(4, 33) = .964$, $p = .440$, $\eta_p^2 = .105$] when comparing BMD to CRCD A. However, there is a main effect for condition when comparing BMD to CRCD B [Wilks' Λ = .854, $F(1, 32) = 5.449$, $p = .026$, $\eta_p^2 = .146$] but not an interaction [Wilks' Λ = .789, $F(4, 29) = .1.936$, $p = .131$, $\eta_p^2 = .211$].

NBMD and Anger. There was a main effect for condition [Wilks' Λ = .897, $F(1, 42) = 4.837$, $p = .033$, $\eta_p^2 = .103$] and an interaction between condition and physiology [Wilks' Λ = .699, $F(4, 39) = 4.206$, $p = .006$, $\eta_p^2 = .301$] when comparing NBMD to Anger A. Similarly, the comparison between NBMD and Anger B also resulted in a main effect for condition [Wilks' Λ = .672, $F(1, 41) = 20.018$, $p < .001$, $\eta_p^2 = .328$] and an interaction between condition and physiology [Wilks' Λ = .622, $F(4, 38) = 5.784$, $p = .001$, $\eta_p^2 = .378$].

Frontal Asymmetry Effects

For the hypothesis testing noted above, the frontal EEG asymmetry scores during the videos were assessed relative to baseline. Because of the law of initial values (Berntson, Uchino, & Cacioppo, 1994), however, significant changes from baseline with respect to increased relative right frontal activation are rarely observed (Jones & Fox, 1992). Therefore, it may be more informative to look at the patterns of frontal asymmetry independently, rather than comparing the asymmetry scores to baseline (see Table 12 for means and standard deviations). The results showed that Fp2/Fp1 was associated with greater relative right frontal activity and F4/F3 was associated with greater relative left frontal activity for all of the video clips. However, F8/F7 had more variability between the emotion conditions and warrant further discussion. The CRCD video clips were expected to be associated with right frontal asymmetry and both CRCD A (M = -.003, SD = .244) and CRCD B (M = -.003, SD = .237) had negative asymmetry scores, which suggests greater relative right frontal activity. MRCD also had a negative asymmetry score (M = -.075, SD = .275) as expected, indicating greater relative right frontal activity. BMD was expected to be associated with right frontal activation; however, the BMD asymmetry score was positive (M = .049, SD = .220), indicating greater relative left frontal activation. The NBMD asymmetry score was positive as expected ((M = .017, SD = .242), indicating greater left than right frontal activation. Finally, both Anger A (M = .006, SD = .230) and Anger B (M = .034, SD = .228) had positive asymmetry scores, which is suggestive of greater left than right frontal activation, as expected.

Summary of Findings

The results of Study 2 suggest that participants generally rated the videos as expected, although one anger video was rated slightly lower on anger than predicted. More specifically, the

contamination-related core disgust and mutilation-related core disgust video clips received high ratings only on grossed out, the bodily moral disgust video clips were rated the highest on morally disgusted and grossed out, and the non-bodily moral disgust video clips were rated the highest on morally disgusted and anger. These patterns are similar to those found in Study 1 and provide qualitative evidence to support the hybrid theory's assertion that bodily moral disgust is more similar to core disgust, whereas non-bodily moral disgust is more similar to anger.

The physiological results were more ambiguous: all of the emotion conditions (with the exception of mutilation-related core disgust, which did not differ from baseline) resulted in decreased RSA; the three emotion conditions in which a change in heart rate was observed (contamination-related core disgust, non-bodily moral disgust, and anger) all had a higher heart rate than baseline; and asymmetry differences compared to baseline were only found in two conditions (bodily moral disgust and anger), both of which had greater relative left activation than baseline. These results provide mixed evidence for and against the hybrid theory (see Table 13 for a comparison of the hypotheses and actual outcomes). The psychophysiological profiles of bodily moral disgust and non-bodily moral disgust differed from one another, as expected. There was some evidence to support that the bodily moral disgust physiological responses were similar to those of contamination-related core disgust, as predicted. However, the non-bodily moral disgust psychophysiological response patterns, which were expected to be similar to anger, differed from anger. A closer look at the data in Table 11 reveals that the non-bodily moral disgust physiological responses were actually similar to the responses to the contamination-related core disgust videos. This goes against what the hybrid theory would predict and is unexpected based on the participants' ratings of the video clips.

The asymmetry scores for Fp2/Fp1 and F4/F3 did not differentiate between the emotion types. However, there was much more variation among the F8/F7 asymmetry scores. The results suggested contamination-related core disgust and mutilation-related core disgust were associated with greater right than left frontal activation at F8/F7, as expected. Non-bodily moral disgust and anger were associated with greater left than right frontal activation at F8/F7 as expected. Interestingly, bodily moral disgust was also associated with greater left than right frontal activation at F8/F7, which was not predicted.

Discussion (Study 2)

The purpose of Study 2 was to explore relations between core disgust and moral disgust. Russell and Giner-Sorolla (2011) proposed that there are two types of moral disgust. They suggested that one type of moral disgust, bodily moral disgust, is directly related to disgust and the other type of moral disgust, non-bodily moral disgust, is directly related to anger. This study tested this hybrid theory of disgust by examining the frontal asymmetry, heart rate, and RSA changes in response to emotionally charged video clips. If the hybrid theory is correct, the physiological responses to contamination-related core disgust and bodily moral disgust video clips were expected to be similar while the physiological responses to non-bodily moral disgust and anger video clips were expected to be similar. The results of Study 2 provided some evidence to support this theory.

It was hypothesized that contamination-related core disgust and bodily moral disgust would result in greater relative right than left frontal cerebral activity, increased heart rate, and increased RSA from baseline. The results of Study 2 partially supported these hypotheses. No changes from baseline in frontal asymmetry were observed with the contamination-related core disgust video clips and the RSA decreased when compared to baseline. However, the

contamination-related core disgust video clips were associated with increased heart rate, relative to baseline. The bodily moral disgust video clips were associated with greater left hemisphere activation and decreased RSA when compared to baseline, which was not expected. There was not a change in heart rate associated with the bodily moral disgust video clips. When the physiological reactions to the contamination-related core disgust video clips were compared to the reactions to the bodily moral disgust video clips, the results were mixed: the bodily moral disgust psychophysiological profile was similar to one of the contamination-related core disgust video clips (CRCD A) but not the other (CRCD B). This is unexpected as the hybrid theory would suggest that the profiles should be the same for all contamination-related core disgust and bodily moral disgust video clips. Contamination-related core disgust video clip A depicted a filthy bathroom, feces, and a man gagging. The disgusting stimuli were present throughout the video clip, whereas participants may not have found contamination-related core disgust video clip B, which showed a man eating a tarantula, disgusting throughout the entire clip. Much of the video clip showed the build up before he ate the tarantula and may have elicited an anticipatory reaction in the participants until the disgusting conclusion.

It was also hypothesized that the non-bodily moral disgust and anger video clips would result in greater relative left frontal cerebral activity, increased heart rate, and decreased RSA. The results provided partial support of these hypotheses as well. The non-bodily moral disgust video clips were not associated with any change in frontal asymmetry relative to baseline and one of the anger video clips was associated with greater relative left frontal hemisphere activation. Both anger and non-bodily moral disgust were associated with increased heart rate and decreased RSA, as predicted. When the physiological reactions to the non-bodily moral disgust video clips were compared to the reactions to the anger video clips, the results suggested

that the psychophysiological profiles were different from one another. This is unexpected, as the non-bodily moral disgust physiological reactions were expected to mirror the reactions to the anger video clips.

The mutilation-related core disgust video clips were hypothesized to result in right frontal cerebral activation, decreased heart rate, and decreased RSA. However, the results suggested that the mutilation-related core disgust video clips did not differ from baseline. Therefore, this hypothesis was not supported. That there was not a decrease in heart rate nor RSA is particularly surprising, given Kreibig's (2010) assertion that the hallmark of core disgust is decreased cardiac output.

When considering each physiological measure in turn, it is important to note that although the RSA values differed from baseline, they did not differentiate the emotions. RSA decreased from baseline for all emotions where a change was observed (all emotions except mutilation-related core disgust). Other researchers have found that decreased RSA is associated with focusing attention (Porges, 2007). Therefore, it is possible that the RSA changes were due to cognitive factors not related to the emotional content of the video clips.

Similarly, when changes in heart rate were observed (for contamination-related core disgust, non-bodily moral disgust, and anger), the changes consistently increased relative to baseline. All of the observed changes were in the predicted directions. However, this may have been a reflection of arousal rather than an emotional response to the video clips. Interestingly, the bodily moral disgust video clips did not result in a change in heart rate relative to baseline.

Furthermore, it was important to consider the frontal asymmetry scores independent of the baseline scores. Although the asymmetry patterns for Fp2/Fp1 and F4/F3 did not differentiate the emotions, a variable pattern emerged from the F8/F7 asymmetry scores. The observed frontal

asymmetry scores indicated that contamination-related core disgust and mutilation-related core disgust were associated with greater right than left frontal activation. This was in the expected direction and in line with previous findings (Jones & Fox, 1992). Non-bodily moral disgust and anger were both expected to have greater relative left frontal activation, which was observed in this study. This is in line with previous findings that suggest approach emotions such as anger are associated with greater relative left frontal activation (Coan, Allen, & Harmon-Jones, 2001). This also supports the hybrid theory in that anger and non-bodily moral disgust have same EEG response patterns. Bodily moral disgust was expected to be associated with greater relative right frontal activity. However, the bodily moral disgust F8/F7 asymmetry score was associated with relative left frontal activation and was more similar to anger and non-bodily moral disgust than core disgust. Although it was not predicted, it is not surprising when considered in the context of the participant ratings. That is, in addition to being rated high on grossed out and morally disgust, the bodily moral disgust video clips were also rated high on anger.

It is worth noting that the participant ratings of the video clips provide evidence to support the idea that contamination-related core disgust and bodily moral disgust stimuli are similar and non-bodily moral disgust and anger stimuli are similar. Perhaps, more importantly, the participant ratings also revealed that the reaction to bodily and non-bodily moral disgust stimuli differ in that the participants felt grossed out when watching bodily moral disgust video clips but not non-bodily moral disgust video clips. This supports the hybrid theory, as feeling grossed out was the highest rated emotion for the core disgust video clips. Because "grossed out" is associated with core disgust and bodily moral disgust but not non-bodily moral disgust, it provides evidence to the hybrid theory's assertion that bodily moral disgust is directly related to disgust, whereas non-bodily moral disgust is not.

While there was some evidence to support the hybrid theory, the results of this study do not support the hypotheses. The response patterns for the five physiological variables were not all in the expected directions for any of the emotion conditions. Contamination-related core disgust was associated with mixed frontal asymmetry scores, increased heart rate, and decreased RSA. Mutilation-related core disgust was associated with mixed frontal asymmetry scores, no change in heart rate, and no change in RSA. Bodily moral disgust was associated with mixed frontal asymmetry scores, no change in heart rate, and decreased RSA. Non-bodily moral disgust was associated with mixed frontal asymmetry scores, increased heart rate, and decreased RSA. Anger was associated with mixed frontal asymmetry scores, increased heart rate for video A and no change in heart rate for video B, and decreased RSA.

General Discussion

The results of this study do not provide enough evidence to support or refute the hybrid theory of disgust. However, the hybrid theory was partially supported by the results of this study. The participants generally rated the video clips in the intended patterns. These ratings support the idea that bodily moral disgust is part of the disgust construct and non-bodily moral disgust is part of the anger construct. The F8/F7 asymmetry scores were the only physiological measure that differentiated the emotions. The Fp2/Fp1 and F4/F3 asymmetry scores, heart rate, and RSA results do not differentiate the emotions and do not provide evidence to support or refute the hybrid theory. The observed F8/F7 asymmetry scores were generally in the expected directions, with the exception of bodily moral disgust. Both contamination-related core disgust and mutilation-related core disgust were associated with greater relative right frontal activation, as expected. Non-bodily moral disgust and anger elicited greater relative left frontal activation, as expected. When taking the participant ratings and F8/F7 asymmetry scores into consideration, it

appears that the hybrid theory's assertion that non-bodily moral disgust is related to anger was supported. Bodily moral disgust, which was expected to elicit right frontal activation, was associated with left frontal activation.

The bodily moral disgust video clips appeared to have caused the greatest emotional response in participants. Four of the six emotion ratings were high (morally disgust, grossed out, anger, and sad) for bodily moral disgust, which is more than any other emotion condition. The morally disgusted ratings were higher for bodily moral disgust than non-bodily moral disgust and, more interestingly, the anger ratings were higher for bodily moral disgust than for non-bodily moral disgust and anger. It is important to keep in mind that these high ratings do not refute the hybrid theory. On the contrary, Russell and Giner-Sorolla (2011) point out that the dominant primary emotion elicited by bodily moral disgust is disgust (as evidenced by the high ratings on grossed out) and the secondary emotion is anger (as evidenced by the lower [than grossed out] ratings on anger). It is safe to say the bodily moral disgust video clips roused strong emotions in the participants and it is possible that these emotions are likely to result in behavioral approach in non-laboratory settings, which accounts for the observed greater relative left frontal activation. Despite the apparent strong emotional reaction to the bodily moral disgust video clips, there was not a change in heart rate from baseline. However, RSA did decrease from baseline.

This study was the first to directly test the hybrid theory of disgust. While the results of this study provided preliminary support for the hybrid theory, it was not without limitations. Participant recruitment was geographically limited and, with one exception, all participants were under the age of 30 years. It is unclear how these results would generalize to the greater population.

Furthermore, even though the total length of the two video clips for each emotion was roughly the same, the video clips may have differed from one another in intensity or duration of the emotionally poignant content. For example, as previously mentioned, one of the contamination-related core disgust video clips contained disgusting content throughout the entire clip, whereas the other video clip displayed the disgusting content near the end of the video clip. Both video clips received high ratings on grossed out because of the content but the first clip may have appeared to have a more intense physiological reaction because the participants had more time to feel disgusted. The video clips that were chosen to represent anger also differed from each other and were unable to be averaged together. Although the video clips were presented in a randomized order, the order the video clips was not counterbalanced. It is unclear what affect the order of the video clips had on the physiological reactivity.

Future research that explores the nature of the relations between core disgust and moral disgust should take these limitations into consideration. Furthermore, researchers should use care when selecting and describing the video clips they use. Researchers in the past have described emotional stimuli as "disgusting" without elaborating on whether they are referring to contamination-related core disgust, mutilation-related core disgust, bodily moral disgust, etc. It is imperative that researchers are taking the type of disgust into consideration when drawing conclusions about the nature of the emotion.

The use of additional physiological measures would be informative. The results of this study suggest there are differences in physiological reactivity for the different types of disgust with some physiological measures (i.e., EEG) but not others (i.e., ECG). Facial electromyography and electrogastrography would be particularly interesting measures to use due to the unique facial and gastrointestinal reactions to disgust (Chapman et al., 2009; Vrana, 1993).

Research in the future should also explore different methods of eliciting different types of disgust, such as reading vignettes. Furthermore, if researchers are able to determine which part of the emotional video clips is most disgusting, they can examine the physiological reactivity to that specific section and eliminate any extra noise that may come from other parts of the clip that aren't disgusting. Finally, it would be informative to explore whether there are differences in the explicitness of the emotional stimuli. That is, whether there are differences between using video clips, news clips, written vignettes, or in-person stimuli to elicit the different types of disgust.

Overall, the results of this study provide mixed results about the accuracy of the hybrid theory. While there is some evidence, such as the participant ratings and the pattern of the F8/F7 asymmetry scores, to support the hybrid theory, it cannot be overstated that none of the hypotheses were fully supported. Although the conclusions of this study cannot definitively define the relations between core disgust and moral disgust, they do provide evidence to warrant further investigation into this area and for further exploration into the associations between core disgust, moral disgust, and anger. In addition to testing the hypotheses related to the accuracy of the hybrid theory, the secondary aim of this study was to explore the psychophysiology of bodily and non-bodily moral disgust, which had not been done before this study. This appears to be the first study to break moral disgust into separate categories while measuring physiological reactions. The results of the study certainly support the idea that moral disgust is not a unitary construct and future research should take notice of the distinct qualities of bodily and non-bodily moral disgust when exploring these complex emotions.

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Table 1

Summary of Hypotheses

Emotion	Laterality	Heart Rate	RSA
Contamination Core	Right	↑	↑
Mutilation Core	Right	↓	↓
Bodily Moral	Right	↑	↑
Non-bodily Moral	Left	↑	↓
Anger	Left	↑	↓

Table 2

Study 1, Phase 1 Participant Ratings

Video ID	Anger	Fearful	Grossed Out	Happy	Morally Disgusted	Sad
CRCD A	2.38	1.69	6.50	1.15	4.12	2.19
CRCD B	1.88	2.23	6.19	1.07	3.46	1.38
CRCD C	1.54	1.35	6.54	1.38	2.92	1.12
CRCD D	1.85	1.15	4.04	1.58	2.12	1.81
MRCD A	2.50	4.00	4.16	1.00	2.27	4.35
MRCD B	1.69	2.35	6.50	1.04	3.27	1.77
MRCD C	1.77	3.65	2.88	1.00	2.15	4.54
MRCD D	1.15	1.27	4.42	1.00	1.31	1.31
BMD A	4.00	2.42	4.77	1.04	6.12	3.04
BMD B	4.88	2.73	4.73	1.00	6.81	4.00
BMD C	1.15	1.04	2.46	2.04	2.19	1.42
BMD D	6.31	2.38	5.65	1.00	6.92	5.69
NBMD A	5.07	2.38	2.27	1.00	6.00	3.96
NBMD B	5.69	1.92	2.00	1.00	6.19	5.23
NBMD C	3.46	1.58	1.23	1.85	3.73	2.15
NBMD D	3.85	1.12	1.54	1.12	4.04	3.81
Ang A	5.00	2.92	1.96	1.00	5.62	3.81
Ang B	5.46	3.19	4.04	1.00	6.54	6.12
Ang C	4.15	1.77	1.46	1.12	5.15	3.62
Ang D	4.27	1.77	1.31	1.00	4.31	4.46
Neu A	1.00	1.00	1.00	5.23	1.00	1.19
Neu B	1.00	1.31	1.00	3.46	1.00	1.58
Neu C	1.00	1.00	1.00	4.46	1.00	1.12
Neu D	1.00	1.00	1.00	3.73	1.00	1.19

Note. The numbers represent the average rating for each emotion for each video clip. CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; BMD = bodily moral disgust; NBMD = non-bodily moral disgust; Ang = anger; Neu = neutral.

Table 3

Study 1, Phase 2 Participant Ratings

Video ID	Anger	Fearful	Grossed Out	Happy	Morally Disgusted	Sad
CRCD A	2.07	1.63	6.50	1.18	3.30	2.14
CRCD B*	1.65	2.37	6.11	1.15	2.76	1.48
CRCD C*	1.34	1.46	6.31	1.18	2.51	1.40
CRCD D	2.14	1.32	4.24	1.13	2.35	2.07
MRCD A	2.20	3.33	3.92	1.05	2.23	4.18
MRCD B*	1.53	2.37	6.22	1.01	2.82	1.70
MRCD C	1.83	3.11	2.84	1.00	2.16	4.61
MRCD D	1.11	1.48	3.99	1.03	1.16	1.27
MRCD E*	1.22	1.34	6.15	1.01	1.50	1.28
BMD A	4.06	2.39	4.54	1.01	5.58	3.01
BMD B*	5.03	2.89	4.85	1.00	6.48	4.22
BMD C	1.15	1.04	2.49	1.66	1.93	1.40
BMD D*	5.91	2.68	5.02	1.00	6.54	5.32
BMD E	5.25	2.96	4.76	1.05	6.13	4.69
NBMD A*	4.99	2.47	2.33	1.03	5.72	4.38
NBMD B*	5.14	2.17	1.87	1.06	5.77	4.97
NBMD C	3.30	1.79	1.26	1.54	3.18	2.22
NBMD D	3.86	1.40	1.60	1.05	3.30	4.03
Ang A	4.59	3.05	1.89	1.03	5.47	4.03
Ang B	5.42	3.09	3.68	1.00	6.02	5.57
Ang C	4.21	1.74	1.54	1.06	4.76	3.68
Ang D*	4.29	1.82	1.34	1.02	4.13	4.14
Neu A	1.00	1.05	1.00	4.69	1.00	1.09
Neu B*	1.03	1.15	1.01	3.20	1.03	1.43
Neu C	1.01	1.05	1.01	3.77	1.00	1.08
Neu D*	1.00	1.05	1.00	2.86	1.00	1.12

Note. The numbers represent the average rating for each emotion for each video clip. Ang = anger; BMD = bodily moral disgust; CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; NBMD = non-bodily moral disgust; Neu = neutral; * = video was chosen for Study 2.

Table 4

Study 1, Phase 3 Participant Ratings

Video ID	Anger	Fearful	Grossed Out	Happy	Morally Disgusted	Sad
Ang E*	4.30	2.50	1.30	1.00	3.30	3.10

Note. The numbers represent the average rating for each emotion for the video clip. Ang = anger; * = video was chosen for Study 2.

Table 5

Study 2 Participant Ratings

Video ID	Anger	Fearful	Grossed Out	Happy	Morally Disgusted	Sad
CRCD A	1.41	1.82	6.18	1.10	2.25	1.47
CRCD B	1.49	2.88	5.78	1.43	2.16	1.53
MRCD A	1.57	2.67	6.00	1.06	2.43	1.71
MRCD B	1.25	1.69	6.06	1.18	1.59	1.20
BMD A	5.29	2.08	5.59	1.12	6.24	4.76
BMD B	5.37	2.92	5.41	1.00	6.35	4.24
NBMD A	4.35	2.08	1.76	1.10	5.14	4.35
NBMD B	5.22	2.67	1.88	1.08	5.55	4.53
Ang A	4.16	2.63	1.35	1.08	3.65	3.31
Ang B	3.94	1.71	1.27	1.20	3.73	3.61
Neu A	1.12	1.29	1.12	3.69	1.14	1.27
Neu B	1.00	1.35	1.06	4.06	1.00	1.41

Note. The numbers represent the average rating for each emotion for each video clip. Ang = anger; BMD = bodily moral disgust; CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; NBMD = non-bodily moral disgust; Neu = neutral.

Table 6

Between Subjects Effects for Gender

Emotion	F	Error df	η_p^2
CRCD	.002	37	.000
MRCD	.182	43	.004
BMD	.086	35	.002
NBMD	.011	42	.000
Anger	.005	42	.000
Neutral	.340	42	.008

Note. * = $p < .05$; BMD = bodily moral disgust; CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; NBMD = non-bodily moral disgust.

Table 7

Descritive Statistics for Physiological Variables for Each Video

Video		Fp2/Fp1	F4/F3	F8/F7	HR	RSA
A (NBMD)	(M)	-.072	.048	.013	72.609	6.450
	(SD)	.197	.254	.260	9.353	1.142
	(N)	49	48	49	49	48
B (BMD)	(M)	-.050	.040	.041	71.465	6.445
	(SD)	.160	.212	.247	9.049	1.332
	(N)	44	49	48	49	48
C (Ang)	(M)	-.053	.059	.006	72.274	6.482
	(SD)	.148	.236	.230	8.864	1.114
	(N)	49	48	49	49	48
D (Neu)	(M)	-.061	.002	-.032	71.369	6.733
	(SD)	.139	.235	.271	8.882	1.106
	(N)	48	49	49	49	48
E (MRCD)	(M)	-.051	.052	-.060	72.109	6.382
	(SD)	.204	.215	.260	8.599	1.155
	(N)	49	49	49	49	48
F (Ang)	(M)	-.065	.037	.034	71.037	6.350
	(SD)	.159	.233	.228	8.450	1.170
	(N)	47	49	49	49	48
G (BMD)	(M)	-.060	-.004	.057	71.741	6.434
	(SD)	.169	.256	.209	9.104	1.212
	(N)	46	48	46	48	47
H (CRCD)	(M)	-.075	.036	-.003	72.499	6.369
	(SD)	.202	.229	.244	8.519	1.271
	(N)	48	49	48	49	48
I (Neu)	(M)	-.078	-.012	-.047	73.149	6.601
	(SD)	.207	.242	.214	9.052	1.187
	(N)	48	49	49	49	48
J (NBMD)	(M)	-.102	.027	.020	73.598	6.219

	(SD)	.210	.236	.278	8.574	1.381
	(N)	49	48	49	49	48
K (CRCD)	(M)	-.086	.042	-.003	73.443	6.501
	(SD)	.199	.284	.237	8.881	1.206
	(N)	47	48	45	48	47
L (MRCD)	(M)	-.110	-.043	-.090	72.065	6.587
	(SD)	.232	.236	.345	8.778	1.110
	(N)	48	49	49	49	48

Note. Ang = anger; BMD = bodily moral disgust; CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; NBMD = non-bodily moral disgust; Neu = neutral.

Table 8

Main Effect for Same Emotion Comparison (both videos for each emotion)

Emotion	F	Error df	η_p^2
CRCD	7.178*	38	.159
MRCD	.005	44	.000
BMD	2.537	36	.066
NBMD	1.590	43	.036
Anger	10.085**	43	.190
Neutral	17.779**	43	.293

Note. * = $p < .05$; ** = $p < .01$ BMD = bodily moral disgust; CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; NBMD = non-bodily moral disgust.

Table 9

Comparison to Vanilla Baseline

	Main Effect			Interaction		
Emotion	F	Error df	η_p^2	F	Error df	η_p^2
CRCD A	2.513	42	.056	3.545*	39	.267
CRCD B	17.675**	39	.312	9.691**	36	.518
MRCD	0.702	43	.016	1.784	40	.151
BMD	1.357	35	.037	4.253**	32	.347
NBMD	15.622**	43	.266	12.095**	40	.547
Anger A	2.252	43	.050	4.606**	40	.315
Anger B	1.998	42	.045	8.385**	39	.462

Note. * = $p < .05$; ** = $p < .01$; BMD = bodily moral disgust; CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; NBMD = non-bodily moral disgust.

Table 10

T-tests for Physiological Variables (Compared to Baseline)

Emotion		Fp2/Fp1	F4/F3	F8/F7	HR	RSA
CRCD A	(t)	.633	-1.174	-.887	-2.147*	3.011**
	(df)	46	48	47	48	47
CRCD B	(t)	1.354	-1.059	-1.612	-4.256**	2.081*
	(df)	45	47	44	47	46
BMD	(t)	-.546	-.415	-2.572*	-.951	3.133**
	(df)	40	47	44	47	46
NBMD	(t)	1.474	-1.401	-1.612	-4.967**	4.267**
	(df)	47	46	48	48	47
Anger A	(t)	-.396	-2.349*	-1.526	-2.131*	2.431*
	(df)	47	47	48	48	47
Anger B	(t)	.334	-1.179	-1.958	.750	3.673**
	(df)	45	48	48	48	47

Note. * = $p < .05$; ** = $p < .01$; BMD = bodily moral disgust; CRCD = contamination-related core disgust; NBMD = non-bodily moral disgust.

Table 11

Comparisons Between Emotions

Emotion	Anger A	Anger B	CRCD A	CRCD B	MRCD	BMD
CRCD A	0.023	11.497**				
CRCD B	8.985**	22.344**				
MRCD	0.300	6.310*	1.080	15.772**		
BMD	1.019	6.459*	0.419	5.449*	.197	
NBMD	4.837*	20.018**	1.479	2.158	5.033*	11.806**

Note. The numbers in the table represent the F-value for the main effect for each comparison; * = $p < .05$; BMD = bodily moral disgust; CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; NBMD = non-bodily moral disgust.

Table 12

Frontal Asymmetry Effects

Emotion		Fp2/Fp1	F4/F3	F8/F7
CRCD A	(Asymmetry)	Right*	Left	Right*
	(M)	-.075	.039	-.003
	(SD)	.202	.229	.244
	(N)	48	49	48
CRCD B	(Asymmetry)	Right*	Left	Right*
	(M)	-.086	.042	-.003
	(SD)	.199	.284	.237
	(N)	47	48	45
MRCD	(Asymmetry)	Right*	Left	Right*
	(M)	-.081	.005	-.075
	(SD)	.191	.205	.275
	(N)	48	49	49
BMD	(Asymmetry)	Right*	Left	Left
	(M)	-.050	.018	.049
	(SD)	.157	.205	.220
	(N)	42	48	45
NBMD	(Asymmetry)	Right	Left*	Left*
	(M)	-.087	.041	.017
	(SD)	.186	.229	.242
	(N)	49	47	49
Ang A	(Asymmetry)	Right	Left*	Left*
	(M)	-.053	.059	.006
	(SD)	.148	.236	.230
	(N)	49	48	49
Ang B	(Asymmetry)	Right	Left*	Left*
	(M)	-.065	.037	.034
	(SD)	.159	.233	.228
	(N)	47	49	49

Neu A	(Asymmetry)	Right	Left	Right
	(M)	-.061	.002	-.032
	(SD)	.139	.235	.271
	(N)	48	49	49

Note. * = in the predicted direction (no predictions were made for the neutral video clips); Ang = anger; BMD = bodily moral disgust; CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; NBMD = non-bodily moral disgust; Neu = neutral.

Table 13

Hypotheses and Actual Outcomes

	Hypothesized					Actual				
Emotion	Fp2/Fp1	F4/F3	F8/F7	HR	RSA	Fp2/Fp1	F4/F3	F8/F7	HR	RSA
CRCD A	Right	Right	Right	↑	↑	Right*	Left	Right*	↑*	↓
CRCD B	Right	Right	Right	↑	↑	Right*	Left	Right*	↑*	↓
MRCD	Right	Right	Right	↓	↓	Right*	Left	Right*	--	--
BMD	Right	Right	Right	↑	↑	Right*	Left	Left	--	↓
NBMD	Left	Left	Left	↑	↓	Right	Left*	Left*	↑*	↓*
Anger A	Left	Left	Left	↑	↓	Right	Left*	Left*	↑*	↓*
Anger B	Left	Left	Left	↑	↓	Right	Left*	Left*	--	↓*

Note. HR and RSA are relative to baseline; Frontal asymmetries are the observed directions; * = in the predicted direction; -- = no change; BMD = bodily moral disgust; CRCD = contamination-related core disgust; MRCD = mutilation-related core disgust; NBMD = non-bodily moral disgust.

Appendix A

Description of Video Clips

Contamination-related core disgust:

- Video A: 57 seconds; a man puts dead mice into a blender and then drinks the mice
- Video B: 60 seconds; a man eats a live tarantula
- Video C: 59 seconds; a scene from *Trainspotters*; a man walks into a very dirty bathroom, makes a bowel movement on the toilet, realizes something dropped into the toilet, and attempts to retrieve it. Shows feces and the actor is gagging.
- Video D: 39 seconds; multiple football players vomiting on the field

Mutilation-related core disgust:

- Video A: 54 seconds; clip from war scene in *Saving Private Ryan*; blood and gut exposure is shown
- Video B: 41 seconds; a man uses a sword to cut off his own tongue. Blood and the severed tongue are shown
- Video C: 40 seconds; clip from *Grey's Anatomy*; a woman slips on a dead body that has bled out on the floor
- Video D: 43 seconds; a person films a medical procedure being performed on his leg; blood continues to pour out of his leg
- Video E: 55 seconds; added in Study 1, Phase 2; a person films himself popping a cyst on his leg; blood and pus come out of the wound

Bodily moral disgust:

- Video A: 61 seconds; an older man flirts with a 14 year old girl and playfully spanks her even though she repeatedly attempts to avoid his advances
- Video B: 68 seconds; a man is grooming a young child and makes inappropriate physical contact with her
- Video C: 44 seconds; two men engage in heavy kissing
- Video D: 52 seconds; a news story describing a case of incest
- Video E: 47 seconds; added in Study 1, Phase 2; a news story describing a pediatrician who molested some of his patients

Non-bodily moral disgust:

- Video A: 60 seconds; shows six teenaged girls bullying a 16 year old girl while a news reporter describes the situation
- Video B: 50 seconds; racism: video of White police officers using violence against Black children who are non-violently protesting
- Video C: 51 seconds; a scene from *25th Hour*; Edward Norton rants against Christianity and Islam
- Video D: 36 seconds; a homophobic mother scolds her son for being gay

Anger:

- Video A: 32 seconds; video of a girl being kidnapped and shouting for help while adults pass by and do not help the girl
- Video B: 64 seconds; a teenaged boy beats up 2 other teenager and kills their dog
- Video C: 52 seconds; a teenaged girl is disrespectful to her mother
- Video D: 58 seconds; a young boy is disrespectful to his mother and slaps her
- Video E: 58 seconds; added in Study 1, Phase 3; a man knocks another man off his motorcycle then hits and kicks the motorcycle

Neutral:

- Video A: 57 seconds; shows various nature scenes for ~5 seconds each while classical music plays
- Video B: 49 seconds; video of a snowy beach scene
- Video C: 52 seconds; video of a lake scene
- Video D: 52 seconds; video of an open field on a breezy day

Note: The videos that are underlined were used in Study 2.

Appendix B

Emotional Intensity Rating Form

☐ Please check this box to give consent for your responses to be used for research purposes. The purpose of this project is to find appropriate video clips to use for my dissertation project. I am trying to find video clips that elicit certain emotions. Your responses will remain confidential.

How did you feel while watching the videos?

Video A	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7

Video B	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7

Video C	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7

Video D	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7

Video E	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7

Appendix C
Online Screening Questions

Sex _____

On average, how many cigarettes do you smoke a day?

Have you ever had a head injury in which you lost consciousness?

Have you ever been treated for depression, anxiety, or any other type of mental illness?

Have you ever been diagnosed with a cardiovascular disorder?

What medications are you currently taking?

Which hand do you <u>prefer</u> to use for each of these activities?

Please put <u>R</u> (right hand), <u>L</u> (left hand), or <u>E</u> (either hand).

a. Writing _____

b. Drawing _____

c. Throwing _____

d. Scissors _____

e. Toothbrush _____

f. Knife (without fork) _____

g. Spoon _____

h. Broom (upper hand) _____

i. Striking match (to hold match or Bic) _____

j. Opening jar (hand on lid) _____

k. Which foot do you prefer to kick with? _____

l. Which eye do you use when using only one? _____

Appendix D

Informed Consent Form

What is the purpose of this research? The purpose of this project is to look at the neurophysiological reactions to various emotional stimuli.

What will be expected of me? You will be asked to fill-out a demographics form then have electroencephalogram (EEG) and electrocardiogram (ECG) electrodes applied to your scalp and torso. You will watch and rate several video clips and then the electrodes will be removed.

How long will the research take? Your participation will take approximately one hour.

Will my answers be confidential? Yes. Your name will not be used at all in this research. You will not put your name on the demographic forms or rating forms, and the researchers will not know how you responded on any of the forms. Your data will be coded using a confidential number.

Can I withdraw from the study if I decide to? Yes, you can withdraw from the research at any time, without penalty, and ask that your data not be used.

Is there any harm that I might experience from taking part in the study? While it is unlikely that you will experience side effects from participating, it is a possibility that you may experience discomfort or other mild effects from the videos. If at any point you experience discomfort, you may notify the researchers and be excused from the study. Any uncomfortable symptoms you may feel will be short-term.

How will I benefit from taking part in the research? You will obtain the satisfaction of knowing that you participated in a study that spans the emotion, social psychology, and neuropsychology fields.

Who should I contact if I have questions or concerns about the research? Contact me (Lauren Golden) at llgolden@vt.edu. You can also contact Dr. Martha Ann Bell, faculty director of the project, at mabell@vt.edu or Dr. David Moore, who chairs the university's Institutional Review Board (the committee reviews all research for compliance with ethical guidelines concerning the treatment of research participants). Dr. Moore can be reached at 540-231-4991 (or moored@vt.edu).

Participant Name_____ Date_____

Participant Signature_____

Appendix E
Participant Information Form

Age: _____ Ethnicity: _____

On average, how many cigarettes do you smoke a day? _____

How many cigarettes have you smoked in the last 24 hours? _____

On average, how much alcohol do you consume a day? _____

Have much alcohol have you consumed in the last 24 hours? _____

On average, how much caffeine do you consume a day? _____

How much caffeine have you consumed in the last 24 hours? _____

Have you ever had a head injury in which you lost consciousness? Y/N

Have you ever been treated for depression, anxiety, or any other type of mental illness? Y/N

Have you ever been diagnosed with a cardiovascular disorder? Y/N

Are you currently wearing contacts? Y/N

Are you currently taking any medications? Y/N

- If yes, please list: _____

_____

_____

Appendix F

Description of Video Clips

Contamination-related core disgust:

- Video A: 59 seconds; a scene from *Trainspotters*; a man walks into a very dirty bathroom, makes a bowel movement on the toilet, realizes something dropped into the toilet, and attempts to retrieve it. Shows feces and the actor is gagging.
- Video B: 60 seconds; a man eats a live tarantula

Mutilation-related core disgust:

- Video A: 41 seconds; a man uses a sword to cut off his own tongue. Blood and the severed tongue are shown
- Video B: 55 seconds; added in Study 1, Phase 2; a person films himself popping a cyst on his leg; blood and pus come out of the wound

Bodily moral disgust:

- Video A: 52 seconds; a news story describing a case of incest
- Video B: 68 seconds; a man is grooming a young child and makes inappropriate physical contact with her

Non-bodily moral disgust:

- Video A: 50 seconds; racism: video of White police officers using violence against Black children who are non-violently protesting
- Video B: 60 seconds; shows six teenaged girls bullying a 16 year old girl while a news reporter describes the situation

Anger:

- Video A: 58 seconds; a man knocks another man off his motorcycle then hits and kicks the motorcycle
- Video B: 58 seconds; a young boy is disrespectful to his mother and slaps her

Neutral:

- Video A: 52 seconds; video of an open field on a breezy day
- Video B: 49 seconds; video of a snowy beach scene

Appendix G

Emotional Intensity Rating Form

How did you feel while watching the videos?

Video A	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7

Video B	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7

Video C	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7

Video D	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7

Video E	**Not at all**			**Somewhat**			**Very much**
Angry	1	2	3	4	5	6	7
Fearful	1	2	3	4	5	6	7
Grossed Out	1	2	3	4	5	6	7
Happy	1	2	3	4	5	6	7
Morally disgusted	1	2	3	4	5	6	7
Sad	1	2	3	4	5	6	7