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Stepheni Uh April 16th, 2014

The Relationship Between Sociomoral Disgust and Physical Disgust: Investigation of Facial Affect in Response to Purity and Fairness Violations

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Abstract

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By Stepheni Uh

There has been much recent speculation regarding the relationship between sociomoral disgust, which refers to disgust elicited by moral violations, and the type of disgust elicited by physical stimuli such a rotten food. This study investigated whether there were similar facial expressions of disgust elicited by two types of moral transgressions and physically disgusting behaviors. This study also explored whether facial muscle activity would reflect spontaneous person affect knowledge retrieval after participants were presented with minimal information regarding a person's face and behavior. The two types of moral transgressions were fairness and purity moral transgressions, which are two out of the five moral foundations (purity, fairness, harm, authority, ingroup) in the Moral Foundations Theory (Haidt and Joseph, 2004). Facial muscle activity related to disgust (levator labii) and anger as well as overall negative affect (corrugator supercilii) was recorded while participants associated faces with behavioral statements. The same facial muscle activity was also recorded while participants were shown faces that were previously associated with behavioral statements in a later task. Facial disgust reactions were similar in response to physically disgusting behaviors as well as purity transgressions, but fairness transgressions did not elicit significant facial reactions. Faces that had been previously associated with moral transgressions, physically disgusting, or neutral behaviors also did not evoke facial disgust, showing no transfer of person affective trait knowledge, contrary to previous neuroimaging findings (Todorov et al., 2007). These results suggest that purity vs. fairness transgressions differentially elicit facial disgust reactions, with only purity transgressions eliciting facial disgust activity. These results suggest that these two domains of moral transgressions differ in their similarity to the processing of physical disgust stimuli, consistent with theoretical views that posit that only some moral violations have a basis in the basic emotion of disgust.

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1. Introduction

The notion that the basic emotion of disgust mediates a variety of social and cognitive aspects of human behavior, such as social interaction and perception of others, is a relatively new concept (Kelly, 2011). Disgust has traditionally been related to offensive physical stimuli that elicit behaviors such as withdrawal or rejection (Haidt et al., 1997). These stimuli include concrete objects including feces, vomit, insects, and etc. This type of disgust is most commonly referred to as *physical disgust* – in other words, the emotion one experiences when exposed to concrete, external, and offensive stimuli such as the aforementioned stimuli (Haidt et al., 1997). More recently, it has been suggested that the cognitive and affective processing involved in physical disgust is also involved in more complex domains including sociomoral transgressions (Kelly, 2011; Chapman and Anderson, 2012). Sociomoral transgressions involve behaviors that violate social and moral norms; for the purposes of this paper, disgust elicited by these transgressions is referred to as *sociomoral disgust* (Chapman and Anderson, 2013). This linkage between the emotion of disgust and the abstract nature of morality has been controversial, however, and few studies have examined the empirical basis for this relationship (Pizarro et al., 2011). The focus of the current study, therefore, is to further examine the role of disgust in moral judgments and violations.

Although disgust has been recognized as a basic and universal human emotion since the time of Darwin, disgust has been the subject of relatively fewer empirical studies than other basic emotions such as fear (Chapman and Anderson, 2012). Disgust has been proposed to have originated from distaste: a form of motivated food rejection after the ingestion of unpleasant-tasting substances, particularly ones that are bitter (Rozin et al., 1999a; Chapman and Anderson, 2012). The behavioral response of distaste is normally oral rejection or simply spitting out the

unpleasant substance (Chapman and Anderson, 2012). In concurrence with the idea that disgust originated from distaste, researchers proposed that the evolutionary advantage of disgust is its function in preventing humans from ingesting or coming into contact with diseases, toxins, or parasites by motivating withdrawal responses from the source(s) of disease – especially food sources (Haidt et al., 1997).

Researchers initially identified disgust very closely with distaste due to similarities in the behavioral responses when experiencing either disgust or distaste: withdrawal behaviors, oral expulsion, physiological concomitants of nausea and gagging, and etc. (Haidt et al., 1994). Rozin and Fallon (1987), for instance, defined disgust as a food-related emotion that causes revulsion at the idea of coming into physical contact (i.e. orally) with the offensive object(s). Darwin also identified disgust as an emotion related to one's sense of taste while Ekman and Friesen (1975) described disgust as a rejection response centered on eating (Haidt et al., 1994). Researchers of disgust, however, were careful to differentiate disgust from distaste despite the fact that their definitions of disgust revolved around distaste.

One strong distinction suggested by many researchers involves the notion that disgust is more of a human subjective emotion while distaste is more widespread among mammalian species (Rozin et al., 1999a). This characteristic difference is thought to be due to the different natures of distaste and disgust. For instance, the behavioral rejection response of distaste is more based upon sensory properties in which the taste, and perhaps smell, of the substance is the primary factor for causing distaste (Rozin et al., 1999a; Chapman and Anderson, 2012). Disgust, on the other hand, is not only elicited by sensory properties of the "disgusting source" but more so by the offensive and contaminating nature of that source (Haidt et al., 1997). Rozin and Fallon (1987), for instance, separated their definition of disgust (mentioned above) from distaste by

asserting that offensive objects are "contaminants" in that they can potentially make adequate food unacceptable even by brief contact or simply association with the food; the contaminants, though, are not necessarily objects that taste bad (Rozin and Fallon, 1987; Haidt et al., 1997). Through this albeit narrow definition, Rozin and Fallon (1987) contributed to the notion that disgust is uniquely human, unlike distaste, and also helped fuel research investigating what other sources in addition to food sources represent offensive and contaminating properties that make something disgusting.

Due to the various types of stimuli that induce the subjective experience of disgust, which also further distinguishes disgust from distaste, several types of disgust have been recently encompassed under the category of *physical disgust*. The original form of disgust was often referred to as *core disgust* by researchers. Core disgust was identified by the definition of disgust provided by Rozin and Fallon (1987) regarding "revulsion at the prospect of (oral) incorporation of an offensive substance" (p. 23). This type of disgust, which is now considered to be a component of physical disgust, is physically signified by nausea or a food-related sensation that discourages ingestion and may induce vomiting as well as the "gape face" otherwise known as the "yuck face," which involves raising of the upper lip and wrinkling of the nose (Rozin et al., 1999a). It is also the category of disgust that is most relatable to the behavioral responses of distaste (Haidt et al., 1997; Chapman and Anderson, 2012). *Animal-nature disgust* also represents a type of physical disgust; it involves elicitors such as poor hygiene, inappropriate sex, and body violations such as blood or injuries (Rozin et al., 1999a). Rozin and colleagues (1987; 1993) suggest that this type of disgust represents the offensive idea that humans are animals. In other words, humans feel disgusted by the potential of being similar to animals and thus avoid engaging in activities that involve the aforementioned elicitors (Rozin et al., 1999a). Animal-

nature disgust, therefore, highlights the social functions of disgust, which arguably make this emotion unique to humans in that it serves to allow humans to reject their "animal natures" (Rozin et al., 1999a). Another type of physical disgust is known as *interpersonal disgust* (Rozin et al., 1999a; Chapman and Anderson, 2012). Interpersonal disgust highlights the contamination property of disgust, otherwise referred to as "contagion," in that it functions to avoid interacting with other people that have been involved in something disgusting, which ranges from something unfamiliar to being diseased (Rozin et al., 1994; Chapman and Anderson, 2012)[1]. This contamination property of disgust has been emphasized in past research. For example, Rozin and colleagues (1994) found that subjects were less willing to wear washed sweaters previously worn by healthy strangers than new sweaters and even less willing to wear washed sweaters worn by people who had a history of misfortune (i.e. limb amputations), infectious disease, or moral taints (i.e. convicted murderers). Interpersonal disgust, therefore, functions to reject people as partners for social contact – whether it is sharing food or clothes or a casual touch – and further emphasizes the social nature of disgust by influencing humans to be selective and critical (Rozin et al., 1999a; Chapman and Anderson, 2012). Core, animal-nature, and interpersonal disgust represent three main categories of physical disgust. They primarily involve concrete and physical elicitors for the disgust response, which is characterized by behavioral withdrawal as well as distinct physiological responses.

Most current theoretical accounts of emotion stipulate that emotional changes occur in three interrelated domains: subjective experience of emotion, physiological and somatic changes such as changes in heart rate and facial expression, and central nervous system (brain) changes (Lang et al., 1998). Thus, studies of disgust have examined its correlates in each of these three

[1] Contagion or the contamination effect of disgust is not only restricted to other humans. Past work has shown that contamination can occur through objects by psychological contamination (where no physical contact occurs but one associates the disgusting object to the neutral object) or brief contact between a potentially disgusting object with a neutral object (refer to Rozin et al., 1986; Morales and Fitzsimons, 2007)

domains. The extent to which activity in each of these domains is correlated remains unclear due to the limited amount of neuroimaging studies done on disgust (Kelly, 2011; Chapman and Anderson, 2013). However, one region has been most commonly identified as a neural marker of disgust, the anterior part of the insula (Chapman and Anderson, 2013). Wright and colleagues (2004), for instance, found that the anterior insula was activated when participants observed disgust-inducing pictures of contamination and human mutilation. Jabbi and colleagues (2008) similarly found increased anterior insular activation when participants looked at disgusted facial expressions. Furthermore, Wicker and colleagues (2003) found that when participants inhaled odorants that produce a strong feeling of disgust and when the same participants observed video clips that showed disgusted facial expressions, the same sites in the anterior insula as well as the anterior cingulate cortex (though not as strongly as in the insula) were activated. A more concrete indicator of disgust, though, is the facial expression that involves the gape face (Kelly, 2011). The levator labii (LL) superioris muscle activity mediates this facial expression (raising of the upper lip and/or wrinkling of the nose; Chapman et al., 2009; Boxtel, 2010; Chapman and Anderson, 2013). This expression has been recognized cross-culturally as an indicator of disgust (Ekman et al., 1978; Kelly, 2011; Chapman and Anderson, 2013). Attention and memory biases for disgusting stimuli have also been found in various studies (Kelly, 2011). Radomsky and Rachman (1999), for example, found that obsessive-compulsive disorder (OCD) patients had better memory for objects that were contaminated than those that were not.

Todorov and colleagues (2007), furthermore, conducted a neuroimaging study on face perception by presenting unfamiliar faces with behavioral statements, some of which corresponding to physically disgusting behaviors. They investigated whether affective person knowledge based on memories formed from minimal information is spontaneously retrieved in

face perception (Todorov et al., 2007). They found that faces that were previously associated with disgusting behaviors activated the anterior insula more significantly than aggressive or positive behaviors (Todorv et al., 2007). This finding is especially interesting due to the paradigm of their study; participants were told to memorize the faces with their paired behaviors, followed by a cover task (one-back recognition task in the scanner that does not require any person evaluation or retrieval of person knowledge) in which participants showed distinct brain activity (i.e. anterior insular activation when shown a face previously associated with a disgusting behavior) when observing faces that were associated to different types of behaviors (Todorv et al., 2007). Their study suggests that even minimal exposure to affective trait knowledge regarding a face can impact spontaneous affective person knowledge as indicated by a transfer of neural activity (i.e. anterior insular activity during the cover task), which has many implications for the social brain (Todorv et al., 2007). Many studies have investigated these indicators utilizing physical disgust stimuli. Though, along with the recent growth of interest in and research done on disgust, the angles at which researchers have approached disgust studies have also diversified. In particular, various researchers have proposed a relationship between disgust and moral behavior; yet, some researchers remain skeptical as to whether or not this type of disgust truly exists (Borg et al., 2008).

Sociomoral disgust is a relatively new domain of disgust that has been distinguished from the physical disgust domain (Rozin et al., 1999a; Chapman and Anderson 2012). Sociomoral transgressions, generally categorized as behaviors and thoughts that violate social and moral norms, are proposed to represent the main elicitors of this type of disgust. In addition, researchers have linked disgust with moral behavior due to the similarities in the language used to describe both disgust and moral transgressions (Jones and Fitness, 2008). For example,

criminal offenses are often described as “revolting,” “disgusting,” or “rotten.” According to Haidt and colleagues (1997), sociomoral disgust is described in America as primarily a type of character judgment of those who jeopardize the dignity of others, such as criminals. Rozin and colleagues (1999a), furthermore, argue that sociomoral disgust is reflected across a broad range of cultures and is used to “…reject certain classes of violators who are beyond redemption” (p. 436). Chapman and colleagues (2009) have also suggested that despite the concrete and nonsocial origins of disgust (i.e. rejection of contaminated food and avoiding disease), this emotion may have evolved within the moral domain in that disgust motivates withdrawal from moral transgressors or from committing a moral offense.

It has been argued by several theorists that sociomoral disgust is simply metaphorical in that it may reflect other negative emotions like anger or frustration (Chapman et al., 2009). By this view, sociomoral disgust is not fundamentally similar to the basic emotion of disgust, and the link to more basic forms of disgust that is suggested by language is only apparent. Many recent disgust researchers have addressed this argument by exploring whether moral transgressions elicit similar behavioral responses as physical disgust stimuli do. Borg and colleagues (2008), for instance, conducted a functional neuroimaging study using sociomoral transgressions that involve incest and nonsexual moral acts as stimuli as well as pathogen scenarios for physical disgust stimuli. Interestingly, they found that the insula was only preferentially active in response to incest acts and not pathogen or nonsexual moral acts while the amygdala was more active for all of the disgust stimuli compared to neutral stimuli (Borg et al., 2008). Neural indicators of disgust in general, however, are still not as concrete and require more investigation due to the fact that disgust is not necessarily a unified psychological or neurological phenomenon (Borg et al., 2008). Physiological studies using LL activity as

indication of disgust have also been used to gauge the existence of sociomoral disgust. The underlying idea of these studies is that if sociomoral disgust is in fact a type of disgust, LL activity may be a reliable indicator for the experience of sociomoral disgust as it is for physical disgust (Chapman and Anderson, 2013). Chapman and colleagues (2009) showed that LL activity was evoked when participants experienced unfairness during the Ultimatum Game and the self-reported disgust was also positively correlated with the decision to reject unfair offers. Other behavioral studies have found that participants who had higher disgust sensitivity, measured by the Disgust Scale (Haidt et al., 1994), tended to deem suspects described in crime vignettes culpable more so than participants with lower disgust sensitivity (Jones and Fitness, 2008); that integral feelings of disgust predicted stronger moral condemnation of behaviors violating purity (Horberg et al., 2009); and that participants who were hypnotized to feel disgust when they saw an arbitrary trigger word later made more severe moral judgments when they read moral transgression vignettes with the presence of the trigger word than vignettes without the word (Wheatley and Haidt, 2005). Morality, nevertheless, is a complex concept that stimulates many debates regarding the definition of morality as well as whether sociomoral disgust is specific to only certain types of moral behaviors and situations (Chapman and Anderson, 2012).

No single agreed-on definition of morality is currently available, due in part to theoretical debates over the nature and complexities of morality (Chapman and Anderson, 2013). Philosophers and researchers have debated whether morality is built upon rationality or emotionality (Rozin et al., 1999b). Cross-cultural work, however, have emphasized the significance of moral emotions as the best predictors of moral judgments more so than rationality

and cognitive development (Haidt et al., 1993; Rozin et al., 1999b)[2]. Haidt and Joseph (2004) recently proposed the Moral Foundations Theory (MFT) as a means to identify the psychological foundations upon which cultures create their moral systems (Haidt et al., 2009)[3]. MFT divides moral foundations into five primary domains: (1) harm/care, (2) fairness/reciprocity, (3) ingroup/loyalty, (4) authority/respect, and (5) purity/sanctity. Harm/care refers to basic concerns for the suffering of others; fairness/reciprocity involves concerns about unfair treatment, inequality, and justice; ingroup/loyalty involves concerns related to loyalty, self-sacrifice, and vigilance against betrayal; authority/respect encompasses concerns related to social order as well as obedience, respect, and proper role fulfillment; and lastly, purity/sanctity refers to concerns about physical and spiritual contamination involving virtues of chastity and control of desires (Haidt and Joseph, 2004; Haidt et al., 2009).

Currently, few studies have investigated the relationship between disgust and each of the moral domains outlined in MFT. Cannon and colleagues (2011), for instance, showed participants one-sentence scenarios that described positive and negative behaviors reflecting each of the five domains in MFT while measuring facial muscle activity. They found that facial disgust (LL activity) was evoked significantly for purity violations, followed by fairness violations but not for the other MFT domains (Cannon et al., 2011). Horberg and colleagues (2009), on the other hand, found that disgust was related to moral judgments about purity but unrelated to moral judgments about fairness/reciprocity or harm/care[4]. Similar to the conclusions made by Horberg and colleagues (2009), Kelly (2011) as well as Rozin and Haidt (2013) emphasized that purity violations are significantly – if not the most out of the other domains –

[2] For the purposes of this paper, descriptions of moral emotions and moral judgments will be based upon the considerations provided by Chapman and Anderson (2013): moral emotions will refer to emotions associated with moral events while moral judgments will be considered to be assessments of moral value including right or wrong, should or should not do, good or bad.
[3] The moral foundations/domains in MFT cannot be directly measured; rather the degree to which individuals endorse and value the virtues and concerns built upon these foundations are capable of being evaluated (refer to Haidt et al., 2009)
[4] Moral judgment was operationalized through punishment and reward – a classic marker of morality (Horberg et al., 2009).

involved with disgust. Purity concerns are interesting due to the fact that they are primarily linked with "spiritual hygiene" though also linked with physical contamination (i.e. keeping the body, mind, and soul clean; Kelly, 2011). Purity norms vary across cultures but they are thought to be central to moral codes of many traditional or religious cultures thereby governing many social and personal behaviors (Kelly, 2011; Rozin and Haidt, 2013). The links between specific domains of moral transgressions and disgust, however, remain unclear.

1.1 Objectives

To date, few studies have investigated the psychophysiological similarities and/or differences in responses to physical versus sociomoral disgust situations. Also, since disgust has only recently been a significant topic of interest in cognitive neuroscience and other diverse fields, exploring the different realms of disgust will help fuel future studies on disgust. More specifically, there is a lack of knowledge concerning whether LL physiology can be a reliable indicator for the cognitive and emotional experience of sociomoral disgust. In addition, the relationship between the emotion of disgust and the particular types of moral transgressions remains unclear – particularly, whether certain domains of moral transgressions are more strongly linked to disgust than others (Chapman and Anderson, 2012). Though, based on past work, fairness and particularly purity foundations of the MFT seem to be most relevant to sociomoral disgust (Cannon et al., 2011; Rozin and Haidt, 2013). The behavioral findings (transfer of anterior insular activity when presented with faces that were previously associated with disgusting behaviors) of Todorov and colleagues (2007), furthermore, have not been explored using psychophysiological measures. Their particular behavioral paradigm is of great interest seeing that it investigates spontaneous facial perception retrieval, a social behavior that is very relevant across all cultures (Todorov et al., 2007). The aim of this study, therefore, is

threefold: (1) to further investigate and to determine whether particular types of sociomoral disgust can be assessed by LL physiology, (2) to clarify whether fairness/reciprocity and purity/sanctity transgressions represent sociomoral disgust, and (3) to explore whether there is a transfer of LL activity after associating unfamiliar faces with disgusting behaviors. The hypotheses for this study are as such: (1) Physical and sociomoral disgust behavioral statements will elicit more LL activity than neutral behavioral statements but LL activity related to physical and sociomoral disgust will not differ from each other, (2) Purity behaviors will result in LL activity most similar to physical disgust LL activity, and (3) faces previously associated with physically or sociomorally disgusting behaviors will still elicit LL activity during a task that does not require any retrieval of person knowledge.

2. Methods

2.1 Participants

Eighteen healthy young adult volunteers (6 males and 12 females) participated in this experiment. Their ages ranged from 18 to 22 years and the mean age was 19.6 years. Participants were recruited from Emory University's psychology department participant pool (SONA systems) and were compensated with class credit. The Emory University Institutional Review Board (IRB) approved this study's procedures. All participants gave informed consent prior to participating in the experiments using a standard consent form approved by the IRB for Human Research Subjects at Emory University

2.2 Stimuli

2.2.1 Initial Test Pictures

Before the experimental tasks, two disgusting and two neutral photo stimuli were presented to the participants in order to determine whether our study was sensitive enough to

detect LL changes to stimuli that have been established to elicit disgust responses. These pictures (four total) were taken from the International Affective Picture System (IAPS). One participant's data was not collected for this initial task due to technical complications.

2.2.2 Faces

The photo stimuli were frontal images of 100 faces (50 males and 50 females) that were selected from the Hamann Cognitive Neuroscience laboratory research set of neutral pictures. The stimuli were color photos and adjusted to be of equal size and luminance.

2.2.3 Behaviors

80 verbal descriptions of behaviors were used for this study (four sets of 20 different behaviors; see Appendix 1). Each set represented a specific behavioral domain: physically disgusting, purity, fairness, and neutral. The purity and fairness sets reflect two domains of moral behaviors as outlined in the Moral Foundations Theory (Haidt & Joseph, 2004). The physically disgusting and neutral behaviors were taken from a previous study on facial perception (Todorov et al., 2007). Some of the purity and fairness behaviors were taken from a study investigating moral disgust (Cannon et al., 2011) while the rest of the behaviors in these two sets were based upon previous work regarding morality and disgust (Haidt et al., 2009; Horberg et al., 2009; Chapman and Anderson, 2012).

2.3 Procedures

2.3.1 Encoding

The experimental tasks were divided into three psychophysiological tasks in which the facial electromyographic (EMG) data were collected. These tasks were created through the program PsyScope X and completed on the computer. Participants were told that the electrodes (referred to as "sensors" during the study) placed on their faces were used to collect cognitive

and affective responses. In the first task (the encoding phase), participants were told that they would engage in a passive memorization task. They were asked to look at a series of photos of faces and behavioral sentences, associate each face with the behavioral statement provided, and to remember them for a later task. Similar to the study done by Todorov et al. (2007), participants were told that it was easiest to remember the stimuli by imagining the person shown actually performing the behavior that appears with the face. One trial consisted of a face and behavioral statement presented for 6s followed by an inter-trial interval of 2 s. Four presentation blocks of 80 face-behavior trials (20 trials for each of the 4 behavioral domains) were presented to the participants. There was a 5 s break between each block (3 total breaks). Within each block, there were five behavioral statements from each domain (four domains total) presented in random order with the associated faces. The behaviors assigned to each of the faces for all 80 trials and the order in which they were presented were counterbalanced using a Latin Square design, resulting in five different lists of face-behavior pairs. The encoding phase took approximately 11 minutes to complete.

2.3.2 Test

In the test phase, we investigated the hypothesis that there would be a transfer of the affective trait information between the encoding phase and the test phase, as assessed by physiological responses (facial EMG activity), when the faces from the encoding phase were shown again without their accompanying affective trait sentences. To ensure that participants viewed each face, a gender discrimination task was used in which participants were instructed to make a decision regarding the gender of the face that was shown (male or female). The gender discrimination task allowed responses to the faces to be investigated without explicitly requiring participants to try to retrieve the affective traits that had been previously associated with each

face. They were told to press the key “m” if the face shown is male or “n” if female. 20 novel faces were intermixed with the 80 faces presented in the encoding phase. The 100 faces were divided into five blocks, and each face was presented for 6 s with an inter-trial interval of 2 s as well as 5 s breaks between each block. Similar to the encoding phase, five behavioral statements from each domain were randomly presented within one block. The order of the faces shown was counterbalanced using a Latin Square design, resulting in five different presentation orders. This task took each participant approximately 13 minutes.

2.3.3 Recall

After the completion of the test phase, participants were asked to make person judgments of the 80 faces that were presented in the encoding phase and also to recall the behaviors that had been associated with the faces during the encoding session. Participants were asked to write down the statements that they remembered to the best of their abilities and then to make their person judgments through a forced choice categorization task. They were asked to indicate, regardless of whether they remembered the actual behavior associated with the face, whether each face was associated with one of the four categories: physically disgusting, purity, fairness, or none of these. They were provided with examples regarding the four categories. Physically disgusting behaviors, for instance, were explained as behaviors that involve disgusting incidents such as having a cockroach infestation in their room. Purity behaviors, on the other hand, were described to be behaviors that involve physically or mentally affecting or contaminating one’s body and/or mind. Examples of purity behaviors included eating unhealthy foods, smoking cigarettes all the time, and thinking about or performing unsacred behaviors. Fairness behaviors were explained as behaviors that involve concerns of equality such as lying or cheating. Participants were instructed to circle the option “none of these” if they believed the face

presented was not associated with any of the aforementioned categories. For the moral categories, the word “moral” was purposely omitted in the instructions. This task was self-timed and took, on average, approximately 20 minutes for each participant.

2.3.4 Ratings

After the completion of the recall task, the participants had the facial EMG electrodes removed and then completed rating scales for the 80 behavioral statements that were presented in the encoding task. Due to the abstract nature and difficulty of defining morality, participants were asked to rate each statement in terms of moral relevance. Instructions for this part of the ratings task included moral relevance referring to behaviors that require one to think about whether that behavior is right or wrong or something that one should or should not do – particularly in the cases that those behaviors will positively or negatively impact someone else. These explanations were based on previous work done on morality (Haidt and Joseph 2007). They were asked to indicate moral relevance on a 0 to 3 scale with 0 corresponding to not at all relevant, 1 as somewhat morally relevant, 2 as substantially morally relevant, and 3 as very morally relevant. Participants were also asked to indicate the valence of the statements in terms of how negative they found the behavior on a scale similar to the moral relevance scale (ranging from 0 as not at all negative to 3 as very negative).

Following the completion of the rating scales, participants were asked to fill out the Disgust Scale-Revised (DS-R; Olatunji et al., 2007) to measure individual disgust sensitivity for correlational measures.

2.4 Psychophysiological Analyses

Electromyographic (EMG; in mV units) data were acquired using the BIOPAC MP500 system. Electrodes were placed over the levator labii muscle region on the right side of the face

as well as the corrugator region (area where one furrows eyebrows and is representative of negative affect; Kreibig et al., 2013). EMG data were analyzed offline using AcqKnowledge software. A 10 Hz high-pass filter was applied to the EMG data to reduce low-frequency noise. The signal was then rectified with an absolute value function and integrated with a 25ms time window, resulting in integrated rectified EMG values. Mean integrated EMG activity during the Encoding and Test phases for the 1 s period prior to each trial (prestimulus baseline) was subtracted from the corresponding activity level during the 6 s period following stimulus onset in order to calculate a change score that controlled for differences in tonic muscle activity across the experiment. Change scores of mean muscle activity for 1 s time windows throughout the 6 s period of stimulus presentation were also computed to observe the trend in facial muscle activity during the stimulus presentation. Approximately 1% of trials were excluded before analysis because of face or body movement during the baseline period.

2.5 Statistical Analyses

Electromyographic (EMG) data were standardized into z-scores for paired t-test measures. The average z-scores for changes in LL activity in response to each behavioral domain stimuli (physical disgust, purity, fairness, neutral, and new for test phase data) were calculated for all participants (N = 18). For the z-score transformation, the mean change in LL activity (raw data measured in mV) for all the trials in the task phase was subtracted from the single trial LL activity and then divided by the standard deviation of the trials for each participant (80 trials in encoding; 100 trials in test). For the encoding phase data, bootstrap two-tailed paired t-tests for the z-score change in LL activity were performed for each disgust domain condition against the neutral condition. The same analyses were conducted for corrugator activity scores.

Test phase EMG data were also analyzed in the same way as the encoding phase EMG data. In addition to the paired t-tests of the disgust domain conditions to the neutral condition, an additional comparison was done between z-score change in LL activity for the new condition and the neutral condition. The same analyses were done for corrugator activity as well.

The same analyses were done for LL activity in response to the disgusting and neutral picture stimuli that were presented before the start of the experimental tasks.

The number of correct person judgments (face categorization for four categories: physical disgust, purity, fairness, none of these) during the recall task was computed for each participant. Moral relevance and valence rating scores of the behavioral statements provided by the participants were also averaged across each behavioral domain condition (physical disgust, purity, fairness, and neutral). DS-R scores were computed for each participant. Pearson's *r* correlation coefficients were computed to assess the relationships between DS-R scores and change in LL activity for the physical disgust, purity, and fairness conditions for all participants (N = 18). Bootstrapped two-tailed paired t-tests were performed for each behavioral condition against each other. Pearson's *r* correlation coefficients were also computed to assess the relationships between DS-R scores and the average moral relevance rating scores for the physical disgust, purity, and fairness conditions for all participants (N = 18).

3. Results

3.1 EMG activity results

3.1.2 Initial Test Results

LL activity in response to disgust picture stimuli was contrasted from LL activity in response to neutral stimuli in order to assess whether our study was sensitive enough to evoke LL activity in response to disgusting stimuli. The disgust picture stimuli evoked significantly

greater change in LL activity (M = 0.42; SEM = 0.09) than neutral picture stimuli (M = -0.42; SEM = 0.09), $t(16) = 4.76$, $p < .01$.

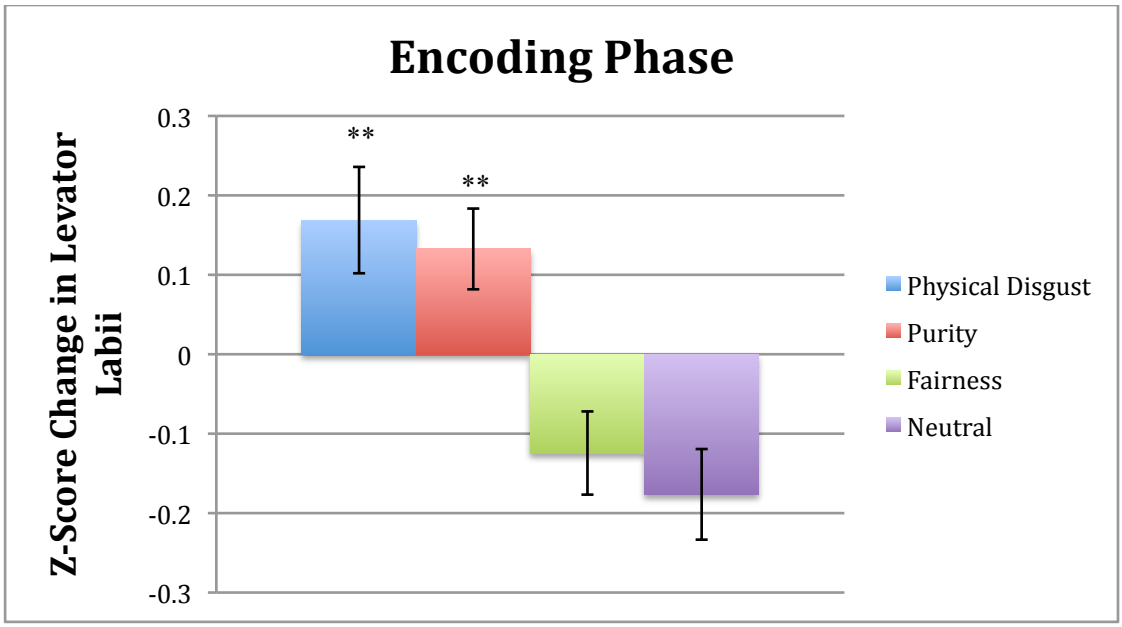
3.1.3 Encoding Phase: Presentation of Face-Behavior Pairs

To assess whether significant changes in LL activity occurred in each target condition, LL activity was contrasted between each condition and LL activity during the neutral encoding condition. During the encoding phase, faces associated with physically disgusting behaviors evoked significantly greater change in LL activity than faces associated with neutral behaviors, $t(17) = 3.07$, $p < .01$ (Figure 1A). Faces associated with purity behaviors also evoked significantly greater change in LL activity than faces associated with neutral behaviors, $t(17) = 3.41$, $p < .01$ (Figure 1A). As seen in Figure 1A, fairness behaviors, on the other hand, did not evoke stronger LL activity than neutral, $t(17) = .70$, $p = 0.46$. Change in LL activity for faces associated with fairness behaviors, however, was significantly different than physically disgusting face-behavior pairs, $t(17) = 2.81$, $p < .05$, as well as from purity face-behavior pairs, $t(17) = 2.88$, $p < .05$ (Figure 1A). Change in LL activity for faces associated with purity behaviors was not significantly different from faces associated with physically disgusting behaviors, $t(17) = .45$, $p = 0.67$ (Figure 1A). Changes in corrugator activity for faces associated with physical disgust, purity, and fairness were not significantly different from change in corrugator activity for faces associated with neutral behaviors during the encoding phase (Figure 1B). Though, there was a trend toward significance for the comparison between change in corrugator activity for purity face-behavior pairs and for neutral face-behavior pairs, $t(17) = 2.00$, $p = .06$ (Figure 1B).

3.1.4 EMG Response to Purity Behaviors

Within the purity foundation, there are violations that reflect physically disgusting behaviors (Chapman and Anderson, 2012). This is due to the fact that purity violations also involve affecting (positively or negatively) one's own body; thus, negative purity transgressions may reflect behaviors that are physically disgusting (Chapman and Anderson, 2013). In this study, we separated purity violations that have physically disgusting components from the physical disgust category by making physically disgusting behaviors involve more external factors while purity behaviors were internal (i.e. directly affecting the purity of one's physical body or mentality). However, because there are several purity transgressions that reflect physically disgusting behaviors, two independent people in the lab rated the purity statements in terms of purity behaviors involving high levels of physical disgust content (8 behavioral statements) and behaviors with low physical disgust content (12 behavioral statements; Appendix 2). LL activity in response to these two purity groups (high vs. low) was contrasted with each other and also contrasted from the neutral domain during the encoding phase. Faces associated with purity behaviors involving high physical disgust content evoked significantly greater change in LL activity than faces associated with purity behaviors involving low physical disgust content, $t(17) = 3.09$, $p < .01$ (Figure 2). Faces associated with purity behaviors involving high physical disgust content also evoked significantly greater change in LL activity than faces associated with neutral behaviors, $t(17) = 4.08$, $p < .01$ (Figure 2). There was also a trend towards significance for the contrast in LL activity between faces associated with purity behaviors involving low physical disgust content and those associated with neutral behaviors, $t(17) = 2.06$, $p = .057$ (Figure 2).

A.



B.

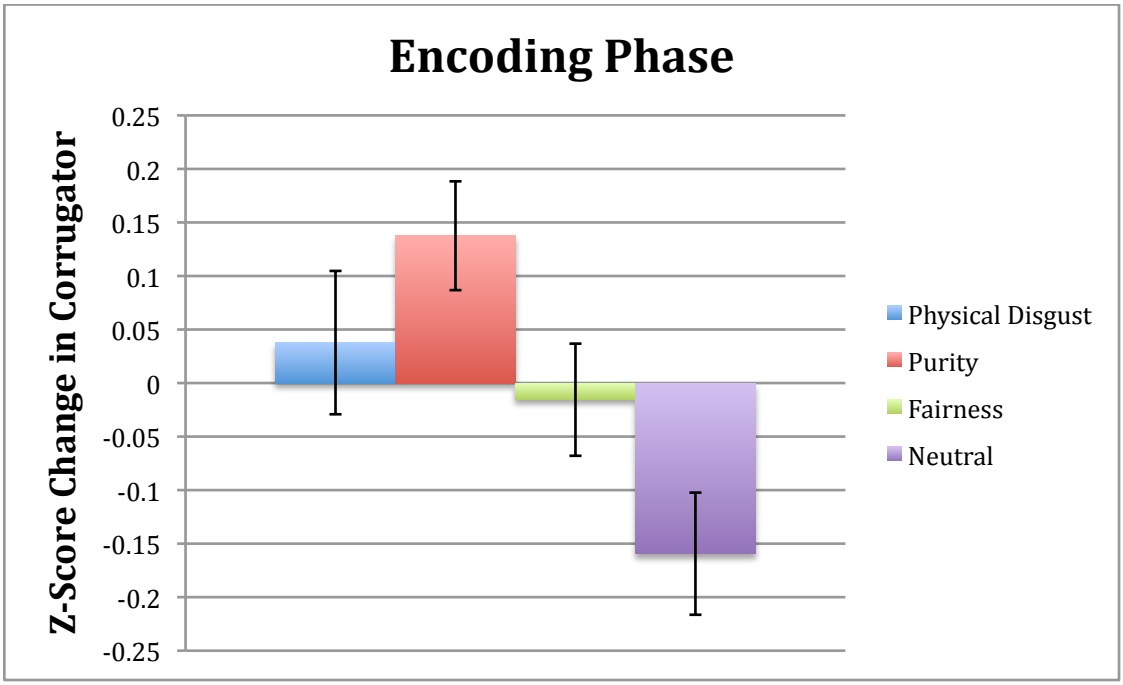


Figure 1. (A) Z-score transformed change in LL activity in response to face-behavior pairs during the encoding phase (N = 18). **(B)** Z-score transformed change in corrugator activity in response to face-behavior pairs during the encoding phase (N = 18). *Note:* ** $p < .01$

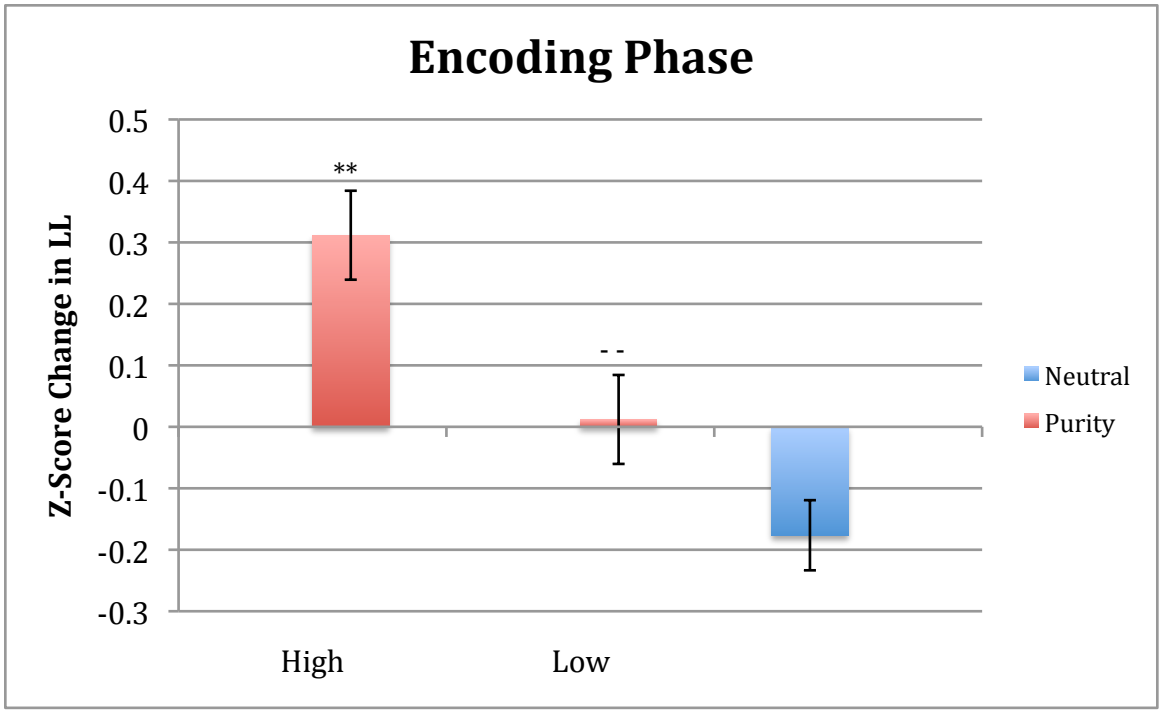


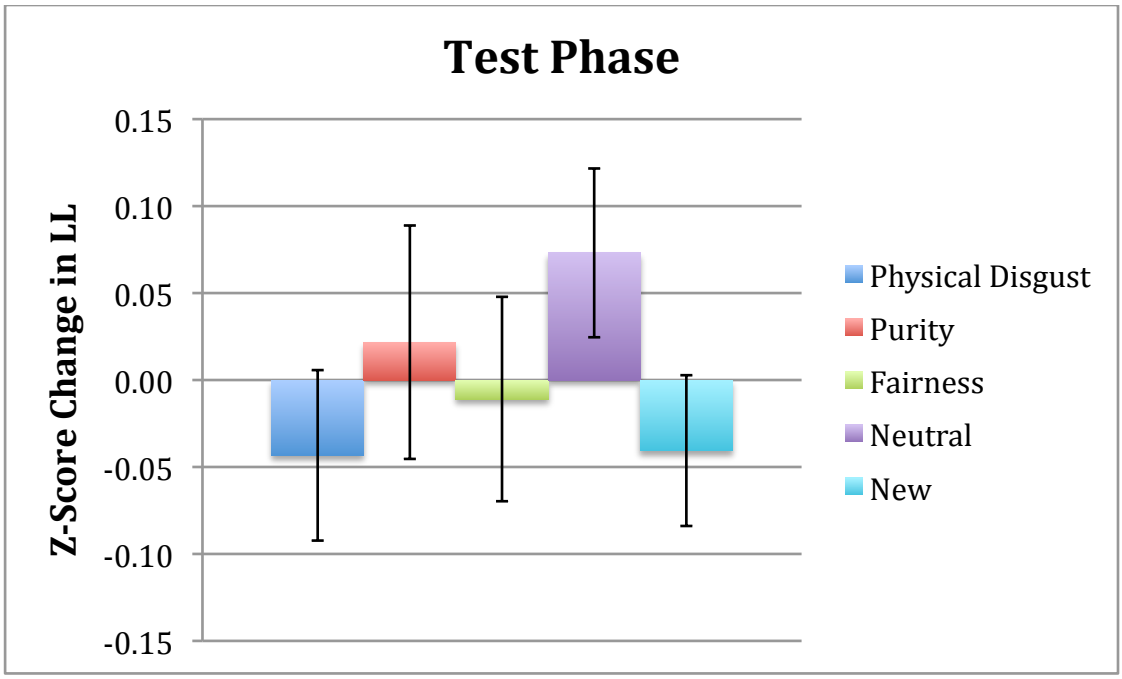
Figure 2. Z-score transformed change in LL activity in response to faces associated with purity behaviors involving high and low physical disgust content vs. neutral behaviors (N = 18). *Note:* ** p < .01; - - p = .057

3.1.5 Test Phase: Transfer of EMG activity

To investigate the hypothesis regarding whether there was a transfer of LL activity from the encoding to test phase, the z-transformed change in LL activity for each domain (physical disgust, purity, fairness, neutral, new) during the test phase was analyzed. Similarly to the paired t-test analyses done for the encoding phase EMG data, the average changes in LL activity for the disgust domain conditions and the new domain condition were compared to the average change in LL activity for the neutral domain condition. The results showed that there was no significant difference in LL activity for faces that had been previously paired with physical disgust, purity, or fairness behaviors from the faces previously paired with neutral behaviors (Figure 3A). Unexpectedly, faces that were previously paired with neutral behaviors resulted in a positive

change in LL activity (Figure 3A). The change in LL activity for neutral faces, however, was not significantly different from the change in LL activity from any of the faces that were previously paired with the other conditions, including the new condition (Figure 3A). The same paired t-test analyses were done for the corrugator activity during each condition. Although there was a positive change in corrugator activity for the fairness condition, the corrugator activity response for the fairness condition did not differ significantly from corrugator activity in the neutral condition (Figure 3B). The corrugator activity response for the fairness condition was only significantly different from the corrugator activity in the new condition $t(17) = 2.30$, $p < .05$ (Figure 3B). There were no significant differences in the change of corrugator activity between the change of corrugator activity in physical disgust, purity, and new conditions from the neutral condition (Figure 3B).

A.



B.

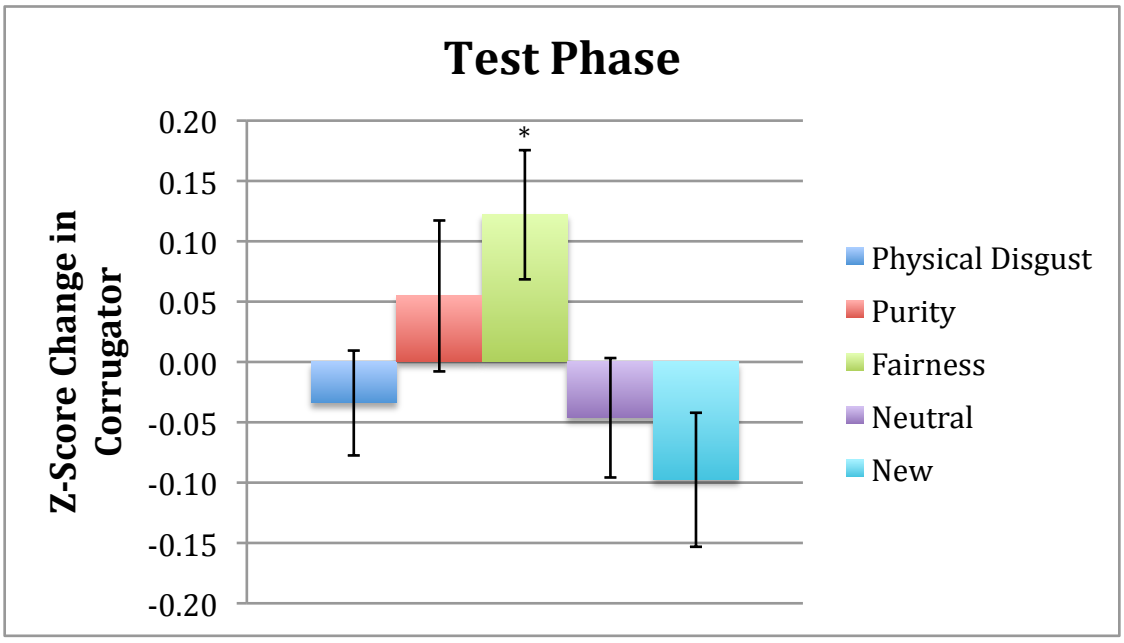


Figure 3. (A) Z-score transformed change in LL activity in response to faces that were previously associated with behavioral statements as well as 20 novel faces during the test phase (N = 18). **(B)** Z-score transformed change in corrugator activity in response to faces that were previously associated with behavioral statements as well as 20 novel faces during the test face (N = 18). Corrugator activity was significantly different for faces previously associated with fairness behaviors from novel faces. *Note:* * $p < .05$

3.2 Behavioral Results

3.2.1 Person Judgments: Categorization

In order to assess the level of explicit memory for the statements and their association with particular faces, the amount of correct categorizations for the faces as a function of the associated behavior were analyzed. One-sample t-tests were conducted to analyze whether the correct categorizations overall as well as the correct categorizations for each condition were greater than chance (0.25). Overall, 31% (SEM = 0.02) of the faces were categorized correctly across all domains (calculated by adding the number of correct categorizations for physical disgust, purity, fairness, neutral conditions for all 18 participants), $t(17) = 3.05$, $p = 0.01$. The number of correct categorizations for each domain condition was calculated for all eighteen participants (four total categorization numbers for each condition) and each correct condition performance was compared to chance performance. 25% (SEM = 0.03) of the faces associated with physically disgusting behaviors were categorized as physical disgust, 27% (SEM = 0.02) of the faces associated with purity behaviors were categorized as purity, and 30% (SEM = 0.03) of the faces associated with fairness behaviors were categorized as fairness. However, physical disgust, purity, and fairness categorizations were not significantly greater than chance. 43% (SEM = 0.06) of the faces associated with neutral behaviors, on the other hand, were significantly categorized correctly, $t(17) = 3.30$, $p < .01$.

3.2.2. Ratings Results

Moral relevance of the behavioral statements was rated by each participant on a scale from 0-3 with 0 corresponding to not at all relevant, 1 as somewhat morally relevant, 2 as substantially morally relevant, and 3 as very morally relevant. Behaviors within the fairness domain condition (M = 2.43; SEM = 0.09) were rated the highest out of the four domain

conditions, followed by purity behaviors (M = 1.89; SEM = 0.12), physically disgusting behaviors (M = 0.70; SEM = 0.14), and finally neutral behaviors (M = 0.02; SEM = 0.01). The averages of the moral relevance ratings of all four conditions were significantly different from one another, as indicated by the results of the paired t-tests conducted for the four domain conditions against each other. Moral relevance for physical disgust was significantly different from moral relevance for neutral behaviors, $t(17) = 4.93$, $p < .01$, purity behaviors, $t(17) = -14.4$, $p < .01$, and fairness behaviors, $t(17) = -13.1$, $p < .01$. Moral relevance for purity behaviors was also significantly different from neutral behaviors, $t(17) = 15.4$, $t < .01$, and fairness behaviors, $t(17) = -5.00$, $t < .01$. Lastly, moral relevance for fairness behaviors was significantly different from neutral behaviors, $t(17) = 27.9$, $p < .01$. Valence ratings, which measured the negativity of the behavior, of the behavioral statements made by each participant were scored similarly to moral relevance rating scores. These ratings made by the participants were scored and averaged to assess whether the conditions were found to be emotionally negative. Fairness behaviors (M = 2.43; SEM = 0.07) were rated highest out of the four domain conditions, followed by purity behaviors (M = 2.26; SEM = 0.11), physically disgusting behaviors (M = 1.88; SEM = 0.16), and lastly neutral behaviors (M = 0.03; SEM = 0.02).

Pearson's *r* correlation coefficients were computed to assess the relationship between DS-R scores of each participant and the change in LL activity during the encoding phase in response to physical disgust, purity, and fairness stimuli. Each subject's average LL activity scores for the physical disgust, purity, and fairness conditions were computed and subtracted with the average LL activity score for the neutral condition in order to remove nonspecific LL change related to the neutral condition. However, there were no significant correlations between DS-R scores and the average change in LL activity for the physical disgust, purity, and fairness

domain conditions. Pearson's *r* correlation coefficients were also computed to assess the relationship between DS-R scores and moral relevance ratings done by the participants. The analyses showed that DS-R scores were only significantly and positively correlated with moral relevance ratings for behaviors within the purity domain, $r = 0.80$, $n = 18$, $p < .01$.

4. Discussion

Behaviors that violate moral standards, which are determined both culturally and individually, elicit a wide range of emotions. Disgust, an emotion that has become a recent contender as a moral emotion, results in an experience that is fairly primal in contrast to the things that often induce the emotion itself: feelings of nausea, gut reactions, revulsion, worries about contamination, and the gaping facial expression (Kelly, 2011). The gape face, which is mediated by the levator labii (LL) muscles of the face, is a classic indicator of disgust: the raised upper lip and wrinkling of the nose (Chapman and Anderson, 2013). As predicted, moral transgressions that violated the purity of one's mind or body resulted in the strong facial expression of disgust similarly to the behaviors that involved something that was physically disgusting. Moral transgressions that involved fairness – primarily behaviors that involved cheating, stealing, and discriminating against others – concerns however, did not elicit LL activity similar to the behaviors that were associated with physical disgust or purity issues. Although several studies have suggested that the fairness domain of the MFT represents a category of moral behaviors that elicit disgust physiologically (Chapman et al., 2009; Cannon et al., 2011), others suggest that fairness behaviors are unrelated to disgust (Horberg et al., 2009). These results indicate that moral transgressions involving purity violations but not fairness violations result in facial expressions similar to the responses to physically disgusting behaviors. These findings partially supported the first hypothesis that moral transgressions will elicit similar

LL activity as physically disgusting behaviors. These results support our second hypothesis, however, since purity violations elicited LL activity that was most similar to the LL activity responses to physically disgusting behaviors. Corrugator activity, which is most indicative of anger but also tied to overall negative affect (Chapman et al., 2009), was not strongly elicited for any of the domains unlike LL activity.

There is speculation with regards to the types of purity behaviors that elicit similar disgust responses as physically disgusting behaviors. Previous studies have utilized purity behavioral statements or scenarios that often reflect physically disgusting behaviors, such as behaviors that contaminate one's physical body (i.e. drinking cow blood; Horberg et al., 2009; Cannon et al., 2011). Other purity violations involve spiritual or mental contamination (Haidt and Rozin, 2013). We incorporated behavioral statements that have been used in previous studies and also formulated statements – particularly those that involve violations of sacredness or divinity – for this study (Horberg et al., 2009; Cannon et al., 2011). In this study, purity behaviors that directly violated one's physical body and reflected high levels of physical disgust components evoked greater LL activity than purity violations of sacrilege and sexual behaviors. Although it is difficult to completely separate purity violations from physically disgusting behaviors, we attempted to separate the two domains based on the definition of the purity foundation offered by Haidt and Joseph's MFT (2004): purity violations directly affect one's own internal physical body while physically disgusting behaviors were external. It is questionable whether these purity violations that are high in physical disgust content are actually moral violations as well. However, it is also important to consider that these behaviors may be very morally significant to individuals from certain cultures, which once again highlights the

complexities of studying moral psychology and moral emotions (i.e. many different influencers on morality; Kelly, 2011).

The experimental findings of Todorov and colleagues' (2007) study provided the basis for the third hypothesis of this study: that there would be a transfer of LL activity when presented with faces that were previously paired with disgusting (both physically and morally) behaviors. Todorov and colleagues (2007) found that after associating faces with distinct affective behaviors, which have been suggested to elicit distinct neural activity (i.e. disgust and anterior insular activity) there seemed to be spontaneous retrieval of trait inferences during face perception when their participants observed the behaviorally associated faces from a previous task. This was indicated by the neural activity that occurred in response to the faces (Todorov et al., 2007). Rather than investigating the transfer of neural activity as an indicator of spontaneous trait inferences, this study utilized psychophysiological measures, specifically EMG activity. After comparing the LL activity in response to faces previously associated with physically disgusting, purity, and fairness behaviors to faces associated with neutral behaviors, however, no significant differences were found. Thus, the third hypothesis of this study was not supported; though this may have been due to several limitations as discussed below.

Self-report measures have been significantly utilized to measure the subjective experience of disgust and morality in past studies (Chapman and Anderson, 2013). The Disgust Scale-Revised (DS-R; Olatunji et al., 2007) is a recent revision of the original Disgust Scale (DS; Haidt et al., 1994), which has been used in various studies to measure individual sensitivities to disgust. Although DS-R scores did not correlate with the average change in LL activity for the participants in this study, other correlation analyses resulted in a positive relationship between DS-R scores and participants' average moral relevance scores of purity behaviors. In other

words, individuals with higher disgust sensitivity rated purity behaviors as more morally relevant. Moral transgressions involving purity behaviors include violations of bodily and sexual norms, such as drug abuse and incest, as well as violations of divinity, such as spreading blasphemy and destroying sacrilegious artifacts or beliefs. Several researchers have suggested that disgust is most strongly associated with purity transgressions (Horberg et al., 2009; Inbar et al., 2009; Rozin and Haidt, 2013), which is suggested by the results of the present study. Although fairness behaviors were rated to be most morally relevant as well as most negative out of the other behavioral conditions, the analyses of this study did not present any significant relationships between the fairness condition and DS-R scores. These findings as well as the LL activity results in response to fairness violations suggest that disgust may not be the actual emotion experienced when exposed to moral transgressions involving fairness. Purity violations, on the other hand, seem to be closely tied to the subjective experience of disgust.

4.1 Limitations

There are several limitations with regards to this study. First, the EMG response magnitudes were relatively low across all participants, which could have been due to various artifacts and impedance issues. Although the facial and body movements of each participant were carefully observed, and noted if unnatural for analyses purposes (i.e. yawning), impedance measures for each participant were not able to be collected in this study. Furthermore, unlike the study done by Todorov and colleagues (2007), the face-association pairs presented in the encoding task phase for this study were only presented once to the participants due to the timing constraints of the study as well as feedback from students who participated in pilot studies. The association of the face and the behaviors, therefore, may not have been as strong, which is a possible explanation for the lack of transfer of LL activity in the test phase of the experimental

task. This limitation may also have influenced the face categorization results in that there was not as strong of an association made for the face-behavior pairs, which is why many of the correct categorizations might have been made by chance rather than by explicitly recognizing which face was associated with which behavior. Lastly, as emphasized by Henrich and colleagues (2010), the participant sample in this study is not representative of the world's population seeing that they are all university-level Psychology students from the United States. It is extremely challenging to truly conduct a study that is universally representative, particularly studies investigating morality. However, emotional facial expressions have been classified to show similarities between industrialized and small-scale societies in large-scale comparative projects (Ekman et al., 1987; Henrich et al., 2010). Nevertheless, it is important to acknowledge and be aware of the fact that the participants in this study, as they were all American university students, are not representative of the entire world population (Henrich et al., 2010).

4.2 Significance and Future Directions

Although disgust seems to be a relatively easy emotion to identify – in terms of personally experiencing the emotion or recognizing someone else experiencing disgust – and is considered to be a basic and universal human emotion, there are many complexities surrounding the moral functions of this emotion (Ekman et al., 1987; Horberg et al., 2011). Some researchers are more hesitant to claim that there is enough empirical evidence for the existence of sociomoral disgust (Pizarro et al., 2011). Many disgust researchers, however, counter this argument by providing evidence for sociomoral disgust as a distinct disgust emotion through empirical techniques such as neuroimaging, facial expressions, and other behavioral measures (Borg et al., 2008; Chapman et al., 2009; Chapman and Anderson, 2012; Rozin and Haidt, 2013). One area of interest that has not been studied extensively concerns whether disgust exists for only certain

types of moral transgressions (Chapman and Anderson, 2012). In order to address this question, the present study investigated the two moral foundations that have been implicated as the moral triggers for the emotion of sociomoral disgust: purity and fairness violations (Cannon et al., 2011). The findings of the present study suggest that purity violations, in particular, elicit a well-known disgust response (LL activity, which reflects the facial EMG activity mediating the gape face). Purity violations often encompass behaviors that are often representative of physically disgusting behaviors (i.e. eating mold, engaging in sexual behaviors, etc.) but the behavioral statements used in this study also incorporated behaviors that were related to violations of divinity or sacredness of one's own thoughts and body. It is also interesting how in this particular study, those who had higher disgust sensitivities as calculated by the DS-R had a greater tendency to rate purity violations as morally relevant. These results are significant in that they reiterate the notion that purity concerns inflict the emotion of disgust by providing more empirical evidence, through psychophysiological measures, for the existence of disgust as a moral emotion. As alluded to by Cannon and colleagues (2011), furthermore, specific facial affect (in this case, LL activity) may be important for indicating moral concerns that serve as the basis for individual perceptions of real-world moral issues. Although there are many more questions to be answered, this study contributes to the growing field of moral psychology and the idea that emotions influence moral judgments (Haidt et al., 1993).

There are several future directions with regards to this study. To further investigate the similarities and/or differences in facial EMG activity as a response of experiencing physical and sociomoral disgust, it would be beneficial to conduct the same study with a larger sample size. Furthermore, to further explore the potential of the transfer of facial EMG activity when presented with faces that were previously associated with disgusting behaviors, presenting the

face-association pairs twice rather than once may strengthen the association of the faces and behaviors. Additionally, a future study in regards to this study includes investigating whether some individuals are more responsive to certain genders or races of the faces that are presented along with the behavioral statement. In this study, the face-behavior pairs were purposely counterbalanced to diminish the effect(s) of race and gender, but studying the influence of race and gender on the physiological and behavioral responses of individuals have many societal implications. This kind of study could be done by analyzing the physiological responses to specific faces, based on race and gender, and their associated behaviors and comparing it to the physiological responses to other faces associated with neutral behaviors. Another avenue of research related to individual responses to purity violations is the strength of cultural influences on individual perception of affective behaviors (Kelly, 2011). For instance, individuals who are more religious than others may have heightened sensitivity towards purity violations by perceiving those behaviors as morally incorrect and as a result feel more disgusted by those violations than non-religious individuals (Rozin and Haidt, 2013). People from different religious or cultural backgrounds, moreover, may find that purity behaviors with high physical disgust content are also significantly morally relevant. As a basic human emotion, disgust seems to be an emotion that is heavily influenced by societal norms and perceptions (Kelly, 2011). Lastly, a future study could be one that incorporates more physiological measures into this study's paradigm since disgust has been related to consistent heart rate deceleration, increased respiration rate, and increased electrodermal activity (Kreibig et al., 2013).

4.3 Additional Comments: Legal and Social Implications of Disgust

The emotion of disgust and understanding its relation to sociomoral behaviors has many implications for both the academic and the general population. The current belief that disgust is a

unique *human* emotion that influences social behavior and perception, even though its origins are thought to be relatively primal, poses many questions with regards to the social role of this emotion (Kelly, 2011). The withdrawal response as well as the facial expression (gape face) when experiencing disgust has been identified across various cultures (Ekman et al., 1987; Chapman and Anderson, 2009). The connection(s) with these basic responses and morality (i.e. moral judgments, moral behaviors) ranges quite extensively. For instance, studies have found that individuals who rate themselves to be more sensitive to disgusting situations are more severe when judging suspects of criminal activity (Jones and Fitness, 2008) and that disgust influences, such as exposure to disgusting smells, can cause individuals to make more severe moral judgments (Schnall et al., 2008). These findings emphasize the belief that disgust provides humans the ability to be critical and judgmental of one another, which may be due to the fear of interacting or being essentially "contaminated" by an individual who performed a relatively disgusting (or morally degrading) behavior (Kelly, 2011). Disgust, therefore, may play a significant role in mediating human perceptions of one another, such as the level at which humans hold each other accountable for their behaviors, which is a judgment that is relevant in the courtroom setting.

The significance of emotions in the legal setting is not without controversy. Some argue that the law should be void of any emotion to remove irrationality while others argue that this is not possible (Nussbaum, 2004). In terms of disgust, Kahan (1998) maintains a strong stance that disgust plays a central role in criminal law. He argues that disgust modulates individual responses to crimes that involve moral transgressions as well as the jury's justification for the level of punishment that is determined for particular criminals (Kahan, 1998). Russell and Giner-Sorolla (2011b) expand upon Kahan's (1998) suggestions about the relationship between disgust

and criminal law by acknowledging that disgust has an influence on moral judgments and perspective on criminal behaviors. However, Russell and Giner-Sorolla (2011b) remain cautious regarding the potential influences of disgust in the courtroom setting. In particular, they refer to their own findings in a recent study that investigated the social justifications for moral emotions (Russell and Giner-Sorolla, 2011a). In this study, participants were less likely to give external or concrete reasons as to why they found certain people in certain scenarios disgusting (Russell and Giner-Sorolla, 2011a). Russell and Giner-Sorolla (2011a) postulate that this response could be due to the fact that people normally do not feel the need to justify why they feel disgusted on the premise that other people also would find the situation disgusting. The function of disgust in the courtroom setting, therefore, may be potentially dangerous in that if certain cases (i.e. sexual crimes) elicit disgust, people may focus on the fact that they feel disgusted despite the difficulty of accessing external reasons (other than reasons such as "it is just disgusting") for why they feel that way (Russell and Giner-Sorolla, 2011b). Basing judgments upon disgust for moral crimes such as sexual crimes may make it difficult for jurors, especially, to have open discussions regarding clear justifications of why they feel disgust, which can cause problems for members of the jury and those involved in the criminal case (Russell and Giner-Sorolla, 2011b). This would particularly be the case if some jurors were more easily disgusted than others, which can potentially cause a division amongst the jurors.

On the other hand, there is the possibility that certain individuals lack the ability to either feel disgust or have very low disgust sensitivities, which make them more prone to committing disgusting behaviors including moral transgressions (Chapman and Anderson, 2012). For instance, there may be abnormal neural circuitry that normally modulates the experience of disgust or even the lack of psychophysiological responses to disgusting behaviors that inhibit the

feelings of revulsion or need to withdraw from morally disgusting transgressions (Raine and Yang, 2006; Chapman and Anderson, 2012). One question is whether psychophysiological measures or even neuroimaging techniques can elucidate the disgust sensitivities of individuals and provide some explanation as to why they engaged in those behaviors. Though, cautious consideration of using scientific techniques to explain behaviors in the courtroom setting would be required due to the many ethical implications and controversies of using science in the courtroom[5]. It could be worthwhile to also ask jurors to go through these behavioral procedures to be aware of the potential influence of disgust on their assessments of the criminals as well as the situations (Russell and Giner-Sorolla, 2011). Other interesting solutions Russell and Giner-Sorolla (2011) suggest to avoid the "negative influences of disgust" is to not trigger disgust in the first place (research indicates that disgust is not easily unlearned since it does not respond to situational cues; Rozin, 2008) or to inform judges of the prejudicial influences of disgust. It is unclear, however, how one can truly prevent disgust from being triggered due to the difficult nature of truly objectifying the nature of a crime. More research on the neural markers of disgust and the overall relationship between disgust and morality is necessary, however, before these conclusions are made.

5. Conclusion

Disgust is a complex emotion that is elicited by a wide range of stimuli. The behavioral responses that indicate the subjective experience of disgust also involve a variety of responses due to the nature of the emotion itself (Chapman and Anderson, 2012). Understanding the relationship between moral judgments and disgust as well as the behavioral responses that indicate the link(s) between the two can play a significant role in clarifying the cognitive

[5] Refer to Morse (2005) and Jones et al. (2009) for a more comprehensive overview of utilizing neuroscience and scientific technologies in the courtroom.

perception of morality as well as the social behaviors of human beings across cultures (Kelly, 2011). Further exploring the behavioral, neural, and cognitive bases of disgust can potentially provide explanations regarding certain types of responses to morally relevant situations and concerns. In addition, the emotion of disgust does not appear to be specific to select cultures; rather, it is a universal emotion that varies upon cultural and societal norms, which influence moral perspectives (Kelly, 2011). Along with past research, the results of this study, furthermore, advocate that sociomoral disgust is in fact a disgust emotion rather than just a metaphor.

Appendix 1

Behavioral Statements for each Behavioral Domain

Physical Disgust

1. "Rebecca vomited on a lady in the bus."
2. "Bill played with dry gum from under the desk."
3. "Sarah blew her nose into a tissue and used it to later wipe her mouth."
4. "Alex had a build up of maggots in his shower."
5. "Katherine did not flush the toilet after a bowel movement."
6. "Brian kept jars of old urine in his bedroom."
7. "Kevin carried around a bag of smelly fish heads."
8. "Olivia poured spoiled and lumpy milk into her cereal."
9. "Neil did not wash his hands after emptying the putrid trash."
10. "Heather had a cockroach family in her bedroom."
11. "Thomas hawked loudly and then spat the phlegm on the sidewalk."
12. "Jessica cleaned the kitchen and toilet with the same sponge."
13. "Bruce burst the pimples on his face in public."
14. "Sam had a rat infestation in his apartment."
15. "Danielle wore the same filthy blouse to work for three days."
16. "Andrea picked her nose before serving the guests' food."
17. "Steven ignored the fact that he had lice."
18. "Anna had moldy vegetables in her fridge."
19. "Jonathan did not wash the dirty dishes for five days."
20. "Mary only changed her underwear once a week."

Purity

1. "Ellen ate out of a bowl that had mold growing inside."
2. "Kenny had sexual intercourse with a dead chicken."
3. "Lucy prays to Satan every night before bed."
4. "Trevor watched porn on a daily basis."
5. "Jenna touched a corpse."
6. "Jack made sexual advances on an 83-year old woman."
7. "Kim licked a dead dog."
8. "Kelsey liked to kiss her brother on the mouth passionately."
9. "Daphne cooked roadkill and ate it."
10. "Joseph sought sexual relations with his sibling."
11. "Alvin spat in the holy water at a Catholic church."
12. "Theresa liked to have sex with multiple guys in one night."
13. "David joined a cult that worshipped demons."
14. "Lindsay ate rotten meat."
15. "Howard hired a prostitute."
16. "Lucas snorted cocaine in a public restroom."
17. "Anthony drank cow blood."
18. "Josephine injected drugs into her arm with a syringe."
19. "Abby tattooed a swear word on her neck."
20. "Clint collected child pornography."

Fairness

1. "Joe stole money from the homeless for the thrill and fun of it."
2. "Melanie refused to help a friend move, after the friend had just helped her the week before."
3. "Larry refused to tutor a struggling classmate for free even though that classmate tutored him before"
4. "Keith marched in a White Power, BNP rally."
5. "Henry leaves very small tips at restaurants even when the service is good."
6. "Sandra participated in a walk for the Ku Klux Klan (KKK)."
7. "Craig organized a fake toy drive so that he could later sell the toys for profit."
8. "Doug hid his grandmother's belongings to confuse her."
9. "Lisa hired people only of her own race."
10. "Frank cheated on his tests to become valedictorian."
11. "Diana threw out a box of election ballots in order to help her favorite candidate win."
12. "Michael stole money from a charity on a regular basis."
13. "Margaret gave raises to only the employees she liked."
14. "Luke cheated in a game of poker to win the money."
15. "Alan purposely told a blind man wrong directions."
16. "Audrey refused to give the homeless person some old clothes she was about to throw out."
17. "Cindy stole food from the local soup kitchen for fun."
18. "Claire interrupts meetings even though she lectures people if they interrupt her."
19. "Linda did not hold the door open for the boy on crutches."
20. "Nancy made fun of crippled people."

Neutral

1. "Scott folded his laundry."
2. "Vanessa bought the evening paper."
3. "Charlie purchased a new raincoat."
4. "Emma took the dog for a walk in the park."
5. "Paul painted his bedroom walls"
6. "Jacqueline drank a cup of coffee in the morning."
7. "Julie listened to her favorite CD."
8. "Greg talked on the phone for an hour."
9. "Caroline went shopping for clothes at the mall."
10. "Rachel drank a glass of water before bed."
11. "Jeff ate a sandwich for lunch."
12. "Ken drank a glass of water before bed"
13. "Angela hummed the familiar tune."
14. "Jason read a book in the cafe."
15. "Edward rented an apartment near the park."
16. "Mark took his suit to the dry cleaners."
17. "Monica watched a DVD with friends."
18. "Lindsey went for a jog in the evening."
19. "Sean took his car in for servicing."
20. "Amy mailed the letter on her way to work."

Appendix 2

Purity behaviors rated with high physical disgust content

1. "Anthony drank cow blood."
2. "Daphne cooked roadkill and ate it."
3. "Ellen ate out of a bowl that had mold growing inside."
4. "Jenna touched a corpse."
5. "Josephine injected drugs into her arm with a syringe."
6. "Kenny had sexual intercourse with a dead chicken."
7. "Kim licked a dead dog."
8. "Lindsay ate rotten meat."

Purity behaviors rated with low physical disgust content

1. "Abby tattooed a swear word on her neck."
2. "Alvin spat in the holy water at a Catholic church."
3. "Clint collected child pornography."
4. "David joined a cult that worshipped demons."
5. "Howard hired a prostitute."
6. "Jack made sexual advances on an 83-year old woman."
7. "Joseph sought sexual relations with his sibling."
8. "Kelsey liked to kiss her brother on the mouth passionately."
9. "Lucas snorted cocaine in a public restroom."
10. "Lucy prays to Satan every night before bed."
11. "Theresa liked to have sex with multiple guys in one night."
12. "Trevor watched porn on a daily basis."

References

Borg JS, Liberman D, Kiehl KA (2008) Infection, incest, and iniquity: investigating the neural correlates of disgust and morality. Journal of cognitive neuroscience 20(9):1529-1546.

Boxtel A (2010) Facial emg as a tool for inferring affective states. Proceedings of measuring behavior 104-108.

Cannon PR, Schnall S, White M (2011) Transgressions and Expressions: Affective Facial Muscle Activity Predicts Moral Judgments. Social Psychological and Personality Science 2:325-331.

Chapman HA, Anderson AK (2012) Understanding disgust. Annals of the New York Academy of Sciences 1251:62-76.

Chapman HA, Anderson AK (2013) Things rank and gross in nature: a review and synthesis of moral disgust. Psychological bulletin 139:300-327.

Chapman HA, Kim DA, Susskind JM, Anderson AK (2009) In bad taste: evidence for the oral origins of moral disgust. Science 323:1222-1226.

Ekman P, Friesen WV, O'Sullivan M, Diacoyanni-Tarlatzis I, KRause R, Pitcairn T, Scherer K, Chan A, Heider K, LeCompte WA, Ricci-Bitti PE, Tomita M, Tzavaras A (1987) Universals and cultural differences in judgments of facial expressions of emotion. Journal of personality and social psychology 53(4):712-717.

Haidt J, Graham J, Joseph C (2009) Above and Below Left–Right: Ideological Narratives and Moral Foundations. Psychological Inquiry 20:110-119.

Haidt J, Joseph C (2004) Intuitive ethics: how innately prepared intutions genearte culturally variable virtues. Daedalus 133(4):55-66.

Haidt J, Joseph C (2007) The moral mind: how five sets of intuitions guide the development of many culture-specific virtues, and perhaps even modules. In Peter Carruthers, Stephen Laurence, Stephen Stich (Eds). *The innate mind, volume 3* (pp. 367-391) New York, NY: Oxford University Press.

Haidt J, Koller SH, Dias MG (1993) Affect, culture, and morality, or is it wrong to eat your dog? Journal of personality and social psychology 65(4):613-628.

Haidt J, McCauley C, Rozin P (1994) Individual differences in sensitivity to disgust: a scale sampling seven domains of disgust elicitors. Person individ Diff 16(5):701-713.

Haidt J, Rozin P, McCauley C, Imada S (1997) The relationship between disgust and morality. Psychology and developing socieites 9(1):108-131.

Henrich J, Heine SJ, Norenzayan A (2010) The weirdest people in the world? Behavioral and brain sciences 33:61-135.

Horberg EJ, Oveis C, Keltner D (2011) Emotions as Moral Amplifiers: An Appraisal Tendency Approach to the Influences of Distinct Emotions upon Moral Judgment. Emotion Review 3:237-244.

Horberg EJ, Oveis C, Keltner D (2011) Emotions as moral amplifiers: an appraisal tendency approach to the influences of distinct emotinos upon moral judgment. Emotion Review 3(3):237-244.

Horberg EJ, Oveis C, Keltner D, Cohen AB (2009) Disgust and the moralization of purity. Journal of personality and social psychology 97:963-976.

Inbar Y, Pizzaro DA, Bloom P (2009) Conservatives are more easily disgusted than liberals. Cognition and emotion 00(00):1-12.

Jabbi M, Bastiaansen J, Keysers C (2008) A common anterior insula representation of disgust observation, experience and imagination shows divergent functional connectivity pathways. PloS one 3:e2939.

Jones O, Buckholtz J, Schall J, Marois R (2009) Brain imaging for legal thinkers: a guide for the perpelexed. Stanford technology law review 5(10-09).

Jones A, Fitness J (2008) Moral hypervigilance: the influence of disgust sensitivity in the moral domain. Emotion 8:613-627.

Kahan DM (1998) The anatomy of disgust in criminal law. *Faculty scholarship series.* Paper 112. Retreived from: http://digitalcommons.law.yale.edu/fss_papers/112.

Kelly D (2011) Yuck! the nature and moral significance of disgust. Cambridge, MA: The MIT Press.

Kreibig SD, Samson AC, Gross JJ (2013) The psychophysiology of mixed emotional states. Psychophysiology 50:799-811.

Lang PJ, Bradley MM, Cuthbert BN (1998) Emotion, motivation, and anxiety: brain mechanisms and psychophysiology. Society of biological psychiatry 44:1248-1263.

Morales AC, Fitzimons GJ (2007) Product contagion: changing consumer evaluations through physical contact with "disgusting" products. Journal of Marketing Research 64:272-283.

Morse SJ (2005) Brain overclaim syndrome and criminal responsibility: a diagnostic note. Ohio St. J. Crim. L. 3:397-412.

Nussbaum MC (2004) Hiding from humanity. Princeton, NJ: Princeton University Press.

Olatunji BO, Williams NL, Tolin DF, Abramowitz JS, Sawchuk CN, Lohr JM, Elwood LS (2007) The Disgust Scale: item analysis, factor structure, and suggestions for refinement. Psychological assessment 19:281-297.

Pizarro D, Inbar Y, Helion C (2011) On Disgust and Moral Judgment. Emotion Review 3:267-268.

Raine A, Yang Y (2006) Neural foundations to moral reasoning and antisocial behavior. Social cognitive and affective neuroscience 1:203-213.

Rozin P (2008) Hedonic "adaptation": specific habituation to disgust/death elicitors as a result of dissecting a cadaver. Judgment and decision making 3(2):191-194.

Rozin P, Fallon AE (1987) A perspective on disgust. Psychological Review 94(1):23-41.

Rozin P, Haidt J (2013) The domains of disgust and their origins: contrasting biological and cultural evolutionary accounts. Trends in cognitive sciences 17(8):367-368.

Rozin P, Haidt J, McCauley CR (1999a) Disgust: the body and soul emotion. In Tim Dalgleish & Mick J. Power (Eds.). *Handbook of cognition and emotion* (pp. 429-445). John Wiley & Sons, Ltd.

Rozin P, Lowery L, Imada S, Haidt J (1999b) The CAD triad hypothesis: a mapping between three moral emotions (contempt, anger, disgust) and three moral codes (community, autonomy, divinity). Journal of personality and social psychology 76(4):574-586.

Rozin P, Markwith M, McCauley C (1994) Sensitivity to indirect contacts with other persons: AIDS aversion as a composite to strangers, infection, moral taint, and misfortune. Journal of Abnormal Psychology 103(3):495-504.

Rozin P, Millman L, Nemeroff C (1986) Operation of the laws of sympathetic magic in disgust and other domains. Journal of personality and social psychology 50(4):703-712.

Russell PS, Giner-Sorolla R (2011a) Social justifications for moral emotions: when reasons for disgust are less elaborated than for anger. Emotion 11:637-646.

Russell PS, Giner-Sorolla R (2011b) The dangers of disgust in the courtroom. American society of trial consultants 23(4):1-7.

Schnall S, Haidt J, Clore GL, Jordan AH (2008) Disgust as embodied moral judgment. Personality & social psychology bulletin 34:1096-1109.

Todorov A, Gobbini MI, Evans KK, Haxby JV (2007) Spontaneous retrieval of affective person knowledge in face perception. Neuropsychologia 45:163-173.

Wheatley T, Haidt J (2005) Hypnotic disgust makes moral judgments more severe. Psychological science 16:780-784.

Wicker B, Keysers C, Plailly J, Royet JP, Gallese V, Rizzolatti G (2003) Both of us disgusted in my insula: the common neural basis of seeing and feeling disgust. Neuron 40:655-664.

Wright P, He G, Shapira NA, Goodman WK, Liu Y (2004) Disgust and the insula: fmri responses to pictures of mutilation and contamination. NeuroReport 15(15):2347-2351.