

**“VILE BODIES”: DISGUST, SELF-DISGUST,
THEIR MEASUREMENT AND PREVALENCE
IN EATING DISORDERS**

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This thesis is presented for the degree of
Masters of Clinical Psychology/Doctor of Philosophy of the University of Western
Australia
School of Psychology
October, 2016

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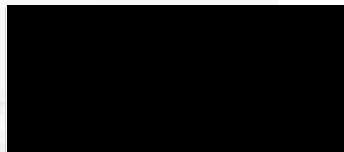
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Abstract

Disgust has become an emotion of interest in psychopathology research. It is suggested that disgust plays a particular role in eating disorders; as an emotion intrinsically connected with food and eating, it is regarded as an ideal affective vehicle for instilling food with negative properties. The behaviours that disgust incites, such as rejection and avoidance, are also thought to be enacted in restriction behaviours, and even binge/purge cycles. However, the relevance of self-disgust in eating disorders, including feelings of revulsion directed towards the body, remains largely unstudied.

This thesis explored the emotions of disgust and self-disgust, with particular reference to their potential relevance in eating disorders. As self-disgust research remains in its infancy, there are few existing tools designed to assess this emotion. Further, there is a need for greater specificity among psychophysiological measures of emotion, which currently fall short of accurately distinguishing between emotions of the same valence, such as disgust and fear. Subsequently, disgust and self-disgust measurement also emerged as a prominent theme in this thesis.

Study One explored the relationship between self-disgust and eating disorder symptomatology in a sample of non-clinical undergraduates, using a revised version of a self-report scale designed to assess experiences of disgust directed at the self, the body, and one's behaviours; the Self and Body Disgust Scale. The psychometric properties of this revised scale were also investigated. The Self and Body Disgust Scale was found to be an internally valid and reliable measure of self-disgust. A significant, positive correlation was identified between self-disgust and global scores on the Eating Disorder Examination Questionnaire, including strong correlations

with specific items assessing weight and shape concern and body viewing behaviours. The results of this study were discussed with reference to the potential implications of self-disgust as a prevalent emotional experience among those with eating disorder symptomatology.

In Study Two, self-disgust, as well as other disgust constructs including disgust sensitivity and disgust propensity, were investigated in a sample of individuals with clinically diagnosed eating disorders. This sample was compared to healthy controls and other clinical groups, including those with major depressive disorder and social phobia. Individuals with eating disorders were found to have the highest levels of self-disgust, followed by other clinical groups, in comparison to healthy controls. Self-disgust emerged as a primary disgust experience in eating disorders, over and above other disgust experiences directed towards external stimuli.

The final study in this thesis involved an exploration of a novel method of disgust measurement, specifically the use of Transcranial Magnetic Stimulation (TMS) as a means of measuring corticomotor excitability associated with emotional facial expressions. While TMS was successfully used to elicit motor-evoked responses in the disgust-relevant levator labii muscle, no modulatory effects of emotional stimuli on corticomotor excitability were observed, placing some doubt over the utility of TMS as a means of disgust measurement.

The results of this thesis contribute to broader theoretical conceptualisations of self-disgust, while also further clarifying the role of disgust and self-disgust in eating disorders. Similarly, this thesis adds knowledge and practical utility to the measurement of disgust and self-disgust, supporting further research in this area.

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List of Abbreviations

AN	Anorexia Nervosa
ANOVA	Analysis of Variance
BED	Binge Eating Disorder
BII	Blood Injury and Injection
BIID	Body Integrity Identity Disorder
BMI	Body Mass Index
BN	Bulimia Nervosa
DPSS-R	Disgust Propensity and Sensitivity Scale Revised
DS	Disgust Scale
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4 th Edition
DSM-V	Diagnostic and Statistical Manual of Mental Disorders, 5 th Edition
EBA	Extrastriate Body Area
ECG	Electrocardiogram
ED	Eating Disorder
EDE- Q	Eating Disorder Examination Questionnaire
EDNOS	Eating Disorder Not Otherwise Specified
EGG	Electrogastrogram
EMG	Electromyogram
fMRI	functional Magnetic Resonance Imaging
GID	Gender Identity Disorder
IAPS	International Affective Picture System
LL	Levator Labii
M1	Primary Motor Cortex

MEP	Motor Evoked Potential
OCD	Obsessive Compulsive Disorder
OSFED	Other Specific Feeding or Eating Disorder
RSA	Respiratory Sinus Arrhythmia
SBDS	Self and Body Disgust Scale
SDQ-III	Self-Representational Questionnaire, 3 rd Edition
SDS	Self-Disgust Scale
SPAARS	Schematic, Propositional, Analogical and Associative Representational Systems
SPAARS-ED	Schematic, Propositional, Analogical and Associative Representational Systems for Eating Disorders
SPSS	Statistical Package for Social Sciences
TMS	Transcranial Magnetic Stimulation
ZM	Zygomaticus Major

Acknowledgements

I would like to start by acknowledging and thanking my supervisors, Sue Byrne, Karina Allen and Kenneth Nunn, who have been wonderful, constant sources of support and inspiration over the past few years. To Sue, my principal supervisor, thank you so much for your guidance, generosity and unwavering encouragement throughout every stage of my PhD. Karina, your warm, affirming way, your expertise and careful guidance (from near and afar) have been invaluable. Ken, thank you for sharing your wisdom and ideas with me, and for instructing me in the ways of the Jedi. Significant thanks also go to Geoff Hammond, my unofficial fourth supervisor, for his patient guidance and help throughout my final study.

I'd like to acknowledge the Centre for Clinical Interventions, for allowing me to conduct research at their site. Thanks go to Anthea Fursland and David Esceg-Hurn in particular. I'd also like to acknowledge and thank everyone who participated in the studies I conducted, particularly those who put up with me practising TMS on them.

I have been lucky enough to benefit from the wisdom and support of a number of clinical supervisors, and I'd like to take this opportunity to acknowledge them. Thanks go to Carmela Pestell, for her gentle guidance, patient approach and encouraging words. Thanks go to Gordon Miles and Joanne Elliott at Princess Margaret Hospital, for their kind supervision and support. Significant thanks go to Leanne Dusz and Kelly Gough at the UWA Counselling and Psychology Service, for their warm, generous supervision and willingness to place trust in me. A special acknowledgement also goes to Matt Tilley, for his enlightening words, affirmation and encouragement during all my mountaineering expeditions.

I want to extend my gratitude to Ian Frampton and Marie-Claire Reville, who hosted me while at the University of Exeter. It was wonderful to spend time with others who share the same enthusiasm for this area of research. I'd also like to acknowledge the intellectual contributions of Bryan Lask, who is sadly no longer with us. I was so lucky to be one of the young researchers who benefited from his support and generosity.

I'd like to acknowledge so many friends and family who have been wonderful presences in my life over the last few years. A special thank you goes to Stephanie Wade, Shraddha Kashyap, Jenna Blumberg and Louise Delane, who have been with me in this course from day one. So much love and appreciation also go to the amazing friends I have made along the way: Briony Swire, Lisa Unwin, Susie Wang, Stephanie Whitworth, Sarah George, Gareth Lee, Chris Brydges, Prue Hepple, Zenobia Talati, James Stewart, Aisling Blackmore, Peter Buckland, Amy Lampard and Jason Sharbanee. A special mention goes to Kate Hilgendorf, one of my oldest friends, and an extraordinarily kind, generous person. I'd like to thank my 'Stanmore Family': Isabel Rossen, Rory Watts, Emma Stevens, Neil McNulty Cooper and Vojdan Radunovic, for so many special evenings of Scrabble, cups of tea and sing-alongs.

An acknowledgement goes to my cousins, Brodie, Sophie, Pippa and Madeleine Lester, for treating me like a sister, and just being plain marvellous. A huge thank you also goes to Philip Lochner, for introducing me to jazz, and for cheering me across the finish line.

Finally, to my wonderful parents, and two of my favourite people in the world, Elizabeth and James: Thank you, thank you, thank you, and I can never thank you enough.

**“They are not content with loving such vile objects as our bodies are, whatever
beauty or gifts they may have”.**

St Teresa (1515/1852)

**“If I wasn’t real,” Alice said- half laughing through her tears... “I shouldn’t be
able to cry”**

Lewis Carroll in Evelyn Waugh’s *Vile Bodies* (1930)

Authorship Declaration: Co-Authored Publications

This thesis contains work that has been published and/or prepared for publication.

Details of the work:

Moncrieff-Boyd, Byrne, S., & Nunn, K. (2014). Self-disgust in anoreixanervosa: Confusion between self and non-self. *Advances in Eating Disorders*, 2(1), 4-18.

Location in thesis: Chapter 3

Student contribution to work: The student completed the literature review, prepared and revised this manuscript.

Details of the work:

Moncrieff-Boyd, J., Byrne, S., Allen, K., & Nunn, K. The Self and Body Disgust Scale: Validation and relationship with eating disorder symptomatology. *Manuscript submitted for publication.*

Location in thesis: Chapter 5

Student contribution to work: The student completed the study design, data collection, data analyses, interpretation of findings, and prepared and revised this manuscript.

Details of the work:

Moncrieff-Boyd, J., Byrne, S., Allen, K., & Nunn, K. An examination of disgust and self-disgust among women with eating disorders. *Manuscript submitted for publication.*

Location in thesis: Chapter 6

Student contribution to work: The student completed the study design, data collection, data analyses, interpretation of findings, and prepared and revised this manuscript.

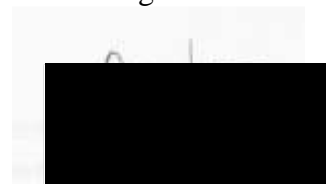
Details of the work:

Moncrieff-Boyd, J. (2015) Anorexia Nervosa (Apepsia Hysterica, Anorexia Hysterica), Sir William Gull, 1873. *Advances in Eating Disorders*, 4(1), 112-117.

Location in thesis: Appendix B

Student contribution to work: The student prepared and revised this manuscript.

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Preamble

This thesis is presented as a series of empirical papers intended for publication (Chapters 5, 6 and 8). Theoretical chapters (Chapters 2, 3 4 and 7) are included in order to discuss background literature and provide context and rationale for the primary focus of this thesis. Chapters 1 and 2 are introductory chapters that provide an overview and theoretical context for the established aims of this thesis. Chapter 3 is a theoretical chapter that has been published as a paper in *Advances in Eating Disorders*. Chapter 4 is a literature review that considers methodological and measurement aspects of this thesis. Chapters 5 and 6 are empirical studies currently under review. Chapter 7 provides further theoretical and methodological background for Chapter 8, which is the final empirical paper included in the thesis. Chapter 9 is a concluding chapter that collectively considers and discusses major findings.

Chapter 1: Introduction

1.1 Thesis Overview

Disgust is ubiquitous to human experience. Historically, disgust has been examined in work concerned with the evolution of emotion and affect. Charles Darwin was the first who sought to provide a description of disgust, commenting on its apparent cross-cultural nature, phylogenetic links and adaptive functionality (1872/2002). A century later, Paul Ekman's (1980; 1992) work on emotion facial expressions again highlighted disgust as a unanimously experienced emotion, with a distinct, universally recognisable facial expression (Ekman, Sorenson & Friesen, 1969). Research extending from this has provided a comprehensive characterisation of disgust that now forms the foundation of modern scientific understandings of this emotion and its function.

However, in comparison to other emotions such as fear, disgust remains relatively little studied in the fields of affective science and abnormal psychology. Disgust has been characterised as the "forgotten emotion in psychiatry" (Phillips, Fahy, David, & Senior, 1998), with a potentially unrecognised or undervalued role in a number of psychiatric conditions. Conditions that appear to inherently involve disgust responses, such as obsessive compulsive disorders and some specific phobias, became obvious candidates for disgust-related research, and studies in the last 15 years have indeed indicated that disgust may play a causal role in such conditions (de Jong & Merckelbach, 1998; Olatunji, 2009; 2010; Page, 2003). Nevertheless, recent progress in understanding suggest that disgust may be of relevance to the nature and pathogenesis of a wider range of psychological conditions, and thus worthy of further theoretical and empirical consideration.

This thesis explores several themes. The first involves a focus on the emotion of disgust and its potential relevance in psychiatric conditions, specifically in the area of eating disorders. Eating disorders are serious mental health conditions with unclear aetiology and limited treatment options, and represent an area that necessitates continued research. Previous inquiry has highlighted the existence of augmented disgust responses among individuals with eating disorders (Aharoni & Hertz, 2012; Harvey, Troop, Treasure, & Murphy, 2002; Troop, Murphy, Bramon, & Treasure, 2000), including disgust expressed towards disorder-relevant stimuli such as food and body shapes. In light of the above, eating disorders represent the primary clinical focus for empirical examinations of disgust within the studies included in this thesis.

Extended from this, self-disgust is considered as a facet of disgust that is experienced and directed towards the self. Self-disgust remains a little researched concept, and has only recently gained attention as an emotional experience distinct from other self-focused emotions such as shame and guilt, with likely relevance in psychopathology (Alanazi, Powell, & Power, 2015; Ille et al., 2014; Overton, Markland, Taggart, Bagshaw, & Simpson, 2008; Powell, Overton, & Simpson, 2014b). Specifically, evidence from clinical and qualitative sources suggest that self-disgust is a salient experience among individuals with eating disorders, with others asserting that it may be a central feature of eating disorder pathogenesis (Fox, Grange, & Power, 2015; Fox & Power, 2009; Nunn, Frampton, Fuglset, Törzsök-Sonnevend, & Lask, 2011; Nunn, Frampton, & Lask, 2012). Building on this, this thesis attempts to provide a further characterisation of self-disgust, as well as broaden understandings of its prevalence in eating disorders.

A final theme relates to disgust measurement. The accurate measurement of emotions using valid, reliable psychometric tools represents an area of continued development and improvement. Thus, the measurement of both disgust and self-disgust represent an additional primary focus, and will involve an exploration of potential measures in both self-report and psychophysiological modalities. In light of the limited measuring tools available for assessing self-disgust, this also involves the development of a revised self-report assessment tool for self-disgust. A psychophysiological measurement tool is also explored as a novel method of assessing disgust, with the expectation that this will progress opportunities for accurate and effective forms of measuring both disgust and self-disgust.

1.2 Thesis Outline

Chapter Two is an introductory chapter providing a theoretical context and rationale for the empirical studies included in this thesis. An initial discussion of broader emotion theory offers a necessary context for the subsequent examination of the emotions of disgust and self-disgust. These emotions are introduced and defined, and the extant literature regarding disgust and self-disgust in the field of eating disorders is summarised. The specific aims of this thesis are also outlined.

Chapter Three is a theoretical paper that considers the proposed basis of self-disgust as a distortion of the bodily and conscious experience of self. This theory is applied specifically to anorexia nervosa and other conditions characterised by a distorted body image.

Chapter Four provides a literature review of existing methods of measuring disgust and self-disgust. The chapter includes an overview of the extant tools of disgust measurement, including commonly used self-report measures, and discusses their development and psychometric properties. Currently available

psychophysiological tools are also considered; specifically ones that assess physiological signals of emotion. This chapter provides a backdrop and context for the future use of selected measures in the thesis' empirical papers.

Chapter Five (Study One) represents the first empirical study of this thesis. This study develops and validates a revised self-report scale (The Self and Body Disgust Scale; SBDS) for measuring self-disgust. The scale is developed from an initial version (The Self-Disgust Scale; Overton et al., 2008) and is modified to assess disgust at aspects of the self, including the body and physical appearance, which are thought to be relevant in eating disorders. The SBDS is validated in a large undergraduate sample, and found to have sound psychometric properties. Concurrent and incremental validity are also ascertained using comparisons with previously established measures of externally-directed disgust.

Chapter Six (Study Two) is the second empirical study, where the SBDS is administered to a clinical sample of patients with diagnosed eating disorders. This study also examines externally-directed disgust in this clinical group. Individuals with eating disorders (across diagnoses) are found to have greater levels of self-disgust in comparison to non-clinical controls and other clinical groups.

Chapter Seven introduces Transcranial Magnetic Stimulation (TMS) as a novel psychophysiological method of emotion measurement. This chapter provides an overview of TMS as a neuropsychological tool, and summarises the current uses of TMS in affective research.

Chapter Eight (Study 3) represents the final empirical study of this thesis, and examines the use of TMS as a method of assessing corticomotor excitability associated with facial signals of disgust in a sample of healthy participants. TMS is

shown to have indeterminate promise as a measure of physiological signals of emotion, specifically those characteristic of disgust.

Finally, in Chapter Nine, the findings of this thesis are considered collectively, and the wider implications of the empirical studies are discussed.

Chapter 2: The Emotions of Disgust and Self-Disgust: Relationships with Eating Disorders

2.1 Chapter Overview and Goals

This chapter includes a summary of the currently accepted theories of emotion, which have been included to provide theoretical background in regard to future considerations of specific emotional states, primarily disgust. This will allow for further understanding of the implications of findings relating to disgust and self-disgust, offering context for further discussions and references to such theories throughout subsequent chapters. This is followed by a specific consideration of the emotions of disgust and self-disgust. Eating disorders are also defined and introduced, and a summary of the extant literature of disgust and self-disgust in eating disorders will be provided. Finally, the rationale and aims for this thesis are presented.

2.2 Dominant Theories of Emotion

2.2.1 The argument for the existence of basic emotions

Emotions are a universal aspect of human experience. However, there remains ongoing contention in regard to what emotions are, and how they are elicited. Various psychological theories exist that provide descriptive and explanatory accounts of emotional experiences. Each theory typically offers a unique conceptualisation of emotional phenomena, promotes a distinct pathway of emotion production, or places varying emphasis on the role of associated cognitive and physiological correlates.

The argument promoting the existence of distinct emotions was championed by a number of theorists who identified evidence in support of the modularity and universality of affective experiences (the ‘modular theory’). In particular, Paul Ekman’s work in the field of identifying universal signals of emotion, including facial expressions, resulted in the proposal that there are a number of discrete, basic emotions that are cross-culturally experienced (Ekman, 1992; Ekman, Freisen, & Ancoli, 1980; Ekman et al., 1969). Ekman (1969; 1992) also drew on descriptions provided by Charles Darwin and theory by Sylvan Tomkins as further support for the understanding of emotions as products of human evolutionary development, with adaptive functionality. Darwin (1872/2008) also pointed to the existence of parallel emotions in animals, particularly non-human primates, highlighting the likelihood of phylogenetic foundations of affective experience.

Ekman (1992) identified six basic, universal emotions, comprising anger, happiness, sadness, surprise, fear and disgust. It is proposed that other non-basic emotions represent secondary combinations of these six emotional experiences (Ekman, 1992; Power & Tarsia, 2007). Further support for the modular theory is provided by the identification of discrete patterns of physiological response during affective experiences, which was first considered by William James (1884) in his early work exploring the phenomenology of feeling states, and by Walter Bradford Cannon (1932). Ekman, Levenson and Frieson (1983) went on to identify specific patterns of autonomic arousal that characterised particular emotions.

The commonalities that exist among emotion antecedents also provide evidence for the universality of specific affective experiences. Ekman (1992) argued that such antecedents are shaped by evolutionary factors and social learning. For example, there is evolutionary benefit from reacting with fear when encountering threatening stimuli, as it would involve the activation of the sympathetic nervous

system (the autonomic response associated with fear) resulting in a sympatho-adrenal response that would facilitate “fight or flight” action. Similarly, the universality of fear signals, such as a fearful facial expression, would provide signals to others of an existing threat, thus facilitating survival in the social group.

These criteria outlined above make up the features defined by Ekman et al (1992) regarding what is a 'basic' emotion. However, there remains ongoing dissent as to what constitutes 'basicness'. Other versions of criteria have been proposed (Izard, 1992; Levenson, 2011; Panksepp, 2007) and there is also disagreement regarding whether certain emotions meet specific criteria (Levenson, 2011). For example, some have argued for the universality of facial expressions of embarrassment and pride (Tracy & Robins, 2008), while others maintain that these emotions are secondary, meeting some but not all criteria for determining basicness.

On the same vein, there is a lack of clarity regarding whether some, or all proposed criteria must be met. In an attempt to address these issues, Levenson (2011) outlined a simplified version containing three criteria, which can be regarded as both the fundamental and essential criteria for determining the basicness of emotion. These include distinctness (the existence of universal physiological markers), hard-wiredness (evidence of phylogenetic origin) and functionality (adaptive mechanisms), and form the foundation for determining the basic nature of affective states within modular perspectives of emotion. This modular theory of emotion contrasts with other conceptualisations that promote a dimensional understanding of affective experience. The factors or dimensions that are typically considered are *valence* and *arousal* (Power & Dalgleish, 2007), where valence can be understood as the pleasantness or unpleasantness (positivity or negativity) of an affective experience and arousal is defined as the collective extremity of an emotional experience. Such theories typically promote an understanding of emotions existing in

dimensional space between the poles of negative/positive valence and low/high arousal (Power & Dalgleish, 2007; Watson & Tellegen, 1985). Such theories have also arisen from arguments regarding what constitutes a 'basic' emotion (Izard, 1992). For example, Ortony & Turner (1990) argued that the role of cognition cannot be removed from emotional experience, and that establishing 'basicness' on the assumption of a biological and phylogenetic underpinnings could not be achieved as it ignores fundamental cognitive components. Others continue to assert that the cognitive components of basic emotions remain 'minimal' at best, highlighting the relevance of reptilian brain regions such as the amygdala that facilitate low-level sensory processing sufficient to produce affective states and shape behaviour, without the influence of higher order processing (Levenson, 2011).

However, the concepts of valence and arousal have also been integrated into current modular understandings of emotion (Roseman, Spindel, & Jose, 1990), where discrete emotional experiences can be considered in regard to their valence (i.e. fear, disgust and sadness as negative emotions) and arousal (i.e. the extremity of a specific emotional experience such as disgust).

This integrated view of emotion modularity will be adopted in this thesis. Specifically, the emotion of disgust will be considered as a distinct emotional state, where disgust represents one of the six basic emotions identified by Ekman et al., (1969), with signal universality and specific cognitive and behavioural correlates. Self-disgust will be regarded as an emotional derivative of primary disgust, involving a disgust response to specific stimuli (i.e. the self and aspects of the self). These emotions will also be considered and discussed with reference to the concepts of emotion valence and arousal. Such considerations will allow for further exploration of specific emotions in regard to their nature and intensity of affective response.

2.2.2 Top-down and bottom-up theories of emotion

Dominant theories of emotion generation typically promote the understanding of emotional processes through top-down or bottom-up processes. Specifically, bottom-up theories suggest that emotion production occurs through the perception of physiological and bodily signs in response to a stimulus, which are then consciously interpreted as feeling states (Seligman, 1971). The most commonly understood bottom-up theory of emotion is the James-Lange theory, based on William James' (1884) initial assumption that emotions are triggered by the experience of bodily sensations. This theory suggests that emotions form in response to feedback received from autonomic and skeleto-motor systems, which are consciously perceived and responded to. Damasio's (1996) Somatic Marker Hypothesis represents a more contemporary theory based on similar underpinnings; the theory suggests that bodily sensations act as physiological 'markers' that are interpreted as feeling states, which, in turn, affect decision-making processes.

Bottom-up explanations contrast with appraisal or 'top-down' theories of emotion that primarily promote the role of cognition and cognitive appraisal in informing the feeling state (Ellsworth & Scherer, 2003; Roseman, 1984; Roseman, Spindel & Jose al., 1990; Scherer, 1988). According to these theories, cognitive appraisal of a stimulus occurs prior to an affective reaction and the associated bodily response. These models of emotion place emphasis on the appraisal dimensions such as novelty, pleasantness or importance, which shape emotional responses (Ellsworth & Scherer, 2003; Roseman et al., 1990; Scherer, 1988). Cognitive appraisals are also understood to be influenced by individual beliefs and intentions, said to account for the variability in individual affect in response to similar events (Ellsworth & Scherer, 2003; Lazarus, 1991).

An interaction of both bottom-up and top-down functioning in the production of emotion is promoted through a number of recent conceptual and empirical investigations. This model can be regarded as the currently accepted understanding of emotion generation, and will be the understanding adopted in this thesis. Specifically, emotional experiences are generated and maintained by an interaction between the two mechanisms described above, where conscious feeling states can be both informed by the perception of bodily change, and also facilitated by the process of cognitive appraisal (McRae, Misra, Prasad, Pereira, & Gross, 2011; Mathews & McLeod, 1994; Ochsner et al., 2009). The introduction of neuroimaging research has enabled investigation of these processes on a neural level, and a number of researchers have successfully identified distinct, yet overlapping, neural circuitry involved in both top-down and bottom-up emotion generation (Ochsner et al., 2009; Phelps & LeDoux, 2005). Accordingly, this thesis will consider the emotions of disgust and self-disgust with reference to both top-down and bottom-up theories of emotion generation, which likely function in parallel in order to produce the feeling state.

2.3 Disgust: The Emotion

2.3.1 The characteristics of disgust

Disgust is a specific emotion characterised by a visceral experience of revulsion and aversion in response to an elicitor. As described above, disgust is recognised as one of the six basic, universal emotions (Ekman, 1992; Ekman et al., 1969). While disgust elicitors can vary between culture and time period (Miller, 1998), Paul Rozin and his colleagues identified several broad disgust domains, which are considered to encompass the majority of typical disgust stimuli. These domains include body products, animals, death, body envelope violations, food, sex and

hygiene (Haidt, McCauley, & Rozin, 1994; Rozin & Fallon, 1987). Experiences of disgust have also extended into social and moral domains, where certain actions or behaviours, once again culturally determined (Miller, 1998; Rozin & Fallon, 1987), can be regarded as abhorrent or revolting.

The experience of disgust is also said to involve an ideational component associated with beliefs about contamination or the potential for contamination (Rozin & Fallon, 1987). These ideations or thoughts are paired with a visceral response often characterised by nausea and in extreme cases, vomiting. Behaviourally, disgust, like fear, results in rejection and avoidance behaviours, and its physiological correlates involve sympathetic and parasympathetic co-activation

While disgust facial expressions (characterised by the nose wrinkled, the tongue protruding) can be observed from infancy, the acquisition of disgust occurs later in childhood and is culturally determined (Miller, 1998; Sawchuk, 2009). Spontaneous disgust responses to core disgust elicitors are not typically observed among children under age eight, and contamination appraisals appear to be learnt and internalised between the ages of three and seven years (Toyama, 1999), corresponding with the development of more sophisticated cognitive capacity, and cumulative exposure to social modelling (Sawchuk, 2009).

Disgust is primarily an adaptive, sentinel emotion. Early accounts of disgust were provided by Darwin (1878/2002), who linked the experience to food and taste. He noted the culturally determined nature of disgust stimuli, describing his own experience of revulsion when being offered foreign foods. Darwin's description of the emotion is emulated in modern accounts of the phylogenetic origins of disgust in food rejection and distaste (Rozin & Fallon, 1987; Rozin, Fallon, & Mandell, 1984). Food rejection, for example in response to bitter substances, is a behaviour observed in other mammal and avian species (Grill & Norgren, 1978; Steiner, Glaser, Hawilo,

& Berridge, 2001) and is often paired with disgust-like facial movements. While in animals this response is distinguished as distaste, disgust is suggested to have developed as an affective elaboration of adaptive mechanisms in distaste, designed to prevent contamination by toxins or pathogens. Disgust has even been conceptualised as part of the ‘behavioural immune system’, a collection of behavioural mechanisms that identify and respond to external threat (Schaller & Park, 2011).

2.3.2 Disgust sensitivity and propensity

Literature examining experiences of disgust has grown over the last two decades, with many studies examining specific disgust concepts such as *disgust sensitivity*. Disgust sensitivity refers to the intensity of a disgust experience in response to specific disgust elicitors (Haidt et al., 1994) and is regarded as a relatively stable personality trait (Herz, 2012). Haidt, Rozin and McCauley (1994) developed a self-report questionnaire, the Disgust Scale, geared towards assessing levels of disgust sensitivity in response to specific elicitors that feature within the seven disgust domains. However, disgust sensitivity has since been distinguished from *disgust propensity*, which refers to the frequency of disgust experiences independent of specific elicitors (Olatunji, Cisler, Deacon, Connolly, & Lohr, 2007; Van Overveld, De Jong, Peters, Cavanagh, & Davey, 2006). This has resulted in dissent among researchers as to which construct is in fact measured by the Disgust Scale (Olatunji, Cisler, Deacon, Connolly, & Lohr, 2007). Van Overveld, de Jong, Peters, Cavanagh and Davey (2006) developed the Disgust Sensitivity and Propensity Scale (DPSS-R) as an alternative self-report measure of both disgust constructs. The DPSS-R has subsequently been validated and provided evidence for the conceptual distinction between disgust sensitivity and propensity (Olatunji, 2009; Olatunji, Cisler, Deacon, Connolly & Lohr, 2007), prompting the need to investigate

them independently. An in-depth review of the self-report measures of disgust sensitivity and propensity is provided in Chapter Four.

2.3.3 Disgust in psychopathology

Disgust has emerged relatively recently as an emotion of interest in psychopathology. Specifically, it is thought that disgust may play a role in conditions that feature extreme, aversive responses to external stimuli. Furthermore, it is thought that individuals with such conditions would be characterised by a generalised pattern of extreme disgust responses across disorder-relevant as well as typical disgust domains. Disgust sensitivity has been examined across a range of conditions, and high sensitivity is found to characterise individuals with obsessive compulsive disorder (OCD; Deacon & Olatunji, 2007; Olatunji & McKay, 2007), eating disorders (Aharoni & Hertz, 2012; Harvey et al., 2002; Troop, Murphy, Bramon, & Treasure, 2000; Troop, Treasure, & Serpell, 2002), sexual dysfunction (Borg, de Jong, & Schultz, 2010), spider phobia (Olatunji, Cisler, et al., 2007; Olatunji & McKay, 2007) and blood, injury and injection phobia (Olatunji, Cisler, et al., 2007; Page, 2003). Following the conceptual distinction made between disgust sensitivity and propensity, associations have also been identified between high disgust propensity (i.e. the frequency of disgust experiences, regardless of stimulus) and anxiety symptoms including contamination, spider and blood-injury and injection fears (Olatunji, Cisler, et al., 2007; Van Overveld et al., 2006). Such findings are indeed suggestive of generalised, heightened disgust experiences among individuals with these conditions, which may predispose extreme expressions of disgust in response to disorder-relevant stimuli (Olatunji & Sawchuk, 2005).

A body of literature has specifically considered the role of disgust in OCD (Berle & Phillips, 2006; Mancini, Gragnani, & D'Olimpio, 2001; Olatunji, Lohr,

Sawchuk, & Tolin, 2007; Sprengelmeyer et al., 1997). Disgust appears particularly relevant to those with contamination-based fears, which is consistent with the underlying ideations of disgust that typically relate to a concern about contamination or the potential for contamination. Levels of disgust sensitivity are shown to attenuate in parallel with OCD symptoms (Olatunji, 2010), highlighting the relevance of disgust as an emotional experience during the illness phase.

Disgust is also thought to have a particular function in blood/injury and injection phobias, due to the frequency of fainting responses that likely indicates parasympathetic syncope (Page, 1994, 2003). As disgust activates parasympathetic pathways, while anxiety increases sympathetic activity, it is thought that disgust may characterise affective responses to blood, injury and injection related stimuli (Page, 1994), and is possibly more or equally prevalent to fear responses in these conditions.

Other abnormal disgust experiences are also observed among individuals with major depressive disorder, who are found to have increased sensitivity to disgusted facial expressions (Hayward, Goodwin, Cowen, & Harmer, 2005). Neuroimaging have also identified hyper-activation of emotion processing circuits while depressed individuals are observing disgusted faces (Surguladze et al., 2010). Those with Huntington's disease consistently show impairments in the recognition and perception of disgust facial expressions (Calder, Keane, Manes, Antoun, & Young, 2000; Gray, Young, Barker, Curtis, & Gibson, 1997), as well as expressions of disgust through auditory modalities (Hayes, Stevenson, & Coltheart, 2007). Similar emotional facial expression recognition deficits have also been observed among those with Parkinson's disease, with some evidence pointing towards a specific deficit in the recognition of disgust (Sprengelmeyer et al., 2003; Suzuki, Hoshino, Shigemasu & Kawamura, 2006).

2.3.4 The neural basis of disgust

Research into abnormal disgust experiences in Huntington's and Parkinson's disease are among a number of investigations that highlight the importance of the insular region in both the recognition and experience of disgust (Hayes et al., 2007; Hennenlotter et al., 2004). In a functional Magnetic Resonance Imaging (fMRI) study, Phillips et al. (1997) identified increased activation of the insular cortex while participants viewed images of disgusted facial expressions in comparison to neutral and fear faces, suggestive of a specific role of the insula in disgust recognition. These findings have been replicated in successive studies (Phillips et al., 2004; Schroeder et al., 2004; Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998). Researchers have subsequently identified links between insular dysfunction and poor disgust recognition in those with Huntington's disease (Kipps, Duggins, McCusker, & Calder, 2007), as well as among Huntington's gene carriers (Hennenlotter et al., 2004). Similar links have also been observed among those with other sources of insular damage (Calder et al., 2000; Ibanez, Gleichgerrcht, & Manes, 2010; Jones, Ward, & Critchley, 2010). The role of the insula does not appear to be limited to disgust recognition; other neuroimaging studies have identified insular activation during experiences of disgust elicited by both visual and olfactory modalities (Wicker et al., 2003; Wright, He, Shapira, Goodman, & Liu, 2004), suggestive of a primary role of the insula in the disgust experience as well as disgust recognition.

Other brain regions, co-activating with the insula, are also implicated in disgust. Researchers of disgust recognition have consistently identified co-activation of prefrontal areas and cortico-striatal-thalamic circuits, including structures in the basal ganglia (Phillips et al., 1997, 1998; Sprengelmeyer et al., 1998). Wicker et al. (2003) noted activation of the anterior cingulate cortex during both the experience and perception of disgust, and others have identified concurrent activation of

orbitofrontal regions, as well as amygdala activation, during viewing of disgust stimuli (Schienle et al., 2002). Such findings also point to the likelihood of a broader emotion-processing neural circuit, elicited by emotions such as disgust, which activate a number of cortical structures including the insula (Damasio et al., 2000; Rolls, 2000; Schienle et al., 2002).

2.4 Self-disgust

2.4.1 A definition of self-disgust

The self emerges as fundamental to the experience of disgust. The directionality of disgust is primarily from the self towards non-self, highlighting the emotion's self-protective function and again reflecting its phylogenetic origins as a method of pathogen avoidance (Rozin & Fallon, 1987). Disgust is an emotion with sentinel functionality: in some circumstances, transient disgust directed at one's behaviour (e.g. accidentally eating spoiled food) can be protective and facilitate disease avoidance (Siegal, Fadda & Overton, 2011). However, self-disgust is neither functional nor adaptive (Powell, Simpson, & Overton, 2013). It represents a variation of the disgust response or inappropriate recruitment of the disgust system, where experiences of revulsion and abhorrence are turned towards the self, aspects of self and/or one's behaviours (Powell, Simpson, & Overton, 2015).

Definitions of self-disgust have varied throughout the literature, and an exhaustive characterisation has only recently emerged (Powell et al., 2014b). Self-disgust has been previously conflated with shame and similar self-conscious emotions (Power & Dagleish, 2007), and has also been regarded as synonymous with self-loathing (Ille et al., 2014; Power & Dagleish, 2007). However, in a recent phenomenological analysis of self-disgust among females with major depressive disorder, the emotion was consistently characterised as a pervasive negative

experience with distinct visceral qualities, extending to physical, behavioural and even psychological aspects of the self (Powell, Overton, & Simpson, 2014a). The study also explored the origins of self-disgust experiences, identifying engagement in comparisons with other people, as well as the internalisation of outside criticism, as relevant antecedents to feelings of self-disgust. Self-disgust has also been successfully differentiated it from more global constructs such as low self-esteem (Simpson, Hillman, Crawford, & Overton, 2010).

Powell, Overton and Simpson (2015) assert that like externally-directed disgust, self-disgust is socio-culturally learnt. Aspects or features of the self (and/or body) become appraised or determined as revolting and unacceptable, and are consequently responded to with disgust. Evidence of physiological experiences consistent with externally directed disgust, such as feelings of nausea (Powell et al., 2013), have also characterised subjective descriptions of self-disgust. The behavioural correlates of self-disgust also appear consistent with external disgust (Powell et al., 2015), such that rejection and avoidance become a rejection and lack of acceptance of self, manifesting as avoidance of experiences that trigger self-awareness, such as evasion of sexual contact (Espeset, Gulliksen, Nordbø, Skaarderud, & Holte, 2012), dissociation, and avoidance of self-viewing (Powell et al., 2013). However, self-disgust is paradoxical in that the self can ultimately not be avoided or rejected, potentially driving feelings of inescapability or irreversibility (Powell et al., 2013).

As self-disgust is an atypical experience, research in the area has primarily focussed on expressions of disgust at the self in clinical populations. However, research in this area remains scarce. This is despite assertions that the role of disgust is undervalued in psychological and psychiatric research (Phillips et al., 1998), and

that self-disgust in particular may play a crucial, yet unrecognised, role in a number of emotional disorders (Power & Dalgleish, 2007).

Existing investigations of self-disgust have primarily focused on major depressive disorder. Overton, Markland, Taggart, Bagshaw and Simpson (2008) developed a Self-Disgust Scale as a method of assessing self-reported levels of self-disgust; an initial study validated the scale and provided evidence of increased self-disgust among individuals with major depressive disorder. Self-disgust was also found to partially mediate the relationship between depressive cognitions and depressive symptoms, highlighting its potential relevance in this condition (Overton et al., 2008; Simpson et al., 2010). In a recent study conducted by Ille et al., (2014), the prevalence of self-disgust was examined among individuals with a range of clinical conditions, providing initial evidence for experiences of self-disgust among wider psychopathology, including OCD, schizophrenia, borderline personality disorders, and eating disorders.

2.4.2 Self-disgust versus shame

In emerging literature regarding self-disgust, there is some dissent over the distinction between this concept and that of shame. Both are considered self-conscious emotions, in that the focus of the emotion is the self and one's behaviour, where one or several of these features fail to meet an internalised standard (Simpson et al., 2010). Miller (1997) implies further parallels between these emotions in regard to their behavioural manifestations, identifying that both shame and self-disgust result in a desire to hide oneself from exposure. Previous studies exploring these emotions have conflated them (Roberts & Gettman, 2004); while others have treated them as distinct experiences (Overton et al., 2008; Powell et al., 2015). However, a key distinction between the two emotional experiences appears to lie in the nature of

disgust, which is characterised by its distinct visceral quality, and the 'yuck' factor that fails to be captured by other negative, self-focused experiences such as shame (Rozin et al., 1993). This factor then engenders the experience of self-disgust as an abnormal manifestation of disgust, still characterised by qualia of revulsion, underpinned by distinct neural correlates and built on phylogenetic foundations of distaste (Rozin et al., 1993)..

2.5 Disgust and Self-disgust in Eating disorders

2.5.1 Eating disorder nosology and diagnostic features

Eating Disorders are serious mental health conditions characterised by eating disturbance, over-evaluation of weight and shape, and behaviours directed towards modifying weight and shape (American Psychiatric Association, 2000). The Diagnostic and Statistical Manual of Mental Disorders IV (DSM-4; American Psychiatric Association, 2000) identified three major eating disorder classifications; specifically anorexia nervosa (AN), bulimia nervosa (BN) and eating disorder not otherwise specified (EDNOS). In the DSM-5, this was expanded to include seven eating and feeding disorders, and diagnostic criteria were updated for AN and BN (American Psychiatric Association, 2013). Current diagnostic criteria characterise AN as a condition involving

- a) a restriction of energy intake resulting in a significantly low body weight, based on age, sex, developmental trajectory and health;
- b) an intense fear of weight gain or behaviours that interfere with weight gain;
- c) body weight and shape disturbance, including undue influence of weight and shape on self-evaluation, or lack of recognition of low body weight (American Psychiatric Association, 2013).

The DSM-V also distinguishes between two types of AN, a restrictive subtype, where individuals do not engage in binge eating or purging behaviours, and a binge-eating/purging subtype, where binge eating and purging are regularly engaged in over at least the previous 3 months. AN is often marked by physiological symptoms such as semi-starvation, amenorrhea, low bone mineral density and abnormal vital signs. These can often be life threatening (American Psychiatric Association, 2013). AN also has high comorbidity with major depressive disorder and OCD (American Psychiatric Association, 2013). The DSM-5 indicates a current prevalence rate for AN of approximately 0.4% of the female population (females only; American Psychiatric Association, 2013), although population-based studies vary in their estimates and higher prevalence rates have been reported e.g. (Allen, Byrne, Oddy, & Crosby, 2013; Stice, Marti, & Rohde, 2013).

BN represents another eating disorder that features

- a) recurrent episodes of binge eating
- b) recurrent compensatory behaviours as a means of weight control including vomiting, laxative, diuretic or other medication abuse, fasting or excessive exercise.
- c) binge eating and compensatory behaviours that both occur approximately once a week for a period of 3 months
- d) undue influence of shape and weight on self-evaluation
- e) behaviours not occurring exclusively during episodes of AN (American Psychiatric Association, 2013).

While BN is not characterised by low weight, it can also be associated with physiological symptoms including amenorrhoea, electrolyte and fluid imbalance, cardiac arrhythmia and gastrointestinal complications. Current population prevalence

rates estimate that 1- 8.7% of young females meet criteria for BN (Allen et al., 2013; Stice et al., 2013).

Other specific eating disorders in DSM-5 include binge eating disorder (BED) and the Other Specified Feeding and Eating Disorders (OSFED) category, which includes atypical AN, sub-threshold BN, and purging disorder.

2.5.2 Emotional phenomena in eating disorders

Emotion has been described as a neglected area in the understanding of eating disorders (Fox, 2009; Fox & Power, 2009; Haynos & Fruzzetti, 2011; Treasure, 2012). The majority of research considering emotion in AN and BN has tended to focus on the function of general negative affect and affect regulation. Specifically, experiences of extreme negative affect and distress intolerance have been found to characterise BN and binge eating disorder (BED), and are implicated in impulsivity and the feelings of urgency that are thought to drive bingeing and purging behaviours (Anestis, Selby, Fink, & Joiner, 2007; Stice, 2001). Conversely, AN appears to be typified by low emotional awareness (Harrison, Sullivan, Tchanturia, & Treasure, 2009; Oldershaw, Hambrook, Tchanturia, Treasure, & Schmidt, 2010), impaired emotion recognition (Kucharska-Pietura, Nikolaou, Masiak, & Treasure, 2004; Zonnevijlle-Bendek, Goozen, Cohen-Kettenis, Elburg, & Engeland, 2002) and emotion dysregulation (Harrison et al., 2009; Haynos & Fruzzetti, 2011). In line with this characterisation, a proportion of the literature has focused on the high rate of alexithymia observed in individuals with AN (Bourke, Taylor, Parker, & Bagby, 1992; Parling, Mortazavi, & Ghaderi, 2010) and to a lesser extent in BN (Schmidt, Jiwany, & Treasure, 1993). Alexithymia is a condition characterised by a difficulty identifying and communicating one's own emotions, difficulty distinguishing between emotions and physical sensations, and concrete thinking patterns (Behar &

Arancibia, 2014). Again, this points to a tendency to consider broad features of emotion and collective affect, as opposed to considering the nature and function of specific emotions in these conditions (Fox & Power, 2009).

Nevertheless, specific emotional states have also been considered in several qualitative investigations of eating disorders, which have highlighted the possible link between negative emotions such as anger and sadness, and symptoms such as body dissatisfaction and food restriction (Espeset et al., 2012). Fear, in particular fear of weight gain, also represents a prominent emotional experience among individuals with eating disorders, representing one of the core diagnostic symptoms of AN (American Psychiatric Association, 2013). Fear of weight gain is also thought to motivate restriction and compensatory behaviours (Eiber, Berlin, Brettes, Foulon, & Guelfi, 2002; Espeset et al., 2012). Exaggerated fear responses to disorder-relevant stimuli, such as high calorie food and overweight body shapes, are also observed among individuals with AN and BN (Harvey et al., 2002), and are again thought to play a role in avoidance behaviours displayed towards food. Further, a number of researchers have highlighted the potential role of fear and anxiety in the pathogenesis of eating disorders, through abnormal fear conditioning mechanisms (Strober, 2004), or high trait anxiety as a prominent risk factor (Pallister, 2008). Other specific emotions also gaining attention as relevant affective experiences in eating disorders; in a qualitative study, Fox (2009) identified anger a pertinent affective motivator for eating disorder behaviour, including purging behaviours in particular.

2.5.3 Disgust and self-disgust in eating disorders: Extant research

Disgust was initially proposed as an emotion of interest in eating disorders based on suggestions that it could represent an ideal affective vehicle for instilling food with negative properties (Davey, Buckland, Tantow, & Dallos, 1998).

Similarly, it is thought that feelings of disgust could motivate avoidance and rejection behaviours towards food and eating. Initial explorations focused on the possibility of increased disgust sensitivity among individuals with AN and BN in comparison to healthy individuals. Several studies using various versions of Rozin et al.'s (1998) Disgust Scale consistently identified increased disgust sensitivity in response to food, the body and body products (Davey et al., 1998; Troop et al., 2000, 2002). It was concluded that individuals with eating disorders displayed increased disgust sensitivity to specific, disorder-relevant stimuli (Troop et al., 2002). However, Aharoni and Hertz (2012) re-examined disgust in AN specifically, identifying increased disgust responses in six out of eight disgust domains in comparison to healthy individuals, promoting the possibility of more generalised sensitivity to disgust among this clinical group. To date, there remains contention as to whether increased disgust sensitivity is a generalised experience among individuals with eating disorders, or whether high sensitivity is limited to disorder-relevant stimuli only.

Broader examinations of disgust and eating pathology have identified an association between abnormal eating attitudes and disgust responses to images of high-calorie foods and overweight body shapes, highlighting disgust as a relevant emotional response to such stimuli on par with fear (Harvey et al., 2002). In a recent study, Hildebrandt et al. (2015) identified poorer response flexibility among individuals with AN who responded to food stimuli with disgust, further suggesting that targeting disgust may be important when addressing negative associations with food in particular.

Despite consistent findings supporting the significance of disgust in eating disorders, there is relatively little research into self-disgust. However, expressions of

disgust at the body and self are frequent throughout clinical descriptions and subjective accounts of both AN and BN, as demonstrated in the following excerpts:

“ I will always be loathsome like this, dirty, spoiled, turned into an animal, and I can never again be a human being. I feel disgust for myself, feel soiled and in order to be clean I would have to take a lot of castor oil . . . I feel so fat, so fat, and that is frightening.” (Stunkard, 1990, p. 266).

“It feels like my body is not a part of me....It feels like an alien. I generally feel that it’s not my own body, it’s somebody else’s body, or something like that... It feels disgusting” (Espeset et al., 2012, p 458).

“When I eat... I feel sick and guilty... I feel that I’m filled up. My body is filled. I just feel... disgusting. It’s a disgusting feeling of gluttony. I feel so much better when I don’t eat” (Espeset et al., 2012, p 457).

Several of the above quotations emerged from Espeset et al.’s (2012) qualitative exploration of negative emotionality in AN, and its association with specific eating disorder behaviour. In the study, frequent expressions of disgust were expressed by participants particularly towards food, the body and the self. Self-disgust also appeared to drive food restriction behaviours, as well avoidance of situations that resulted in increased body awareness (such as self-viewing or sexual contact). Espeset et al. (2012) concluded that addressing disgust responses to the self may be a necessary focus of treatment for AN.

Initial quantitative research into self-disgust in eating disorders has been conducted by Ille et al., (2014), who examined experiences of disgust and revulsion

at the self among a sample of individuals with varied clinical diagnoses. Individuals with AN and BN, along with those with borderline personality disorder, were among those reporting the highest levels of self-disgust. Consequently, it appears necessary to continue expanding investigations of this emotion in these clinical groups.

2.5.4 Disgust and self-disgust in explanatory models of eating disorders

There are a number of aetiological models of eating disorders that feature both disgust and self-disgust. A comprehensive emotion-focused model in eating disorders was developed by Fox and Power (2009) based on the Schematic Propositional Analogical Associative Representation Schema (SPAARS) theory of emotion (Power & Dagleish, 2008). The model distinguishes between two routes of conscious and unconscious emotion generation, incorporating a schematic level of influence on emotional experience, and considers the influence of ‘coupled’, interacting emotions. When applied to eating disorders, Fox and Power (2009) promote the role of disgust and anger as coupled emotions that are central to the eating disorder experience, and conceptualise the symptoms of AN and BN as affect regulation strategies in response to inhibited experiences of anger and exaggerated experiences of disgust (Fox & Power, 2009). The SPAARS- ED model also incorporates self-disgust as a manifest experience when negative emotions become re-directed at the body and self (Fox, Grange & Power, 2015).

In the broader emotion literature, there is also a proposed uni-directional relationship between disgust and anxiety, where primary experiences of disgust may result in secondary fear/anxiety responses. In an investigation conducted by Davey, Bickerstaffe and MacDonald (2006), disgust was shown to produce similar negative interpretation biases to those commonly seen in anxiety (Mathews, Richards, & Eysenck, 1989). It was concluded that disgust promoted a negative interpretation bias

of ambiguous stimuli, which could not be accounted for by co-activation of anxiety or an increase in general affectivity. The authors suggested that this pointed towards a potentially causal role of disgust in anxious psychopathology, where elevated disgust can lead to a tendency to detect threat in disorder-relevant stimuli (Davey, Bickerstaffe, & MacDonald, 2006). When applying this finding to eating disorders, it is possible that initial disgust responses towards food and weight gain trigger a negative interpretation bias, which may then predispose anxiety/fear-related responses to such stimuli.

Other factors potentially underlying self-disgust in AN specifically are also presented in detail in chapter 3.

2.6 Summary and Thesis Aims

Based on prevailing theories of affective experience, disgust represents a specific emotion state with signal universality, an associated physiological response pattern, common antecedents and typical behavioural correlates. Similarly, disgust generation can be understood as a product of top-down and bottom-up mechanisms, which incorporate the perception of bodily signals of disgust, such as nausea, and the influence of cognitive appraisal, i.e. contamination-based ideations. In research literature, components of the disgust experience have been separated into disgust sensitivity and propensity, which have subsequently been independently investigated. More recently, self-disgust has also been explored as a specific emotional derivative of disgust, where the object of revulsion and aversion becomes aspects of the self, one's body and one's behaviours. Preliminary research has established the relevance of self-disgust in a number of psychological conditions such as major depressive disorder (Overton et al., 2008; Powell et al., 2014) with emerging indications that it may also feature in broader psychopathology (Ille et al., 2014).

Given the evidence promoting the potential relevance of disgust in eating disorders, there is a need for further consideration of this emotion within this clinical group. While previous studies have established the existence of augmented disgust sensitivity among individuals with AN and BN, there is currently no extant study that has explored levels of disgust propensity in eating disorders. Emerging understandings of self-disgust also promote consideration of this emotional experience, particularly among conditions that typically feature extreme negative responses to the self and body. Thus, an initial aim of this thesis is to explore disgust and self-disgust among individuals with eating disorders, in the hope of establishing a basis for understanding the extent and nature of these emotions in this clinical group.

An area worthy of ongoing attention in the field of disgust and relates to measurement. There is a need for further development of tools and methods geared towards assessing emotional experience more broadly, as well as tools that have specific utility in measuring disgust. This need extends to self-report measures, as well as psychophysiological tools geared towards assessing objective, physiological correlates of emotion. Due to the developing nature of research into the area of self-disgust, investigation of the measurement of this emotion also remains in its infancy. Thus, a second aim of this thesis is to explore the practical measurement of both disgust and self-disgust, in both self-report and psychophysiological modalities.

2.6.1 Overview of chapters and empirical studies addressing these aims

A combination of theoretical and empirical chapters will consider and investigate the aims of this thesis. Chapter Three is a theoretical paper that explores the potential underpinnings of self-disgust specifically in AN, characterising AN as a disorder of self-ownership. This paper aims to provide further theoretical insight into

the possible antecedents, as well as consequences, of self-disgust in this clinical group.

A comprehensive review of self-report and psychophysiological measures of disgust and self-disgust is provided in Chapter Four, allowing for an in-depth consideration of existing tools used to assess disgust. This chapter includes a critique of the strengths and weaknesses of such measures, as well as rationale for the use of particular measures in subsequent empirical studies.

In order to empirically investigate the aims of this thesis, Study One (Chapter Five) involves developing and validating a modified self-report measure of self-disgust, the Self and Body Disgust Scale, based on Overton et al.'s (2008) Self-Disgust Scale. The scale is modified to include items specifically designed to assess visceral revulsion at the self and the body, and is validated in a large undergraduate sample (n=746) in order to ascertain its psychometric properties. This study also includes a preliminary investigation of potential relationships between self-disgust and eating disorder symptomatology.

In Study Two (Chapter Six), the validated Self and Body Disgust Scale will be administered to a sample of individuals with clinically diagnosed eating disorders (n=68), non-clinical controls (n=68) and clinical comparison groups (major depressive disorder, n=64; social phobia, n=58). Levels of disgust sensitivity and propensity are also examined. Findings from this study will provide an indication of whether eating disorders are characterised by high disgust propensity as well as high disgust sensitivity. This study will also establish the extent of self-disgust experiences among individuals with eating disorders, in comparison non-clinical and other clinical groups.

Chapter Seven will provide a description of the neural basis of facial expressions, as well as a description of transcranial magnetic stimulation (TMS), a

psychophysiological tool that has recently been used to assess corticomotor excitability indicative of emotionally-induced defensive action. This chapter will provide background and rationale for Study Three (Chapter Eight), the final empirical study in this thesis, which explores TMS as a novel measure of corticomotor activity associated with facial expressions of disgust. Study Three's experimental design involves administering TMS to a sample of healthy participants (n=35) while viewing images designed to evoke specific emotional responses, including disgust. It is anticipated that an investigation of TMS may provide initial evidence for its utility as a measurement tool of disgust, with potential implications for a wider range of emotions.

In Chapter Nine, the central findings of these empirical studies will be collectively considered and discussed. The themes and aims of this thesis will be revisited in the hope that these findings have added practical and theoretical knowledge to the areas of disgust, self-disgust, and their measurement.

Chapter 3: Disgust and Anorexia Nervosa: Confusion between Self and Non-self

REVIEW

Disgust and Anorexia Nervosa: Confusion between self and non-self

Advances in Eating Disorders, 2(1), 4-18.

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3.1 Abstract

Disgust is recognised as a significant emotion in several psychological conditions, including Anorexia Nervosa. The disgust experience is underpinned by the ability to discriminate between the self and non-self. Self/non-self discrimination is an adaptive, phylogenetic mechanism that facilitates rejection and avoidance of potentially aversive external influences. In this review, Anorexia Nervosa is conceptualised as a disorder of disrupted self/non-self discrimination, where a disturbed sense of self results in emotional responses characterised by disgust and abhorrence at the self: self-disgust. The features underlying self/non-self discriminatory ambiguity in Anorexia Nervosa are discussed in relation to low interoceptive sensitivity and the possibility of constraints on neuroplasticity in the somatosensory cortex during puberty. The consequences of altered experiences of self, and the emotional response of self-disgust, are considered in relation to core Anorexia Nervosa symptoms including food restriction and avoidance, and the development of more complex negative emotional responses to the self. Dysfunction in the insular cortex is proposed as the neural correlate associated with these processes, with dysfunction in the insula and associated neurocircuitry occupying a potentially crucial role in the development and maintenance of Anorexia Nervosa. This review has implications for future Anorexia Nervosa theory and research, as well as possible treatment approaches.

3.2 Introduction

Disgust is one of the six universal and basic emotional experiences (Ekman, 1992). It has a specific facial expression (mouth drawn back, nose wrinkled) and a more general behavioural response characterised by avoidance and rejection (Darwin, 2002). It has a subjective experience, namely revulsion and abhorrence, and is accompanied by a physiological response including parasympathetic nervous system activation with nausea and vomiting. It has a well-defined neural activation signature and associated neurocircuitry (Phillips et al., 1997).

Investigation of the relationships between discrete emotions and psychopathology has examined the role of disgust in the development and maintenance of conditions such as major depression disorder, Huntington's disease, obsessive compulsive disorder, phobias and more recently, anorexia nervosa (AN; Berle & Phillips, 2006; Cisler, Olatunji, & Lohr, 2009; Gray, Young, Barker, Curtis, & Gibson, 1997; Hayes, Stevenson, & Coltheart, 2007; Mancini, Gragnani, & D'Olimpio, 2001; Olatunji, Cisler, McKay, & Phillips, 2010; Overton, Markland, Taggart, Bagshaw, & Simpson, 2008). This research has given new insights into causal mechanisms and possible treatment approaches for these conditions. While investigations in eating disorders have predominantly focused on disgust responses to external stimuli such as food, eating disorders are characterised by high levels of self-directed negative emotion, including disgust. Expressions of disgust and abhorrence at the body and self are frequent in phenomenological accounts of AN (Nunn, Frampton, Fuglset, Törzsök-Sonnevend, & Lask, 2011; Troop & Baker, 2009). However, little empirical research has investigated this (Calder et al., 2007).

This review will consider the role of self-directed disgust in eating disorders, specifically AN, as an extreme affective consequence of failed self/non-self discrimination. The phylogenetic diversity (bio-evolutionary relationships across

species) and adaptive advantages of self/non-self discrimination will be considered, followed by a discussion of instances where organisms fail to discriminate accurately between self and non-self. The possible precursors to, and implications of, self/non-self discriminatory failures in AN will also be discussed, including the function of disgust as a central negative emotional response to the self. This conceptualisation has concurrent implications regarding other core symptoms and behaviours of AN, including disrupted eating behaviours and body image disturbance. Lastly, this conceptualisation will be aligned with a recently proposed aetiological hypothesis of AN, which postulates dysfunction in the insular cortex of the brain, both extrinsically because of its connectivity and intrinsically because of its primary functions, as a central risk factor in the development and maintenance of the disorder.

3.3 The Domains of Disgust: From Food to the Self

Darwin's (1878/2002) account of disgust linked the origin of this emotion to eating and food. The elicitors and expressions of disgust are localised around food and items that are offensive to taste, while physiological responses are centred on the mouth and gustatory system. Darwin (1878/2002) also highlights that both body and mind 'revolt' at the prospect of a disgusting food. Nausea can be induced through mere thoughts of offensive food items. Later accounts also focus on the ideational properties of disgust, which separate the emotion from more phylogenetically primitive food rejection behaviours (Rozin & Fallon, 1987). Rozin and colleagues argue that disgust, rather than being prompted by taste, is elicited by the knowledge of a substance's animalistic and self-contaminating properties. Miller (1997) defines disgust as a socio-moral sentiment that conveys a feeling of aversion at something with the potential to contaminate or pollute. These definitions extend disgust elicitors

outside the realm of food-related items and, in the process, extend the scope of disgust to more complex domains of human experience.

The border between the self and the non-self emerges as central to the disgust experience. The skin is the biological border between the self and non-self, with the mouth representing the main entry point of the to-be-incorporated environment to the self. Rozin and Fallon (1987) describe food-related disgust as a ‘guardian of the mouth’; an affective motivator that drives away potentially harmful substances that threaten the body through oral incorporation. Food rejection behaviours have the adaptive benefit of protecting organisms from potentially noxious substances. These self/non-self borders also appear to operate in reverse, where bodily fluids such as saliva, a principal disgust elicitor, only become disgusting once they have left the body. This is referred to as the ‘ego-alien’ effect, where a substance crossing the self/non-self border changes in acceptability; what was once self is now other, and can induce a disgust experience. Disgust functions as a protective repertoire of behaviours, not only of the bodily self, but also of the psychological and moral self, where socio-moral otherness can be a rapid disgust elicitor. Disgust at otherness appears to relate to the potential for contamination or pollution of the self, and subsequent rejection of otherness (non-self), becomes a behaviour that maintains the integrity of the body and the self.

3.4 The Phylogenetic Diversity of Self/Non-Self Discrimination: From Cells to People

The ability to distinguish between self and non-self confers a significant adaptive advantage across the phylogenetic spectrum. The varieties of self/non-self recognition across species belie the common mechanisms of incorporation (taking something in), recognition as self or non-self, and rejection through transformation or

excorporation (removal from the body). This may be as basic and biologically fundamental as endocytosis and exocytosis in single cell organisms, or in single cells of a multicellular organism across a lipid bilayer membrane boundary. It may be as complex and seemingly abstract as the representational excorporation of a limb in the somatosensory cortex, as in the “alien limb” syndrome. On an evolutionary time scale, elaborate immune systems, metabolic transformation and elimination pathways, dermal coverings and gastroenterological configurations have emerged and become elaborated. These enable integrity of the self and a protection against non-self, with the gradual emergence of an inside – outside divide, facilitating the maintenance of internal homeostasis while the organism nevertheless adapts to the outside world.

Phylogenetic examples of self/non-self boundary discrimination are evident in the mammalian immune system, which uses methods of microbial non-self-identification for protective and defensive purposes (Medzhitov & Janeway Jr, 2002). Such methods include the detection of microbial non-self structures, known as pathogen-associated molecular patterns and microbe associated molecular patterns (PAMPS and MAMPS). These patterns are identified by specific pattern recognition receptors, so called Toll-like receptors, and are conserved strongly throughout phylogenesis. The molecular patterns are interpreted as signals of invasion or disease, triggering an immune response. Such strategies facilitate protection of the self from potential pathogenic (adverse non-self) influences at a cellular level.

The skin represents an example of a tissue boundary that regulates interaction between the self and environmental non-self. At its most basic function, integument (the outermost layer of an organism) represents a physical boundary between an organism and its environment, between the self and the non-self. Integument also

acts as a barrier that protects an organism from potentially harmful, external influences or intrusions (Chuong et al., 2002).

The skin represents a vital component of the integumentary system among numerous vertebrates, likened to a protective wall around a city (Nesse, & Williams, 1995). As a demarcation boundary, the skin literally encases the self. As a protective barrier, the skin is able to defend the self from adverse environmental forces using various chemical, immune and mechanical harbingers and bulwarks.

The bitter rejection response is observable among avian and mammalian species, including primates (Grill & Norgren, 1978). In a number of primates, bitter tastes elicit specific behavioural reflexes, including tongue movements and gagging, which facilitate oral rejection of the offending substances (Steiner, 1973). The bitter rejection response represents a behaviour designed to maintain the integrity of the self through the rejection of potentially harmful substances that may be orally incorporated. The mouth, as a portal to the self, relies on such mechanisms as a line of defence against harmful substances or objects that may penetrate other sensory and cognitive defences such as sight, touch or memory (Rozin & Fallon, 1987). Food rejection through emesis represents a further mechanism designed to remove undesirable or dangerous substances that have penetrated the body's outer fortifications.

Disgust, while human-specific, can be regarded as an affective elaboration upon a foundation of food rejection present in many other species, where central nervous system signatures of self/non-self response find expression in affective short-cut, or compressed behavioural signalling by way of emotions. Disgust forms part of the 'behavioural immune system', which includes a number of behavioural and psychological mechanisms designed to detect and respond to pathogens in the present environment (Schaller & Park, 2011). The adaptive benefits of disgust are

evident in the physiological behaviours it promotes: physical distancing, withdrawal and rejection of the disgust elicitor; or physiological responses of nausea and vomiting at a gastroenterological level (Morrow, Angel, & Dubeshter, 1992), facilitating the excorporation of undesirable substances that may have penetrated the self. The ideational aspects of disgust, such as a fear of contamination, adulteration, pollution and violation are similarly associated with the preservation of the self against aversive outside influences, including, in the case of socio-moral disgust, other people.

3.5 Human Examples of Self/Non-Self Confusion

A consideration of examples where organisms fail at self/non-self discrimination can illustrate the consequences of failure of this adaptive mechanism. When the distinction between the self and non-self becomes ambiguous or confused, self-directed harm can result. In cases of autoimmunity, pathogen recognition becomes disturbed and the self becomes identified as foreign. Self antigens become the object of an immune response that attempts to eradicate the antigen, resulting in tissue damage, injury and illnesses as diverse as ulcerative colitis, systemic lupus erythematosus, thyroiditis and many of the arthritides. Autoimmunity represents a cellular failure of self/non-self discrimination, where pathogen recognition is disturbed and the self is identified as foreign and potentially aversive.

Alien hand syndrome has been used to designate a spectrum of conditions observed following a corpus callosotomy, cortical infarction, or other cortical injury, where one hand engages in unintended, autonomous movements independent of an individual's will or control (the specific motor component is sometimes referred to as anarchic hand syndrome). Alien hand also involves a subjective experience that the hand and its behaviours do not belong to the self. While it remains unclear whether

sensory deficits are associated with the condition (Aboitiz et al., 2003), it appears to represent an example where parts of the body become dissociated with the sense and will of the self; a loss of agency. Another condition of neurological origin where the distinction between self and non-self becomes confused is phantom limb pain; following amputation patients with limb amputations commonly experience sensation or pain in the limb area. This experience has been attributed to a mismatch between the brain's somatosensory representation of the body, and the actual bodily state (Ramachandran & Hirstein, 1998).

In cases of somatoparaphrenia, individuals experience complete disownership of a limb or body part. The condition has been associated with damage in temporo-parietal and medio-frontal regions, with co-occurring orbitofrontal damage (Feinberg, Venneri, Simone, Fan, & Northoff, 2010) and posterior insular dysfunction (Cereda, Ghika, Maeder, & Bogousslavsky, 2002). Somatoparaphrenia is also characterised by delusional beliefs and confabulations that the rejected body part does not belong to the individual or may even belong to someone else. These beliefs remain resolute even in the face of conflicting evidence such as mirror viewing (De Vignemont, 2011). Paranoid schizophrenia represents yet another illness that has been characterised as a condition of disturbed self-experience. Sass (2003) argues that the sense of the self as a subject in the world in schizophrenia is weakened or suppressed, and subsequently phenomena experienced by such individuals become externalised (i.e. hallucinations).

In cases of body integrity identity disorder (BIID), an individual holds an intense desire to experience amputation or paralysis of one or more healthy limbs. Limbs are often described as being alien, unwanted, or not fitting with the rest of the body. The condition has been conceptualised as the result of a mismatch between an individual's internal body representation (body image) and their physical body shape

(First, 2005). A number of individuals with BIID have elective amputation surgery, while others often resort to extreme self-amputation measures. Gender identity disorder (GID) is another condition characterised by an overwhelming sense of discomfort or ‘wrongness’ associated with genital anatomy and function. GID can result in the desire to remove or modify biologically given sexual body parts, and augmentation of the genitalia and other body parts in order to fit the individual’s gender self-identity. While the full range of contributors and specific determinants of BIID and GID remain unclear, these conditions represent an extreme example of the potential consequences associated with self/non-self discriminatory ambiguity or failure.

3.6 Disgust in AN: a Consequence of Self/Non-Self Discrimination Failure?

AN is a complex, refractory disorder with unknown aetiology, characterised by the restriction of energy intake resulting in significantly low body weight, accompanied by an intense fear of weight gain and a disturbed experience of body weight and shape (American Psychiatric Association, 2012). Recent literature has considered the role of disgust as a potentially significant emotion within this condition, particularly in relation to food and eating behaviours, with disgust representing an ideal affective vehicle for the development of negative attitudes towards food and food intake (Davey & Chapman, 2009; Troop, Murphy, Bramon, & Treasure, 2000). Other researchers suggest that the role of disgust in eating disorders may be primarily ideational (Griffiths & Troop, 2006), where a potential for contamination and the need to protect the self is sufficient to induce a disgust experience. These beliefs apply to contamination through oral incorporation, but can also extend to social, moral or spiritual contamination. Such suggestions overlap with

formulations of the role of disgust in obsessive compulsive disorder, where contamination beliefs are associated with compulsive behaviours such as repetitive washing (Berle & Phillips, 2006; Lawrence et al., 2007). Specific beliefs or ideations may likewise come into play in the relationship between disgust and avoidant behaviours in AN, where disgust expressed towards food, and the subsequent rejection of food, may be more reflective of the ideations and beliefs associated with the food, i.e. the ability to induce overeating, to fatten or to control.

Recently, researchers and theorists have suggested that disgust characterises feelings towards the body and the self more generally in AN; mirroring the phylogenetic shift from food to affect and from other to self (Nunn et al., 2011; Schienle et al., 2004; N. Troop & Baker, 2009). While differing definitions of self-disgust exist, it can be regarded as a discrete, self-conscious emotion involving extreme experiences of loathing and abhorrence at the experienced self, the body in general or particular body parts and one's actions, especially those that violate the desired self (Roberts & Goldenberg, 2007; Simpson, Hillman, Crawford, & Overton, 2010). Sociological definitions of self-disgust suggest that it represents a response to violations of socio-cultural expectations of the self, which can be particularly relevant in relation to the self-in-action, i.e. the body. While commonly associated with emotional experiences of shame and guilt (Power & Dalglish, 2008), it is perhaps the 'gross', or extreme quality of the violation, that discriminates between these emotions, where self-disgust engages visceral responses and qualia characterised by revulsion, abhorrence and subsequent dis-ownership of the self.

3.6.1 Self-disgust: A working definition of disownership of the self

When faced with an object with potentially contaminating properties, or a situation that presents a threat to the self, disgust acts as an affective activator of

boundary behaviour to reject, distance and ultimately protect the self from harm.

Self-disgust represents an emotional response entering awareness as a result of:

1. discrimination failure, or ambiguity, between self and non-self
2. recognition of parts of the self as other, or non-self, and
3. rejection of those parts deemed non-self.

Self-disgust represents an involuntary recruitment of the defensive disgust system, where disgust, as an affective force, is turned upon the self. Self-disgust can be likened to an “autoimmune” mechanism, where structures designed to protect an organism from harm fail at self/non-self discrimination, and self becomes non-self or enemy. Other examples of inappropriate central nervous system recruitment include the “hijacking” of the reward – reinforcement system in addictions and the threat detection systems in paranoia.

The inability to distance the self from parts of the self, or for the body to avoid parts of the body, without eliminating parts of the self, threatening the integrity of the body, is the central predicament of the self-disownership syndromes. In AN, it is possible that the body experiences alterations in the boundaries of the bodily self that are unacceptable by internal, or internalised, standards, violating set-point or threshold metrics in the representation of the self and the body, resulting in perceptual distortion. Avoidance behaviour (such as the avoidance of mirror viewing) may also act to reinforce this distortion through a lack of potentially corrective visual information. Parts of the body, and parts of the self, while usually protected, become viewed as alien. As a result, the body and self become sources of distress and disgust.

3.6.2 Interoceptive sensitivity: Body and self awareness

What can account for the proposed confusion between the self and non-self in AN? One explanation is the potential role of reduced interoception and its effect on body awareness. Interoception refers to the sense of the physiological state of the body, with interoceptive sensitivity reflecting an individual's degree of awareness of their internal state. Low interoceptive sensitivity has been found to characterise individuals with eating disorders. Studies indicate that individuals with AN experience difficulties recognising bodily signals relating to hunger and satiety (Fassino, Pierò, Gramaglia, & Abbate-Daga, 2004) together with pain (Lautenbacher, Pauls, Strian, Pirke, & Krieg, 1991; Raymond et al., 1999). In comparison to healthy participants, individuals with AN also demonstrate a reduced ability to perceive their own heart rate, a skill that is linked to general sensitivity to visceral processes (Pollatos et al., 2008). This reduction in interoceptive sensitivity is suggestive of a generalised reduction in ability to perceive bodily signals, and has associated consequences including the potential for body feedback misinterpretation. Low interoceptive sensitivity has also been associated with a greater capacity for distortion of external experiences of body representation and ownership (Tskaris, Jimenez & Constantini, 2011). Such findings have potential implications for conditions like AN, where poor interoception could result in a disturbance of the integration between internal and external experiences of the body. This, in turn, may predispose ambiguity surrounding the borders of the self.

Interoception is also linked to feelings and emotion states (Craig, 2009). In line with Damasio's somatic marker hypothesis, the body state informs the feeling state through rapid, unconscious processing of physiological and bodily sensations, with interoception and internal body awareness involved in engendering emotional responses (Damasio, 2008). Consequently, a reduction in interoceptive sensitivity

has the potential to alter affective responses to bodily signals. Low interoceptive sensitivity may also result in a disruption of emotions *about*, as well as *within*, the body. A reduced sensitivity to internal body signals, paired with a disruption in body awareness as a result of the interchange between interoceptive and exteroceptive signals, may give rise to feelings of ‘otherness’ or ‘wrongness’ about the body. The resultant emotional response to the self, elicited by the feelings of otherness adulterating the body and self would consequently be characterised by revulsion and disgust.

3.6.3 Somatosensory representation lags during periods of sudden growth

Humans experience rapid periods of growth during puberty. Between the ages of ten and seventeen females, in particular, experience swift bodily growth in areas such as the abdomen, thighs, hips and face, in addition to characteristic secondary sexual development. While the changes to body areas are extensive, it is possible that for some individuals, the speed of these changes is not matched by equally rapid changes in the representations of the body in the brain. A number of cortical areas have been implicated in body representation, such as the extrastriate body area (EBA) in the occipital lobes and the fusiform body area in the temporal lobes, which potentially form part of a complex, distributed neurological system that integrates corporeal awareness (Berlucchi & Salvatore, 2010) supporting the disentangling of one's own behavior from another's (Cohen et al, 2007).

The sensory homunculus (Latin for “little human”) is the cortical representation of the body located in the somatosensory cortex. While neuroplastic changes to homuncular representations of the body occur over time, it is possible that during puberty, cortical representation changes are unable to match the speed of the body, resulting in a period of failure to cortically represent phasic bodily

development (Nunn, Lask & Frampton, 2011). Competition between one area of growth may also impede the cortical representation of another. This mismatch between cortical representations and actual body size may be registered as excess weight, which in turn could trigger homeostatic mechanisms that attempt to reduce body size to match the cortical representation. This mismatch may also be reflected in awareness, where experiential awareness of the body is constructed from both representational and interoceptive information. As a result, awareness may once again be characterised by experiences of wrongness or otherness, prompting emotional experiences of disgust directed at the self. This is the homuncular component of the nested causal explanation within the noradrenergic hypothesis of AN (Nunn, Frampton, & Lask, 2012).

3.6.4 Consequences of self/non-self discriminatory failures in AN

Characteristic cognitions and behaviours in AN can be regarded as consequences of self-disgust in response to difficulties distinguishing between the self and non-self. As detailed earlier, the behavioural correlates of a disgust experience are rejection and avoidance. While conditions such as BIID see the development of a need to reject/remove a certain body part, in AN, the feeling of wrongness and otherness is associated with the inability to escape the body and self. Consequently, the correction of body disgust and “otherness” may be sought through exerting control over substances that alter the body. Food, as a substance that crosses the self/non-self boundary, represents a medium that can be regulated and controlled in order to regulate the experienced self. In an attempt to reach a feeling of homeostatic normalcy and relief, individuals with AN may rely on exerting control over food and eating behaviours through methods such as restriction or self-induced vomiting. Behavioural avoidance of external body viewing, such as mirror and

reflection evasion, could also be regarded as avoidance behaviours in response to the feelings of otherness and revulsion associated with the self. Incidences of self-harm among those with AN may also be in response to disgust at the self and body.

Body image disturbance and body dissatisfaction, as central symptoms of AN, may also reflect disturbances in internal body representations, and, by extension, body awareness (Kaye, 2011). While definitions of body image tend to focus on its construction through socio-cultural mechanisms, more exhaustive definitions recognise the construction of body image through the interplay between internal and external body representations (First, 2005; Tsakiris, Tajadura-Jiménez, & Costantini, 2011). When an individual's 'image' of his or her body does not match his/her internally constructed expectation, in addition to the socially constructed expectation, poor body image and low levels of body satisfaction can result.

Subsequent emotional experiences among individuals with AN, such as feelings of self-directed contempt, may arise as complex affective hybrids that are underpinned by feelings of otherness, wrongness and disgust aimed at the body and self. Contempt is one such complex emotional hybrid that involves feelings of both disgust and anger. In AN, contempt may also be self-directed as a result of a failure of the body and self to meet internalised standards. Self-directed contempt, involving subjective qualia of anger, outrage and disgust, may drive wishes to punish the body and self, resulting in self-rejection, revulsion and hatred of the self.

3.7 The Insular Cortex: The Neurobiological Correlate of Self Awareness

AN has been conceptualised as a disorder of failed self/non-self discrimination. Poor interoceptive sensitivity, paired with periods of rapid bodily growth, lead to ambiguous or distorted body representations, culminating in

experiences of disgust directed at the self. Consideration of the neural correlates that might underlie these deficiencies re-focus attention on the proposed insular hypothesis of AN (Nunn et al., 2011), which implicates dysfunction in the insular cortex as a central risk factor for the development and maintenance of the disorder.

The insular cortex is located below the Sylvian fissure, anterior to the parietal lobes and inferior and posterior to the frontal lobes. The insula is a highly interconnected neuroanatomical structure that is associated with various functions including autonomic regulation, somatosensory function and gustatory function (Penfield & Faulk Jr, 1955; Shelley & Trimble, 2004). The insula is also regarded as a central neuroanatomical region underlying interoception and, with it, pain processing, temperature processing, hunger and thirst, as well as other visceral sensations (Craig, 2003). The anterior insula in particular is also implicated in the experience of subjective feelings, the engendering of the body state, and awareness of a sense of self (Craig, 2009). Specific to our purpose among the insula's diverse functions are the experience, regulation and perception of taste and disgust. The insula has been identified as the central neural correlate of disgust perception from visual, olfactory and aural sensory modalities (Heining et al., 2003; Phillips et al., 1998), as well as the recognition of facial signals of disgust (Phillips et al., 1997). Instances of insular damage, such as that which occurs among individuals with Huntington's disease, has also been associated with deficits in disgust processing and recognition (Hayes et al., 2007; Sprengelmeyer et al., 1996). Dysfunction in the insular region has also been implicated in other psychopathology in which disgust represents a central emotional response associated with disorder symptomatology and maintenance, such as obsessive compulsive disorder (Phillips et al., 2000).

The insular hypothesis of AN (Nunn et al., 2011) proposes that dysfunction in the insula and its cortical and subcortical circuits, paired with socio-cultural

pressures to diet and pubertal changes, may trigger the development of AN, and be responsible for the majority of behaviours and conditions associated with the disorder. Specifically, heightened experiences of disgust, as well as self-disgust associated with reduced interoceptive sensitivity and body awareness, may be attributable to dysfunction in the insula and several major pathways in which the insula functions as a central connective region between the cingulum, striatum (especially ventral striatum), precuneus and other limbic connections, particularly the amygdala and hippocampus.

A review by Kaye, Fudge and Paulus (2009) highlighted the insular region as a central neuroanatomical feature underlying a number of associated AN symptoms, including poor interoception, poor body image and aversive responses to food stimuli. Several neuroimaging investigations have also supported the likelihood of altered insular function in AN, including the identification of functional abnormalities during tasks assessing body dissatisfaction and self/other discrepancies. In an fMRI study investigating two aspects of body image, individuals with AN displayed increased activation of insular and prefrontal regions in comparison to controls when asked to compare self-images to graphically altered thin self-images; suggestive of increased activity in neuro-affective regions during body image satisfaction conditions (Mohr et al., 2010). In an investigation of the neural correlates of body dissatisfaction, an AN sample reported greater dissatisfaction with their own body shape in a self/other body comparison task, where task completion corresponded with greater activation of insular and pre-motor regions in comparison to controls (Friederich et al., 2010). In an investigation conducted by Sachdev, Mondraty, Wen and Gulliford (2008), individuals with AN displayed hypoactivity of insular and attentional circuits upon presentation of self-images, in comparison to healthy controls, implicating the insula as a potential neural basis of distorted self-

image. Despite the variation in activation patterns observed between the above studies, all identified functional abnormalities in the insular region among AN participants during tasks that accessed the self. As suggested in Friedrich et al. (2010), the presence of emotional saliency in a self-viewing task (such as the inclusion of self/other comparisons, or the inducement of a strive for thinness), could account for hyper-activation of insular region observed in some studies.

We are therefore faced with the possibility of relatively increased anterior insular activation, mediating affective content such as disgust and relatively decreased posterior insular activation in relation to the mediation of somatosensory function (Jakab, Molnár, Bogner, Béres, & Berényi, 2012). The neuroanatomic landmark of the central insular sulcus forms an approximate dividing line between somatosensory information about the self (the smaller posterior insula granular cortex) and the material instantiation and integration of emotional, motivational and perceptual identification of “other” (the larger anterior insula agranular cortex). If the definition of “other” is that which does not give back somatosensory feedback to the anterior insula, then reduced activity of the posterior insula increases the likelihood that parts of the body, especially soon-to-represented parts in the developing young person, will be responded to as non-self by the anterior insular cortex. In the presence of negative mood states, this perception of “other” might engender disgust.

It remains to be seen how the local small scale circuitry of the insular cortex will be parcellated in relation to ownership, awareness and dissatisfaction phenomena like disgust. Both bipartite and tripartite models are consistent with the data (Deen, Pitskel, & Pelphrey, 2011; Nieuwenhuys, 2012; Jakab et al., 2012). Recent progressions in neurobiological understanding have also pointed towards the potential importance of large scale brain networks as a means of conceptualising psychopathology, where aberrant functioning in cortical regions and connecting

pathways potentially underlie a number of psychological disorders (Menon, 2011), particularly applicable to AN. Within this model, the anterior insular is central to the Salience Network (SN) that mediates between the Central Executive Network (CEN) implicated in external attention and orientation and an internal process orientation, the Default Mode Network (Buckner, Andrews-Hanna, & Schacter, 2008). This model is proffered as applicable to other psychopathologies that involve disturbances in interoceptive awareness and consciousness, and, thus, may be potentially compatible with the current conceptualisation of AN together with its common comorbidities.

3.8 Implications and Future Directions

The role of self/non-self discriminatory failures has potential implications for future phenomenological and aetiological conceptualisations of AN and, therefore, possible treatment interventions. If reduced interoception, and its ability to modulate external awareness, play an important role in the pathogenesis of the disorder (Lilenfeld, Wonderlich, Riso, Crosby, & Mitchell, 2006) future studies might investigate the possibility of low interoceptive sensitivity premorbid to the disorder, or representing a heritable trait co-occurring in muted form in healthy first degree relatives.

The potential role of developmental delay of neuroplasticity in somatosensory representation has implications in regard to typical peri-pubertal onset of AN, where a mismatch between internal body experiences and actual body growth may drive weight restriction behaviours in an attempt to establish homeostasis and subjective feelings of normalcy. Future investigations may also attempt to identify the presence

of altered body part representation in the somatosensory cortex as a structural indicator associated with the disorder.

The alterations in emotional engendering of the experienced body as a result of self/non-self discriminatory failures may also play a role in the development of central AN symptoms such as distorted body image and body dissatisfaction. While explanatory pathways of body dissatisfaction and poor body image have often focused on external socio-cultural factors such as the thin ideal and the role of self-objectification, these forces may work in combination with internal factors including an alteration of body awareness resulting in a disturbed sense of self (Kaye, Fudge, & Paulus, 2009), prompting feelings of otherness and “wrongness” about the body and self. Core behaviours such as food restriction, avoidance and vomiting may also be associated with need to modulate distressing self-experiences in an attempt to attain normalcy and relief from a misrepresented and disgusting self.

3.8.1 Implications for research

While extant studies of AN have investigated the possibilities of altered disgust responses to various external stimuli, relatively few have investigated what appears to be the most relevant disgust stimulus: the self. Expressions of disgust and abhorrence at the body and self are, in fact, frequent in clinical descriptions, case series, and phenomenological accounts of AN (Lask & Frampton, 2011; Troop & Baker, 2009). However, there is little empirical evidence supporting the existence of self-disgust in the disorder, with the focus often steered towards the role of other negative emotions, such as anxiety, shame and low self-esteem. Future examinations of affective function in AN may need to broaden considerations to include the possibility of a core experience of viewing the self as alien and other, eliciting a myriad of affective responses including fear, anxiety, anger and disgust. Similarly,

considerations of the neural correlates underlying disgust and other AN phenomenology such as low interoceptive sensitivity and disturbed external body awareness (body image) may need to focus on the insular regions and circuits involving the insular cortex as regions of potential dysfunction (Kaye et al., 2009; Nunn et al., 2011).

An inherent problem of emotional exploration, in both research and practice, is the difficulty associated with translating a subjective emotional experience into a semantic description. A word used to describe a subjective feeling may be different to another's description of the same experience. Likewise, the same semantic descriptor may be used to describe two very different subjective emotional experiences. Furthermore, what individuals 'feel' may not necessarily translate easily into words. This may be particularly problematic among individuals who also suffer from alexithymia, a condition characterised by marked difficulties identifying and describing emotions experienced by the self and others, which has increased prevalence among individuals with AN (Bourke, Taylor, Parker, & Bagby, 1992; Zonnevijlle-Bendek et al., 2002). Nevertheless, clinical attention may need to be placed on emotional descriptions of the body and self among AN patients. For example, in Skårderud's (2007) *Mentalisation-Based Psychotherapy for AN*, encouraging an individual to experience, feel and 'mind' their body in various situations represents a pertinent aspect of assisting them to develop a greater understanding of their own feelings and cognitions.

3.8.2 Implications for practice

Interventions targeting interoception and neuroplasticity may also represent potentially viable treatment options for AN. Recent research has promoted mindfulness training and meditation as potentially promising interventions for

individuals with low interoceptive sensitivity (Arnold, 2012), where such strategies facilitate greater awareness of the internal body state and increased accuracy of body signal interpretation. Pharmaceutical interventions that increase levels of neurotransmitters responsible for brain plasticity, such as noradrenaline (atomoxetine; Marzo, Bai, & Otani, 2009), nitric oxide (Gallo & Ladecola, 2011) and glutamate (ketamine; Pittenger & Duman, 2007), may have the potential to improve brain plasticity and assist in correcting cortical misrepresentations of the body.

Intense physical stimulation of newly developed areas subject to misattribution as “other” using thermal, pressure, vibration and subliminal electrical stimulation to facilitate updating of representations and reduce disgust, might be considered. Real time functional magnetic resonance imaging (rtfMRI) also offers conceptually elegant opportunities to explore in vivo hypothesis testing and treatment (Cohen, 2001). Masking to the self and from the focus of others of competing areas, such as the face and hands, using masks and mittens for extended periods throughout each day to reduce disgust might also be tried to test this formulation.

3.9 Conclusion

This review proposes self/non-self discriminatory failure as the central feature that underlies experiences of self-disgust in AN. Discrimination between the self and non-self is an adaptive mechanism that provides organisms across the phylogenetic spectrum with the ability to protect the self from potentially aversive external influences. Examples of the failure of this mechanism arise from the cellular to the most complex levels of multicellular experience. AN can be regarded as an extreme consequence associated with a failure of this adaptive mechanism, where poor interoception and incomplete body representations in the tertiary somatosensory

insular cortex give rise to a sense of otherness adulterating the self. Consequently, the conscious, emotional response to the body and self becomes characterised by disgust and disgust-related emotions such as abhorrence and contempt.

The consequences of such self/non-self discriminatory failures have been discussed in relation to core AN cognitions including a degraded body image and body dissatisfaction, as well as central behaviours such as food restriction and avoidance. These processes have been associated with the dysfunction in the insular region of the brain, which occupies a potentially crucial role in the development and maintenance of AN. Finally, the clinical and empirical implications of this review have been considered, with future investigation necessary in order to examine the exact role of the discussed features in AN.

Chapter 4: The Measurement of Disgust and Self-Disgust

4.1 Chapter Overview and Goals

This chapter provides a review and critique of several existing measures of disgust, covering self-report, behavioural and physiological measures. Self-report measures of disgust are considered in order to provide a rationale for the use of the Disgust Propensity and Sensitivity Scale (Revised version) in subsequent empirical chapters. This chapter also considers the measurement of self-disgust, a concept that has had very little exploration in the measurement literature. Measurement methods of externally-directed disgust are applied to self-disgust in order to elucidate what might be an effective measure of this discrete emotional experience. This chapter provides a backdrop for future empirical chapters that involve the application and assessment of novel measures of disgust and self-disgust.

4.2 Self-Report Measures of Disgust

4.2.1 The Disgust Scale

The Disgust Scale (DS) was initially developed by Haidt, McCauley and Rozin (1994), and is typically regarded as the gold standard self-report measure of disgust (Herz, 2012). It is a 25-item measure that assesses an individual's level of disgust towards a number of disgust elicitors that fall under specific disgust domains. The disgust domains in the DS, previously identified by Rozin and Fallon (1987) and refined during the scale's development, consist of seven distinct categories: food, animals, body products, sex, body envelope violations, death and hygiene. The DS is

designed to measure disgust sensitivity, initially defined by Rozin & Fallon (1987) as the predisposition to experience a disgust response.

The original 32-item DS was validated on several student and community samples (Haidt et al., 1994). Initially, the scale included 16 items framed as true/false reaction questions, and 16 items that were rated on a scale format (not disgusting, slightly disgusting, very disgusting). These items were selected from a 66-item Preliminary Disgust Scale that was developed from a sample of college undergraduates. In this original version of the DS, several items were also included that measured the level of belief of laws of sympathetic magic; that disgusting-ness can be ‘catching’ or transmissible (e.g. “ even if I was hungry, I would not drink a bowl of my favourite soup if it had been stirred by a used but thoroughly washed fly swatter”). Strong, positive correlations were identified between the two scale formats (true/false items and scale format items), which were revised but retained, with two response formats subsequently included in future versions of the DS. A Cronbach’s alpha of $\alpha=.84$ was obtained across all samples and all items, indicating good internal consistency, and a confirmation sample was also used to replicate the above results. Haidt et al.’s (1994) initial factor structure produced a seven-factor solution that fit the proposed disgust domains, with only one factor including two overlapping domains (death and body envelope violations).

In Haidt et al.’s (1994) initial study, correlations were examined between the DS and a number of cognitive and personality traits in order to assess convergent and discriminant validity. Scores were compared with items assessing emotionality, which determined that the scale was not merely assessing general emotionality among individuals. The scale correlated significantly with sensation seeking ($r=-.49$), fear of death ($r=.39$) and the personality factor of neuroticism ($r=.23$). Discriminant validity was assessed and confirmed by an absence of correlations between disgust

sensitivity and self-monitoring and lie scales. Based on such results, Haidt et al. (1994) determined that disgust had a distinct ‘protective’ quality to it, with higher levels of disgust sensitivity associated with higher levels of vigilance regarding external threat.

Olatunji et al. (2007) conducted a comprehensive follow-up analysis of the DS, identifying a divergent factor structure and proposing a number of revisions to the scale. Olatunji et al. (2007) identified a three factor structure for the DS (established as Core Disgust, Animal Reminder Disgust and Contamination-Based Disgust), following the removal of four items with poor factor loadings. Upon further examination of the specific items, it was suggested that several of these items may be theoretically incongruent with the scale, as they appeared to assess socio-moral aspects of disgust, rather than sensitivity to disgust experiences. A further two items were also identified for removal due to content overlap and low item-total correlations. A revised version of the scale, comprising 25-items, was subsequently tested on an undergraduate and clinical sample, and demonstrated good internal consistency ($\alpha=.87$) and construct validity (when correlated with the Disgust Emotion Scale; Olatunji, Williams, et al., 2007). Olatunji et al. (2007) also conducted an investigation of the utility of the revised DS when assessing disgust sensitivity among individuals with obsessive compulsive disorder (OCD). Higher scores on the Core Disgust and Contamination-Based Disgust sub-scales were identified among individuals with OCD that experienced washing concern, as opposed to healthy individuals without washing concern. Such findings proved consistent with previous indications of increased disgust sensitivity among individuals with contamination-based OCD, and thus added further support for the convergent validity of the revised 25-item DS (Olatunji, Williams, et al., 2007).

Despite adequate validation and result replication of the proposed 25-item revision, Olatunji et al. (2007) identified a number of enduring shortfalls in the DS. The main criticism related to the context-dependent nature of the scale's items, where all questions were posited in relation to a specific disgust object or situation. Thus, they argued that the scale may assess disgust responses towards specific elicitors, rather than generalised/trait disgust sensitivity. Concern also arose about the use of the DS when assessing clinical populations, based on suggestions that the inclusion of specific disgust contexts may inflate scores among certain clinical groups. Nevertheless, the DS continues to be a widely used measure that has been applied across various cultural and clinical populations, and has been utilised in various empirical investigations of disgust (de Jong, van Overveld, & Peters, 2011; Inbar, Pizarro, Iyer, & Haidt, 2012; Navarrete & Fessler, 2006; Olatunji et al., 2009).

4.2.2 The Disgust Propensity and Sensitivity Scale

The Disgust Propensity and Sensitivity Scale (DPSS) is a 12-item (originally 16-item) self-report questionnaire that was originally designed in order to assess disgust experiences independent of specific disgust elicitors (Van Overveld et al., 2006). The DPSS was initially created by Cavanagh and Davey (1997), and was subsequently modified by Van Overveld, de Jong, Peters, Cavanagh and Davey (2006), who conducted a comprehensive psychometric assessment of the scale in a Dutch population. An investigation of the relationship between scores on the DPSS and a number of clinical conditions was also undertaken. It was anticipated that the scale might provide a more explicit assessment of the relationship between disgust and a number of clinical conditions such as specific phobias and OCD, due to the context-independent nature of its item structure. For example, the scale includes items such as "I experience disgust", which is responded to on a 5 point Likert scale

(never through to always). This context-independent structure represents a specific point of difference from the DS.

In further contrast with the DS, the DPSS was designed to include items assessing disgust sensitivity and propensity, rather than sensitivity alone. More broadly, Van Overveld et al.'s (2006) study contributed to dissent in the literature regarding the definitions of certain disgust constructs. Van Overveld et al. (2006) re-defined disgust sensitivity as the unpleasantness of the experience of disgust, likening it to anxiety sensitivity, suggesting that the DS actually measures disgust propensity i.e. the frequency or tendency to respond with disgust (Van Overveld et al., 2006). The definitions of these concepts are still used interchangeably in the literature, and are yet to be consolidated. However, in the DPSS, items assessing the distinct constructs of disgust sensitivity and propensity were designed to be consistent with Van Overveld et al.'s (2006) definitional revision.

Initial validation of the DPSS demonstrated good internal consistency (propensity subscale, $\alpha=.89$; sensitivity subscale, $\alpha=.87$) and a two-factor structure consistent with the two disgust constructs; disgust sensitivity and propensity (Cavanagh & Davey, 2000). Van Overveld et al.'s (2006) subsequent study produced a more extensive validation of the DPSS, and Cavanagh and Davey's (2000) proposed 2 factor structure was confirmed through exploratory and confirmatory factor analyses. Convergent validity for the scale was established through correlations with other disgust scales, specifically the DS (Haidt et al., 1994) and the Disgust Questionnaire, with both of these scales correlating moderately with the DPSS. Interestingly, the DS correlated more highly with the disgust propensity subscale, indicating that these constructs may be more closely related, and supporting Van Overveld et al.'s (2006) conceptual distinction between disgust sensitivity and propensity.

The DPSS also correlated with a number of clinical symptom scales that have previously been associated with increased experiences of disgust, including scores on scales assessing blood/injury fears, as well as the Fear of Spiders Questionnaire (Van Overveld et al., 2006). Individuals who identified as having blood-associated fainting also exhibited higher DPSS scores. The disgust propensity sub-scale was found to be a significant predictor of spider fears, and both disgust sensitivity and propensity appear to significantly predict fear of blood (Van Overveld et al., 2006).

Olatunji et al., (2007) conducted a further investigation of the psychometric properties of the DPSS on an American undergraduate sample (n=340). The study also investigated the measure's relationship with certain anxiety disorder symptoms, including spider fear and blood, injury and injection (BII) fears. Consistent with Van Overveld et al.'s (2006) study, the scale demonstrated excellent internal consistency for the total score (.90) and both subscale scores ($\alpha=.84$ for disgust propensity, $\alpha=.83$ for disgust sensitivity). The factors extracted also indicated a 2 factor solution that contained no cross-loadings, and theoretically fit Van Overveld et al.'s (2006) proposed factors of disgust sensitivity and propensity. However, Olatunji et al., (2007) identified several changes in factor loadings that deviated from Van Overveld et al.'s (2006) study, suggesting that the specific items may lack face validity and require removal from the scale. Convergent validity was again assessed by exploring associations between DPSS scores and spider and blood/injury-injection (BII) fears. Discriminant validity was also assessed and confirmed through a comparison with positive affect, with no significant relationship between DPSS and positive affect scores identified. After controlling for negative affect, scores on the DPSS correlated significantly with spider and BII fears, and less strongly with injection and fainting avoidance. Regression analyses were also conducted in order to look at the ability of the DPSS to predict anxiety symptoms, with one or both of the subscale scores

predicting significant, unique variance in spider avoidance, injection fainting and injection avoidance (Olatunji, Cisler, Deacon, Connolly, & Lohr, 2007).

Based on their analysis, Olatunji et al. (2007) suggested that the DPSS may be a more relevant measure of disgust among clinical populations. This was supported by the scale's non-normal distribution among a healthy adult population, and the relationships identified between the DPSS subscales and various anxiety disorder symptoms. While the DS remains more extensively utilised in disgust research, a number of empirical investigations have begun to move towards using the DPSS in order to investigate both facets of disgust (Cisler, Olatunji, & Lohr, 2009; Olatunji, 2009; Van Overveld, de Jong, Peters, van Hout, & Bouman, 2008). Goetz, Cogle and Lee (2013) also conducted a follow-up investigation of the factor structure of the DPSS-R, revealing a three-factor structure (the third factor labelled 'self-focused/ruminative disgust), with the authors suggesting further refinements of the scale, including the removal of two items. However, this finding is yet to be replicated, and the 12-item DPSS-R continues to be the most commonly utilized version to date.

4.3 Measures of Facial Signals of Emotion

4.3.1 Facial expressions of disgust

Initial research into facial signals of emotion was conducted by Paul Ekman. Ekman (1979;1980) identified a number of universally recognised facial movements that appeared to characterise the basic emotions of fear, disgust, happiness, sadness, surprise and anger. A number of emotion measurement opportunities have arisen as a result of Ekman's work. Specifically, the use of facial electromyogram (EMG) has been widely confirmed as a reliable and useful means of assessing facial muscle

activity associated with affective responses (Cacioppo, Martzke, Petty, & Tassinari, 1988; Tassinari & Cacioppo, 1992).

Facial EMG activity has been identified as a particularly useful method of discerning emotional valence (Vrana, Spence, & Lang, 1988; Vrana, 1993; Cook, Hawk Jr, & Davis, 1991). Activity in the corrugator supercilii (located between the eyebrows, drawing them downwards) is commonly associated with the expression of negative emotional states including fear, anger and disgust (Bradley, Cuthbert, & Lang, 1999; Dimberg, 1990). A number of investigators have also attempted to isolate muscle activity for specific negative emotions, with some suggesting that activity in the corrugator region may be greater during experiences of disgust in comparison to fear (Yartz & Hawke, 2002). Activity in the levator labii region has also been identified as a specific region associated with disgust. The levator labii superioris (LL) is located alongside the nose, raising the upper lip and wrinkling the nostrils. Vrana (1993) investigated the specific muscle activity associated with disgust using emotion-inducing imagery, examining LL activity during disgust conditions compared to anger, joy and pleasant imagery. Consistent with previous work, activity in the corrugator region distinguished the negative emotions of anger and disgust. Furthermore, activity in the LL was specifically associated with viewing of disgust imagery (Vrana, 1993). This finding was replicated by Yartz and Hawke (2002), who identified increased LL activity during disgust conditions of the International Affective Picture System (IAPS), a standardised body of images used to elicit a variety of emotional states. This activity was found independent of disgust subtype, participant gender or reported level of arousal. Yartz and Hawke (2002) suggested that this muscle region may represent a specific means of discriminating disgust from other negative emotions. However, other investigators have failed to replicate these results (Wolf, Mass, Ingenbleek, Kiefer, Naber and Wiedemann,

2005; Stark, Walter, Schienle & Vaitl, 2005). Stark, Walter, Schienle and Vaitl (2005) found that facial EMG responses of the LL were increased during disgust stimuli in comparison to neutral stimuli, but did not correlate with self-report experiences of disgust, suggesting that LL activity may occur as a function of the intensity of disgust experiences.

Despite such inconsistencies, a number of researchers have utilised facial EMG methods as a means of assessing disgust in clinical samples. De Jong, Peters and Van der Hallen (2002) used guided imagery to investigate disgust responses associated with spider phobia. Individuals with spider fears were shown to have differential facial EMG activity in response to spider-related stimuli, with increased muscle activity in the LL, corrugator and zygomatic regions in comparison to those without spider fears. EMG has also been used as a method of exploring disgust responses in vaginismus, a condition of sexual dysfunction that involves an inability to achieve sexual penetration (Borg, de Jong & Shultz, 2010). In response to sexually relevant stimuli, females with vaginismus demonstrated increased muscle activity in the LL area of the face in comparison to control and other clinical groups, with the authors concluding that disgust may be a relevant emotional experience in the condition (Borg et al., 2010).

Despite some conflicting findings, there appears to be evidence for a pattern of facial muscle response during disgust that involves corrugator supercilli activation, as an indicator of general negative affectivity, and LL activation as an indicator of specific disgust responses. Subsequently, the use of facial EMG as a means of measuring the recruitment of these facial muscles under certain conditions may provide a means of assessing disgust. However, in regard to the use of the LL as a specific indicator of disgust, it may be important to consider the effect of disgust intensity on subsequent responses in the target muscle (Borg et al., 2010).

The use of facial EMG is also not without criticism, and has noted disadvantages. First, facial EMG is reliant on subjects demonstrating overt facial expression as a signal of emotional experience, and this is not sensitive to assessing mild to moderate affective experience (van Boxtel, 2010). There is also dissent regarding whether EMG can be effectively applied as a means of discerning discrete emotions. While it has consistent evidence as a tool discriminating between positive and negative affective states (van Boxtel, 2010; Vrana, 1993; Vrana et al., 1988), the difficulty isolating readings of specific facial muscles, resulting in increased crosstalk, reduce its specificity as a means of identifying specific emotional reactions. Similarly, emotions often occur in a continuous, dynamic 'flow', which can be hard to assess using EMG methods (van Boxtel, 2010). These issues in particular limit the utility of EMG as a method of measuring specific emotional responses such as those of disgust.

4.3.2 The startle/eye-blink response

The startle/eye-blink response has been widely examined as a means of assessing emotional responsiveness, with frequent indications that it represents a reliable marker of emotional valence. Several investigations have identified augmented startle/eye blinks during negative emotional states such as disgust and fear, while failing to identify similar patterns during positive states (Vrana et al., 1988; Yartz & Hawke, 2002; Balaban & Taussig, 1994). In a study conducted by Yartz and Hawke (2002), equivalent modulation of startle/eye-blink responses were identified in both disgust and fear image conditions (Yartz & Hawke, 2002). A gender difference was also identified, with women showing greater startle/eye blink responses during disgust conditions in comparison to men. However, these findings conflict with earlier explorations, which suggested that startle/eyeblick modulatory

effects occur in response to fear alone. In an exploration of responses to emotion-inducing visual scenes, Balaban and Taussig (1994) identified augmented startle/eye-blink responses when participants viewed fear scenes only, with no modulation observed during disgust scenes, despite equivalent subjective ratings of intensity and arousal in both emotions. The authors concluded that the eye blink measure may be more relevant for fear and threat related stimuli, as opposed to more generalised negative affect, including experiences of disgust. The inconsistencies in these findings cast some doubt as to whether disgust does indeed result in modulated startle/eye-blink responses, but taken together, appear more in support of a generalised effect of negative valence (Yartz & Hawke, 2002). Further research appears necessary in order to consolidate understandings of the potential specificity of the response with regard to fear, and provide further evidence for whether this response can be used as a facial marker of disgust. The startle/eye-blink response also receives general criticism as a method of affective assessment due to inaccuracies inherent in the means of measuring responses. Specifically, the majority of responses are taken using EMG recordings, which, as discussed above, are prone to crosstalk from neighbouring muscles, and their effect reduced in terms of specificity (van Boxtel, 2010).

4.4 Autonomic Measures of Emotion

4.4.1 Vagal tone

Measures of autonomic activity, including sympathetic nervous system activity, have been extensively investigated as physiological measures of emotion though means such as heart rate and electro-dermal activity. However, relatively fewer studies have investigated the relationship between the parasympathetic nervous system and emotion. The vagal system is the central component of the

parasympathetic nervous system. The vagus nerve is the tenth cranial nerve that extends from the brain stem to a number of areas in the chest and abdomen, including the heart, and is primarily associated with the maintenance of homeostasis in bodily systems. Vagal tone refers to the control and influence on heart rate as a result of the vagus nerve, and has been posited as an effective measure of parasympathetic nervous system recruitment (Porges, 1985). Vagal tone can be measured from respiratory sinus arrhythmia (RSA), which refers to the naturally occurring variation in heart rate in association with phases of inspiration and expiration. An electrocardiogram (ECG) can be used to detect the intervals between heart beats, known as heart periods (Porges, 1985), and can be used as an indicator of cardiac vagal tone.

A number of studies have investigated both tonic and phasic RSA in association with emotion experience and regulatory processes (Friedman & Thayer, 1998; Frazier et al., 2003; Eisenberg et al., 1996; Fabes & Eisenberg, 1997; Mezzacappa et al., 1996). While RSA has had less examination as a measure of specific emotions, it has merit as a potential means of assessing disgust (Accurso et al., 2001; Friedman & Thayer, 1998). Studies employing the use of RSA as a measure of disgust are based on the assumption that disgust has a distinct autonomic pattern characterised by parasympathetic activation. William James' (1884) early conception of emotions was suggestive of a distinct pattern of autonomic activity characterising certain emotions, an idea that has been consistently revisited in more recent research (Christie & Friedman, 2004; Ekman, Levenson & Frieson, 1983). Increased parasympathetic activity and associated bradycardia (Gross & Levenson, 1993; Johnsen, Thayer, & Hugdahl, 1995) have been widely identified as common physiological markers of disgust (Levenson, Ekman, & Friesen, 1990; Rozin &

Fallon, 1987), and have been associated with other visceral sensations, such as feelings of nausea, that often accompany this emotion.

Several investigations have used RSA as a means of assessing parasympathetic activation in BII phobia (Accurso et al., 2001; Friedman & Thayer, 1998), which is thought to be associated with a disgust-related emotional response to BII-related stimuli (Page, 1994, 2003). Page (1994) suggested that patterns of fainting among BII phobia is linked to heightened feelings of disgust, resulting in parasympathetic activation that leads to vasovagal syncope (Page, 1994). However, the findings linking parasympathetic activation and subjective experiences of disgust in BII phobia are mixed. A number of studies have identified patterns of emotional responding in BII phobia characterised by disgust (Sawchuk, Lohr, Westendorf, Meunier, & Tolin, 2002) to greater extent than expressions of fear (Tolin, Lohr, Sawchuk, & Lee, 1997). In contrast, others have failed to identify associations between fainting, experiences of disgust and levels of parasympathetic activation among a sample of fainting individuals with BII phobia, in comparison to non-fainting individuals (Gerlach et al., 2006). Gerlach et al. (2006) also found no association between levels of self-report disgust sensitivity and RSA measures, creating dispute over whether disgust experiences are implicated in parasympathetic activity and subsequent fainting in response to BII stimuli.

The conflicting findings in BII phobia may be influenced by the fact that both sympathetic and parasympathetic activation has been implicated in disgust experiences, further complicating understandings of autonomic patterns associated with this emotion. In fact, a number of studies have identified heart rate increases, as well as increases in electro-dermal activity (Johnsen et al., 1995; Levenson et al., 1990) in response to disgust stimuli, indicative of sympathetic rather than parasympathetic activation. Christie et al. (2004) failed to identify a discrete pattern

of autonomic activity among participants viewing disgust-inducing film clips, and a study by Demaree (2006) failed to identify changes in RSA in response to a range of disgust-inducing stimuli. It has subsequently been proposed that the *type* of disgust stimuli may be responsible for variability in autonomic patterns during experiences of disgust (Gerlach et al., 2006; Kreibig, 2010; Rohrman & Hopp, 2008). In support of this, a review of autonomic nervous system activity in emotions provided evidence for differentiation between two distinct patterns of disgust-related autonomic activity based on the type of disgust elicitor (Kreibig, 2010). Specifically, contamination-related disgust stimuli appeared to elicit parasympathetic and sympathetic co-activation, while mutilation-related disgust appeared to be characterised by a reduction in sympathetic activity and some parasympathetic activation (Kreibig, 2010). Subsequently, much of the variability in autonomic specificity of emotions could be attributed to differences in the stimuli employed for emotion induction across various experimental designs (Christie & Friedman, 2004). Such findings also cast some doubt over the existence of a single, overarching pattern of autonomic response during experiences of disgust.

While RSA represents a potentially promising measure of parasympathetic activity, its use within emotion research, specifically for disgust, is clouded by the conflicting extant findings regarding the specific autonomic pattern associated with this emotion. While there is some evidence of parasympathetic activity during experiences of disgust, there is also a body of research pointing to concurrent sympathetic activation. Similarly, this pattern appears to be further modulated by the type of disgust stimuli presented (Christie & Friedman, 2004; Kreibig, 2010). Nevertheless, future research that more firmly establishes a consistent pattern of parasympathetic activation in response to specific disgust stimuli (likely mutilation-

based) may expedite RSA as a means of assessing autonomic responses that are characteristic of specific manifestations of disgust.

4.4.2 Electro-dermal skin conductance

Electro-dermal skin conductance has been consistently used as an indicator of sympathetic arousal (Cacioppo et al., 2007) and is widely utilised in emotion research. The use of skin conductance is based on the assumption that activation of the sympathetic nervous system as a result of emotional arousal can lead to an increase in sweat gland activity, which subsequently affects the levels of electro-dermal activity. Multiple studies have used skin conductance as a means of assessing disgust responses. In Ekman et al.'s (1983) paper exploring autonomic activity specific to certain emotions, increases in skin conductance were detected in response to re-lived experiences of disgust over re-lived experiences of sadness. Lang, Greenwald, Bradley and Hamm (1993) used skin conductance responses to measure visceral experiences when viewing IAPS images, findings consistently increased skin conductance during the disgust conditions in comparison to viewing of other emotion-inducing images. In response to viewing disgust-inducing film clips, male and female participants also displayed increased electro-dermal activity accompanied by a reduction in heart rate, in comparison to responses when viewing a neutral film clip (Codispoti, Surcinelli, & Baldaro, 2008). Other studies of responses to disgust film clips have provided consistent results (Gross & Levenson, 1993; Gross, 1998). Studies using directed facial action in order to create facial expressions have similarly identified increased electro-dermal activity during disgust facial expressions (Levenson et al., 1990). Kreibig's (2010) review of autonomic nervous system activity identified consistent findings of increased skin conductance in both

contamination and even mutilation-based disgust, as well as across various methods of disgust induction.

An increase in skin conductance is also consistently produced during experiences of other negatively valenced emotions, such as fear (Ekman, Levenson, & Friesen, 1983; Kreibig, 2010). Subsequently, electro-dermal responses have reduced specificity as an indicator of specific emotions. Increased electro-dermal activity has also been identified during exposure to pleasant stimuli (Lane & Nadel, 2002; Winton, Putnam, & Krauss, 1984), and it has therefore been suggested that it is more reflective of general levels of emotional arousal, regardless of valence (Lane & Nadel, 2002). Nevertheless, this method of measurement may lend itself to assessing the extent of emotional arousal associated with disgust, when used in conjunction with self-report methods.

4.5 Other Physiological Indicators of Disgust: Gastric Myoelectrical Activity

Relatively few studies have employed measures of the gastrointestinal system in emotion-based research. However there is emerging evidence that it may be a useful means of assessing disgust. According to Rohrmann and Hopp (2008), experiences of disgust have the potential to activate a physiological counter-pattern to what is known as the cephalic phase response, a response triggered by sensory signals that prepares the gastrointestinal system for food intake (Power & Schulkin, 2008; Smeets, Erkner, & de Graaf, 2010). A physiological pattern contrary to this response has been identified in individuals when exposed to unappetising food (Power & Schulkin, 2008; Stern, Jokerst, Levine, & Koch, 2001) or imagining eating unappetising food (Zhou & Hu, 2006), involving a decrease in gastric myoelectrical activity. It may be expected that disgust, and emotion with phylogenetic roots in

distaste and food rejection, might result in similar reductions in gastric activity (Messiner, 2011).

Initial studies exploring the pattern of gastric activity associated with disgust have been varied. In order to measure this activity, a number of studies have used an electrogastrograms (EGG) as a method of recording gastric myoelectrical waves using surface electrodes placed on the skin, allowing for comparisons between rates of normogastria (tonic gastric activity) with phasic changes in activity. Using this methodology, Baldaro et al. (1996) identified a decrease in EGG amplitude during exposure to an unpleasant film clip. However, follow-up studies have failed to replicate this result (Baldaro et al., 2001). Vianna and Tranel (2006) expanded previous investigations to include a range of emotion-inducing stimuli, including film clips specifically designed to elicit disgust. The study identified changes in gastrointestinal function across a broad range of emotions, including disgust conditions. These changes primarily involved an increase in peak amplitude within the normal range of gastric contractions, reflective of an increase in stomach contraction amplitude (Vianna & Tranel, 2006). EGG recordings also positively correlated with subjective ratings of emotion.

Messiner, Muth and Herbert (2011) investigated gastric myoelectrical activity using EGG during the viewing of disgust images taken from the IAPS. The study found that levels of bradygastria predicted subjective ratings of state disgust when viewing high arousal disgust images, however, no consistent main effect of bradygastria was identified across all disgust images. While such studies provide some emerging evidence for reduced gastric myoelectrical activity during experiences of disgust, further investigations appear necessary in order to add to extant findings.

4.6 Measuring Self-Disgust

While self-disgust is a far less researched emotion, it has been an emerging area of study in association with a number of clinical conditions such as major depression (Overton et al., 2008), body dysmorphic disorder (BDD; Neziroglu, Hickey, & McKay, 2010), self-harm (Klonsky & Muehlenkamp, 2007) and eating disorders (Aharoni & Hertz, 2012; Espeset, Gulliksen, Nordbø, Skårderud, & Holte, 2012). Research of this emotion has necessitated the development of methods of measuring and assessing disgust aimed at the self. While self-report methods have now been developed, means of assessing self-disgust are yet to broaden into other emotion assessment mediums such as cognitive and psychophysiological approaches.

The assessment of self-disgust is also clouded by variations in its definition; including suggestions that self-disgust may well be synonymous with shame or self-hatred. However, if self-disgust does encompass parallel properties to externally directed disgust, then it would be expected to result in the same physiological and behaviour response patterns when disgust at the self is elicited. Accordingly, the remainder of this paper will consider existing self-report measures of self-disgust, as well as potentially promising methods of assessment that draw on previously established physiological measures of externally directed disgust.

4.6.1 The Self-Disgust Scale

Overton, Markland, Simpson, Taggart and Bagshaw's (2008) Self-Disgust Scale was initially developed to explore self-disgust among individuals with major depressive disorder. The scale was derived from the Self-Description Questionnaire (SDQ-III; Marsh & O'Neill, 1984) and contains 12 items assessing self-directed disgust (e.g. "I find myself repulsive"). The scale was validated on a sample of undergraduates and was found to have excellent internal consistency ($\alpha = .91$) and

test re-test reliability (e.g., $r=.94$). Factor analysis of the scale produced a two factor structure labelled the disgusting self and disgusting ways. Overton et al. (2008) established convergent validity for the SDS using correlations with the Disgust Sensitivity Scale (DS; Haidt, McCauley & Rozin, 1994), obtaining significant correlations between scores on both scales. The SDS was subsequently used to identify a partially mediating role of self-disgust in the relationship between depression and dysfunctional cognitions (Overton et al., 2008).

Simpson, Hillman, Crawford and Overton (2010) similarly utilised the Self-Disgust Scale in order to investigate associations between self-disgust, self-esteem and dysfunctional cognitions among individuals with depressive symptoms. This study provided further support for the internal consistency of the scale, as well supporting the distinctiveness of self-disgust from other related constructs such as self-esteem. Olatunji, David and Ciesielski (2012) also provided validation for a 4 item short version of the SDS (obtaining a Cronbach's Alpha of $\alpha = .84$). This four-item version was used in order to assess the relationship between self-disgust and moral judgements, with findings suggesting that increased levels of self-disgust were associated with less severe moral judgements (Olatunji et al., 2012). While the utility of the SDS appears to have been established, wider use of the scale in other populations may provide further support for its construct validity. A recent revised version of the scale (the Self-Disgust Scale-Revised; Powell, Overton & Simpson, 2015) has also been developed, with preliminary psychometric analyses in a non-clinical sample ($n=293$) indicating it has excellent internal consistency ($\alpha=.92$) and a similar, 2-factor structure comparable to the original scale. However, A broadly accepted definition of self-disgust is yet to be consolidated in the literature, and the scale may need to undergo further modifications or revisions as broader conceptualisations of self-disgust are established.

4.6.2 Psychophysiological measures of self-disgust

Various psychophysiological methods employed in measuring externally directed disgust could be similarly applied when the self is the object of disgust. Similar to Ekman and Friesen's (1978) facial recognition coding system, Tracy, Robins & Schriber (2009) developed a Facial Action Coding System (FACS) for self-conscious emotions, such as embarrassment, shame and pride. However, this visual coding system has not been extended to self-disgust. Physiological measures of autonomic activity, such as heart rate and skin conductance, may have utility as a means of assessing arousal responses that arise during experiences of self-disgust. Neziroglu, Hickey and McKay (2010) explored this possibility in a study investigating disgust experiences aimed at the body among individuals with BDD based on clinical indications that body viewing avoidance and body camouflaging could be driven by disgust. The study assessed heart rate and skin temperature of individuals with and without BDD during a mirror viewing task. Participants were asked to focus on an aspect of their face that they disliked for a one minute period across a series of five trials, then self-report their levels of anxiety and disgust. Significant increases in heart rate were observed from baseline across several trials among the BDD sample, but were not observed in controls. However, no changes in skin temperature were observed in either group. Subjective ratings of anxiety and disgust were also elevated among individuals in the BDD sample, making it difficult to attribute these physiological changes purely to disgust (Neziroglu et al., 2010). Nevertheless, this difficulty with emotion specificity is common to psychophysiological measures of emotion, and the use of concurrent self-report measures are one way of verifying the presence of specific emotions.

While the utility of vagal tone as a measure of disgust is also clouded by difficulties determining emotional specificity, it nonetheless presents another

potential means of assessing self-disgust. Parasympathetic activation, as a co-occurring autonomic response to certain types of disgust, may be elicited during experiences of self as the object of disgust. However, as self-disgust may not be easily categorised into the contamination-based and mutilation-based disgust, it may be more difficult to predict the potential pattern of autonomic activity that may be associated with the experience.

It is possible that individuals exhibit facial markers of disgust when the emotion is felt in association with the self. This possibility would potentially enable the use of behavioural measures such as facial EMG and startle/eye-blink responses as a means of detecting facial signals of self-disgust. However, there is currently little understanding of the behavioural and physiological correlates of self-disgust, and further research would be needed in order to ascertain whether such responses function in parallel with typical disgust experiences.

4.6.3 Complications associated with the measurement of self-disgust

One difficulty associated with the measurement of self-disgust is that it appears to be an emotional experience that is more salient in certain population groups. While transient feelings of disgust and the self or one's actions may arise at some point, it is unlikely to be a common emotional experience among the majority of individuals. In fact, the phylogenetic development of disgust precludes disgust at the self, as it is essentially an 'other-directed' emotion. Disgust's adaptive function as a method of pathogen avoidance through eliciting body rejection behaviours (facial expression, nausea and vomiting) and avoidance behaviours means that disgust is fundamentally a sentinel, self-protective emotion. We are often disgusted by 'otherness', where the degree of removal from the self can be predictive of the level of disgust experienced. Similarly, a phenomenon known as the 'ego-alien'

effect refers to the change in a substance's level of disgust as it crosses the self/non-self border (i.e. saliva in the mouth versus saliva in a glass). Therefore, establishing a reliable means of assessing self-disgust among non-clinical populations may be difficult, with such investigations are potentially limited to particular clinical groups where the emotional experience may be more relevant.

Moreover, there may be ethical concerns in regard to assessing self-disgust in an experimental setting. While this emotional experience is suggested to be inherent or recurring under certain circumstances in clinical conditions such as major depressive disorder, eating disorders or BDD, in order to be measured empirically it would need to be elicited or augmented in order to be assessed. Doing so could potentially result in associated distress in the participant, particularly if the means of elicitation is associated with upsetting clinical symptoms.

This leads to the final consideration of the difficulties associated with self-disgust, which is that of means of elicitation. While self/body viewing using mirrors presents a viable option, and has been used previously (Neziroglu et al., 2010), specific features or aspects of the self that are experienced as disgusting may not be visible or chosen to be attended to in a mirror viewing exercise. Similarly, mirror viewing is not likely to elicit experiences of self-disgust directed towards one's behaviour. Any means of eliciting self-disgust is also likely to elicit other negative, self-directed emotions such as anxiety, shame or anger. Exploration of other means of elicitation, potentially drawing on other methodologies used in emotion research such as video viewing or memory sequences, may be necessary in order to discover an effective, reliable and ethical means of eliciting self-disgust.

4.7 Conclusion

As an emotion of interest, disgust possesses several key characteristics as a core, universal emotion with clear behavioural correlates and an identifiable, characteristic facial response. Rigorous investigations into several self-report measures of disgust constructs, including disgust sensitivity and propensity, have provided valuable means of gauging subjectively experienced facets of disgust. In particular, the DPSS-R appears to offer some advantage over the conventionally used DS, in that it is able to assess the distinct constructs of disgust sensitivity and propensity, as well as measure disgust responses independent of a disgust elicitor. However, self-report methods are limited by subjectivity, thus leading to explorations of psychophysiological methods that enable the assessment of objective patterns of physical response consistent with certain emotional reactions. The use of facial EMG and the measurement of eye-blink/startle responses facilitate the assessment of facial markers indicative of emotion, providing a further means of assessing behavioural characteristics of disgust. Various means of physiological assessment that have also been explored, including EGG, skin conductance and heart rate measures, and offer promising indicators of patterns of autonomic activity associated with disgust.

In regard to the measurement of self-disgust, self-report measures have been developed and used in a variety of population samples. Applying the physiological approaches taken to assessing externally directed disgust may provide a promising method of discerning disgust aimed at the self. Using comparative assessments of externally and self-directed disgust may also provide a means of comparison and enable the identification of similar patterns of psychophysiological responses.

The major difficulty arising in the measurement of both external and self-directed disgust relate to challenges with specificity between these and other

emotions with negative valence. Specifically, emotions such as fear often engage similar behavioural patterns (avoidance) and can result in similarly autonomic patterns, making it difficult to accurately discern these experiences. Furthermore, situations where both emotional responses may be elicited (i.e. blood/injury or some specific phobias such as spiders) create further complications for measurement. Subsequently, the use of several concurrent assessment measures, including self-report, may provide a means of correlating emotion experiences across several modalities. Nevertheless, the limitations of accurately identifying specific emotions may need to be recognised and addressed when reaching conclusions in assessment studies, particularly when certain responses may have relevance for particular clinical groups.

Chapter 5: The Self and Body Disgust Scale: Validation and Relationship with Eating Disorder Symptomatology

RESEARCH PAPER

**The Self and Body Disgust Scale: Validation and Relationships with Eating
Disorder Symptomatology**

Submitted to: Psychological Assessment

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5.1 Abstract

Objective: Disgust has been identified as a significant emotional experience in eating disorders. In contrast, self-disgust remains a relatively little researched emotion, despite recent suggestions that it may provoke specific eating disorder symptoms. This study examined the psychometric properties of the Self and Body Disgust Scale (SBDS), a modified self-report questionnaire assessing visceral qualities of repulsion at the body, the self and one's behaviours. This study also investigated relationships between levels of self-disgust and eating disorder symptomatology in a non-clinical population.

Method: Seven hundred and forty-six undergraduates completed a revised version of the SBDS and the Eating Disorder Examination Questionnaire (EDE-Q). Following an assessment of the psychometric properties and factor structure, correlational analyses were used to assess the relationship between self-disgust and eating disorder symptoms.

Results: Psychometric analysis of the SBDS revealed excellent internal consistency and acceptable test-retest reliability. Levels of self-disgust were positively correlated with global and subscale scores on the EDE-Q.

Discussion: Initial validation of the modified SBDS indicated that it is a psychometrically sound measure of disgust and revulsion at the self. The current results provided support for an association between high levels of self-disgust and increased eating disorder symptomatology in a student population.

5.2 Introduction

Disgust is a basic emotion characterised by feelings of revulsion and abhorrence in response to a disgust elicitor (Darwin, 1878/2002; Ekman, Levenson, & Friesen, 1983; Phillips, Fahy, David, & Senior, 1998; Rozin & Fallon, 1987). It is marked by a behavioural pattern of rejection and avoidance, which is reflected in the characteristic disgust facial expression (the mouth drawn back, nose wrinkled and often tongue protruding) that facilitates oral elimination. Disgust is regarded as adaptive in function, with phylogenetic origins in food rejection (Darwin, 1878/2002) and an evolutionary basis as a method of pathogen avoidance (Rozin & Fallon, 1987).

Disgust has been implicated in several psychiatric conditions including obsessive-compulsive disorder (OCD; Cisler, Olatunji, Feldner, & Forsyth, 2010), specific phobias (de Jong & Merckelbach, 1998) and eating disorders (Griffiths & Troop, 2006; Troop, Murphy, Bramon, & Treasure, 2000). The majority of past studies have investigated disgust experiences in response to certain external elicitors, identifying frequent expressions of disgust in response to disorder-relevant stimuli (de Jong & Merckelbach, 1998; Phillips et al., 1998). For example, in cases of OCD, disgust is often elicited by perceived contaminants such as dirt or germs (Berle et al., 2012; Berle & Phillips, 2006).

More recently, disgust research has been extended to explorations of self-directed disgust, based on the assumption that the self can become a source of revulsion and abhorrence (Overton, Markland, Taggart, Bagshaw, & Simpson, 2008). While self-disgust has previously been associated with other self-conscious emotions such as shame and guilt (Power, Dalgleish, 2007; Roberts & Goldenberg, 2007), it has been recently characterised and distinguished as a distinct emotional experience that involves enduring feelings of repulsion directed towards the self as a whole, or

parts of the self (Powell, Overton & Simpson, 2015). Based on Powell, Overton and Simpson's (2015) definition, the phenomenon of self-disgust maps on to the cognitive-affective responding processes of basic disgust responding to the self. It can represent both a transient feeling state as well as an ongoing mood trait, or 'emotion schema'. Roberts and Goldenberg (2007) provide a socio-cultural definition of self-disgust as a response to violations of social conduct, particularly in relation to body and gender, where certain behaviours or aspects of the self may be considered immoral or deviant. Disgust directed toward the self is also conceived of as a disownership emotion applied in error to parts of the self, which also involves a distinct visceral quality (Moncrieff-Boyd, Byrne, & Nunn, 2014), mapping on to definitions of disgust as a powerful, bodily experience of revulsion accompanied by feelings of nausea (Rozin & Fallon, 1987).

5.2.1 The Measurement of disgust and self-disgust

A number of self-report scales have been developed in order to investigate experiences of externally-directed disgust. The Disgust Sensitivity Scale (Haidt, McCauley, & Rozin, 1994) assesses disgust responses towards a range of disgust elicitors. The scale has been widely validated and is regarded as the gold standard measure of externally directed disgust. In contrast, the Disgust Propensity and Sensitivity Scale (DPSS- R; van Overveld, de Jong, Peters, & Schouten, 2011; van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006) investigates two distinct aspects of disgust; sensitivity (the intensity of the disgust experience) and propensity (the frequency of the disgust experience). The scale includes items that measure these aspects of disgust independent of specific disgust elicitors. Both scales have been widely utilised in order to examine the role of disgust among specific

psychopathology (Cisler, Olatunji, & Lohr, 2009; Davey & Chapman, 2009; de Jong & Merckelbach, 1998; van Overveld, Jong, & Peters, 2010).

To date, only one scale in English has been developed to assess self-disgust. The Self-Disgust Scale (SDS) was created by Overton, Markland, Simpson, Taggart and Bagshaw (2008) in order to investigate the presence of this emotional experience among individuals with major depressive disorder. The scale was derived from the Self-Description Questionnaire (SDQ-III; Marsh & O'Neill, 1984) and contains 12 items assessing self-directed disgust (e.g. "I find myself repulsive"). Initial development and validation of the scale indicated that the scale had excellent internal consistency (Cronbach's Alpha = .91) and good test re-test reliability ($r = .94$). Convergent validity was established based on significant correlations with the Disgust Sensitivity Scale (Haidt et al., 1994). Factor analysis of the SDS produced a two factor structure; the 'disgusting self' (e.g. "I hate being me") and 'disgusting ways' (e.g. "the way I behave makes me despise myself"). Overton et al. (2008) used the scale to investigate the relationship between self-disgust and depression, with self-disgust partially mediating the relationship between dysfunctional cognitions and depressive symptoms. A further investigation using the SDS replicated these results (Simpson, Hillman, Crawford, & Overton, 2010). Olatunji, David and Ciesielski (2012) used a short, 4-item version of the SDS in order to investigate the relationship between levels of self-disgust and the severity of moral judgement of others, with findings indicating that greater levels of self-disgust are associated with less severe punishment of moral transgressions. Olatunji et al. (2012) also provided additional support for the internal consistency of the SDS 4-item version (Cronbach's Alpha = .84).

Despite support for the psychometric properties of the SDS, the current version of the scale may require revision for subsequent use in a wider range of

clinical populations (Powell, Overton & Simpson, 2014). Specifically, it is possible that the current version of the scale fails to capture self-disgust as an experience of visceral revulsion directed towards the self and the body as a physical manifestation of self. Furthermore, it appears important to distinguish between the emotion of self-disgust and other concepts such as low self-esteem, and a general negative sense of self. While Simpson et al.'s (2010) study indicated that self-disgust and self-esteem are discrete constructs, individuals with general negative self-opinion may display a negative attribution bias and endorse items that capture a negative view of the self (e.g. "I hate being me"). There is also some difficulty identifying the discriminant emotion of self-disgust. Current conceptualisations in Overton et al.'s (2008) SDS have used examples that appear to fit concepts of pride and self-approval (e.g. "I'm proud of who I am"), where a negative endorsement may again merely capture low self-opinion and negative attribution bias rather than the presence of self-disgust.

While a specific antonym for disgust may not exist, it is possible to consider what a behavioural opposition to disgust may be. Like other emotions with negative valence, disgust is associated with rejection and avoidance behaviours (Rozin & Fallon, 1987). In the context of self-disgust, these behaviours may manifest as self-avoidance or rejection of the self. Accordingly, approach behaviours could potentially represent an opposing construct to self-disgust in a behavioural context. This may provide an avenue for assessing experiences of self-disgust, through the inclusion of self-report items that attempt to capture approach or acceptance-based behaviours exhibited towards the self.

5.2.2 Self-disgust and eating disorder symptomatology

Self-disgust has been identified as a potentially prominent emotional experience in eating disorders such as anorexia nervosa (AN) and bulimia nervosa

(BN; Espeset, Gulliksen, Nordbø, Skarderud, & Holte, 2012; Ille et al., 2014; Polivy & Herman, 2002). Eating disorders are serious mental health conditions that typically involve significant overvaluation of weight and shape accompanied by abnormal eating behaviours (American Psychiatric Association, 2013). Expressions of disgust towards the body and self are frequent among individuals with eating disorders (Espeset et al., 2012; Polivy & Herman, 2002; Troop & Baker, 2009), and have been subsequently associated with key clinical characteristics of these conditions. Troop and Baker (2009) suggest that disgust at the body, potentially triggered by perceived fatness or over-eating, is transferred or generalised to feelings about the self. Experiences of body dissatisfaction and negative body image, both regarded as fundamental clinical features of eating disorders, have similarly been characterised as emotional experiences akin to self-disgust (Polivy & Herman, 2002). In a qualitative study of emotional experiences in AN, Espeset, Gullikson, Nordbo, Skarderud and Holte (2012) highlighted the frequency of expressions of disgust towards the self and body triggered by food intake and experiences that increased body awareness (e.g. sexual contact). Behavioural responses to these feelings of self-disgust were characterised by food restriction and purging. It was concluded that self-disgust may be a central emotional experience in AN, with a potential role in driving restrictive and compensatory behaviours (Espeset et al., 2012).

Several studies have also investigated experiences of shame and guilt in eating disorders, particularly expressed towards the body and eating (Burney & Irwin, 2000; Skarderud, 2007). While shame and guilt have been conceptualised as complex emotional hybrids that involve disgust (Power & Dalglish, 2007), there are both theoretical and clinical reasons for distinguishing self-disgust from these related emotions. First, there may be a need for treatments to address self-disgust as an emotional component of core body dissatisfaction and as a driver of restrictive and

compensatory behaviours. Secondly, findings indicating high levels of disgust and self-disgust in eating disorders may lend support to aetiological models of AN that implicate brain regions intrinsic to disgust, specifically the insula (Aharoni & Hertz, 2012; Nunn, Frampton, Fuglset, Törzsök-Sonnevend, & Lask, 2011). The bodily instantiation of self-disgust, the visceral qualia and the representation of that bodily instantiation of self-disgust within the brain also have a potential precision and capacity for operationalised measurement, which existing concepts of shame and guilt do not.

5.2.3 The present study

This study examined a modified version of the SDS (the Self and Body Disgust Scale; SBDS) with the aim of assessing its psychometric properties following several changes designed to capture self-disgust as a distinct construct, involving visceral qualities of revulsion and abhorrence at the self. The scale was also modified in order to assess experiences of body disgust that may be relevant to eating disorders and other disorders of body image.

The use of self-acceptance was posited as the discriminant experience of self-disgust. It was hypothesised that items assessing the construct of self-acceptance would negatively correlate with self-disgust, and would load onto the proposed two SBDS factors (consistent with the factor structure identified for the SDS).

In addition to testing the psychometric properties of the SBDS, this study aimed to examine the relationship between the newly validated SBDS and eating disorder symptomatology in a large undergraduate sample. Based on previous indications that individuals with eating disorders experience high levels of self-directed disgust, it was hypothesised that greater levels of self-disgust, as measured

by the SBDS, would positively correlate with scores on a measure of eating disorder symptoms.

5.3 Methods

5.3.1 Participants

Seven hundred and forty six students (183 male, 563 female) were recruited from undergraduate psychology courses. Participants ranged in age from 17 to 62 years ($M= 19.29$, $SD= 4.93$). A smaller, random sample of 50 participants (100% female) was contacted via email and invited to participate in the second, online phase of the study, with 48 participants responding (96% response rate). Informed consent was obtained from all participants, and participants in the second phase of the study received course credit in exchange for participation. These participants were also contacted 8-10 weeks later in order to complete the test-retest phase of the study, with 26 participants responding (54% response rate).

5.3.2 Materials

Self-Disgust Scale (SDS; Overton et al., 2008), and the Self and Body Disgust Scale (SBDS; Appendix A)

The SDS (Overton et al., 2008) assesses the presence of self-directed disgust. Previous validation of the scale indicated that it has excellent internal consistency and test-retest reliability. For the purposes of the current study, the scale was revised in order to capture a more precise definition of self-disgust as visceral revulsion at the self. The wordings of two items were altered to reflect concepts that are synonymous with this definition of disgust (e.g. ‘revolting’, ‘abhorrent’, ‘foul’), and to avoid overlap with more general negative opinion (“The way I behave makes me despise myself” altered to “I find the way I behave abhorrent”, and “It bothers me to look at myself” altered to “It sickens me to look at myself”). The concept of

'acceptance' was also posited as a potential discriminant construct for self-disgust (i.e. self-acceptance). The word "accept" was used to replace several reverse-scored items in the original scale (e.g. "I am proud of who I am" was altered to "I accept who I am"). A total of four items were removed from the scale. One item was removed as it was thought to capture global self-loathing rather than specific disgust at the self ("I hate being me"). Two further items were removed as they referred to perceived experiences of others towards the self ("My behaviour repels people", and "Overall, people dislike me"). One filler item was also removed. Finally, two items were added to the scale in order to assess disgust at the body ("Parts of my body are foul" and "When I walk around, I feel revolting").

The revised version of the scale, therefore, comprises 16 items constructed on a Likert scale (1=strongly agree, 7= strongly disagree). Six filler items are removed for scoring giving 10 items for use in score calculations (items 1, 3,6,9,11,13 and 16 are reverse-scored). Scores can range from 10 to 70, with higher scores indicating greater levels of self-disgust. The revised scale is provided in Appendix A.

The Disgust Sensitivity and Propensity Scale-Revised (DPSS-R; van Overveld et al., 2006)

The DPSS-R is a 12-item self-report measure designed to measure levels of disgust sensitivity and disgust propensity. The scale was translated to English by Olatunji et al. (2007). Validation of this revised, English language version demonstrated excellent internal consistency (Cronbach's alpha= .90). Items are responded to on a scale ranging from 1 ("never") to 5 ("always"), with sub-scores individually calculated for disgust sensitivity and propensity.

Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994).

The EDE-Q is a self-report questionnaire (28 items) that assesses cognitive and behavioural symptoms commonly featured in eating disorders (Fairburn & Beglin, 1994). The majority of items are responded to using a seven level rating choice (indicating the proportion of days out of 28 days). Four subscale scores were calculated from these items, assessing weight concern, shape concern, eating concern and dietary restraint. A global EDE-Q score (ranging from 0-6) was calculated from an average of these subscale scores, which was used in the current study as a measure of ED symptomatology. The questionnaire includes a further six diagnostic items that assess pathological eating episodes and compensatory behaviours, with one question specifically addressing binge eating.

5.3.3 Procedure

Participants completed the SBDS as part of a larger screening procedure conducted in an undergraduate psychology unit. Participants completed the questionnaire in paper and pencil format in a classroom setting. Informed consent was obtained from all participants prior to the completion of the questionnaire.

The 48 participants who took part in the second phase of the study were administered an online version of the SBDS, the DPSS-R and the EDE-Q within a larger battery of questionnaires. The complete questionnaire set took approximately 30 minutes to complete. All questionnaires were administered in the following fixed order (DPSS-R, SBDS, EDE-Q) in order to minimise any emotional transfer from the EDE-Q to scores on the SBDS. To examine test-retest reliability, participants were invited to complete questionnaires again 8-10 weeks later, with 26 participants doing so. Ethical approval was obtained for all aspects of the study.

5.3.4 Statistical Analysis

Internal consistency of the SBDS was assessed using Cronbach's Alpha. Test-retest reliability and concurrent validity were assessed using the 26 participants who recompleted the measure 8-10 weeks later, and were calculated using correlational analyses. Given the alterations made to the scale, principal components analysis with Promax rotation was used to examine the factor structure of the SBDS. Following removal of missing data, a total of 597 participants completed both the SBDS and the EDE-Q. Correlational analyses were used in order to assess the relationship between scores on the SBDS and corresponding scores on the EDE-Q. Hierarchical regression analysis was used to assess the incremental validity of the SBDS as a predictor of Global EDE-Q scores. Participants with missing values were excluded from the analyses.

5.4 Results

Mean and standard deviation scores for all measures (including EDE-Q subscales) are provided in Table 1. Examination of the Shapiro-Wilk score ($W = .930$, $p < .001$), along with examination of the Q-Q plot, indicated that the data were non-normally distributed. As a result of this, non-parametric correlational analyses (Spearman's RHO) were conducted. Prior to the main validation analysis, a missing values analysis was conducted. Little's MCAR test revealed no non-random missing values in the data set ($\chi^2 = 142.56$, $p = .27$).

Mean scores for individual items on the SBDS ranged between 5 and 7, indicating that the majority of participants responded towards the "Strongly Disagree" end of the Likert scale.

Table 1. Means and standard deviations for Self and Body Disgust Scale, Eating Disorder Examination Questionnaire global and subscale scores, Body Mass Index and Disgust Propensity and Sensitivity Scale-Revised

Measure	M	SD
SBDS	24.89	11.34
EDE-Q Global	1.63	1.32
Restraint subscale	1.64	1.5
Eating Concern subscale	0.93	1.18
Shape Concern subscale	2.15	1.64
Weight Concern subscale	1.81	1.57
BMI	20.61	5.91
DPSS-R	30.06	5.71
Propensity	16.54	2.93
Sensitivity	13.52	3.66

5.4.1 Factor structure of the SBDS

The obtained Kaiser-Meyer-Olkin Measure of Sampling Adequacy was (KMO) = .92, indicating excellent sample adequacy (Hutcheson & Sofroniou, 1999).

Following PCA with Promax rotation, only one factor was retained (in accordance with Kaiser's criterion of eigenvalues >1). The eigenvalue for this factor was 5.53, accounting for 55.3% of variance. Table 2 shows the factor loadings for the one factor solution. All factors exhibited salient loadings (>.4). Following the

factor analysis, correlations between items were inspected in order to identify any evidence of co-linearity and multicollinearity. All correlations between items were between .3 and .8, indicating adequate correlation between items. A correlation of $r=.796$ was obtained between item 13 (“It sickens me to look at myself”) and item 16 (“when I walk around, I feel revolting”). Based on the fact that this score was just within the suggested range for correlations between individual items, both items were retained. No multicollinearity was detected.

Table 2. Component Loadings for the Self and Body Disgust Scale

Item	Loading
1. I find myself repulsive	.84
2. I accept who I am*	.73
3. I find the way I behave abhorrent	.59
4. I accept the way I look*	.74
5. Parts of my body are foul	.68
6. I find the way I behave acceptable*	.68
7. I do not want to be seen	.74
8. I often do things I find revolting	.67
9. It sickens me to look at myself	.86
10. When I walk around, I feel revolting	.86

*items have been reverse scored

5.4.2 Internal validity

The Cronbach’s Alpha obtained for the SBDS was $\alpha=.91$, indicating excellent internal consistency for the scale. No items were identified for removal in order to improve the alpha score. All items demonstrated acceptable item-total correlations (ranging from .52-.80).

5.4.3 Test-retest reliability

Test-retest reliability was assessed using SBDS scores taken at Time 1 and Time 2. A significant, positive correlation was obtained, $r_s(26) = .71$, $p < .01$, 95% CI [.39, .90], indicating adequate test-retest reliability.

5.4.4 Concurrent validity

A significant correlation was obtained between total scores on the SBDS and the disgust sensitivity subscale of the DPSS-R, $r_s(48) = .32$, $p < .05$, 95% CI [0.03, 0.56]. Total SBDS scores did not correlate with disgust propensity scores, $r_s(48) = .14$, $p = .17$, 95% CI [-.14, .40] or total scores on the DPSS-R, $n(48) = .25$, $p = .08$, 95% CI [-.05, .51].

5.4.5 Correlations with eating disorder symptomatology

Spearman's correlations were carried out between the SBDS total score and the EDE-Q global, sub-scale scores and BMI. Correlations with diagnostic items concerning binge eating and purging episodes were also calculated. The correlations are displayed in Table 3. All correlations apart from that with BMI were positive and significant at the $p = .01$ level.

Table 3. Spearman correlations and confidence intervals for scores on the Self and Body Disgust Scale and Eating Disorder Examination Questionnaire global and subscale scores

Score	Spearman correlation(s) with SBDS total score	95% Confidence Interval
EDE-Q Global	.52*	[.45, .58]
Restraint subscale	.31*	[.23, .39]
Eating Concern subscale	.47*	[.40, .54]
Shape Concern subscale	.55*	[.49, .61]
Weight Concern subscale	.51*	[.45, .58]
Binge Eating Episodes	.29*	[.21, .36]
Purging Episodes	.20*	[.13, .26]
BMI	.06	[-.02, .15]

* Significant at .01 level (2-tailed).

5.4.6 Incremental validity

A hierarchical regression was used to assess incremental validity of the SBDS as a predictor of Global EDE-Q scores (Hunsley & Meyer, 2003). Examination of the Variance Inflation Factors (VIF) indicated no evidence of multicollinearity. A Durbin-Watson score of 1.914 was obtained, indicating that the assumption of independent errors was also upheld.

Scores on the DPSS were entered into the first step of the regression, followed by SBDS scores, with Global EDE-Q scores entered as the dependent variable. The first step produced a significant model, $F(1,45) = 5.89, p < .05, r = .34$. The inclusion of SBDS scores in the second step significantly improved the model, $F_{\text{change}}(1,44) = 5.20, p < .05$, supporting the incremental validity of the SBDS as a

predictor of Global EDE-Q scores. B values and standardised Betas are reported in Table 4. In Model 2, a significant standardised beta value was obtained for the SBDS but not for the DPSS, again supporting the predictive value of the SBDS.

Table 4. Hierarchical regressions for the Disgust Propensity and Sensitivity Scale-Revised and Self and Body Disgust Scale predicting Eating Disorder Examination Questionnaire global scores

	B	Standard Error	Beta	95% Confidence interval for B
Model 1				
Constant	.75	.39		[-.03, 1.53]
DPSS-R (Total)	.03	.01	.34*	[.01, .06]
Model 2				
Constant	.62	.37		[-.13, 1.37]
DPSS-R (Total)	.02	.01	.25	[-.01, .05]
SBDS	.02	.01	.32*	[.01, .03]

* $p < .05$. Model 1: $F(1,45) = 5.89$, $p < .05$, $r = .34$; $R^2 = .12$. Model 2: $F(2,44) = 5.82$, $p < .01$, $r = .48$; $R^2 = .21$, $\Delta R^2 = .10$.

5.5 Discussion

This study examined the psychometric properties and factor structure of a revised version of a self-report measure of self-disgust, initially developed by Overton et al. (2008). A number of modifications were made in order to assess self-disgust as a visceral experience of revulsion or abhorrence at the self, the body and/or one's behaviours. The revised scale was correlated with global and item scores on

the EDE-Q, in order to determine whether higher levels of self-disgust were correlated with increased eating disorder symptomatology.

In line with Overton et al. (2008), the SBDS performed well and demonstrated excellent levels of internal consistency and adequate test-retest reliability. However, the scale diverged in regard to its previously identified factor structure. Overton et al.'s (2008) original factor analysis yielded two factors consisting of the "Disgusting Self" and "Disgusting Ways". In the current study, exploratory factor analysis failed to produce two identifiable factors, with all items sufficiently loading onto one factor only. It appears likely that the alteration of several items in Overton et al.'s (2008) original scale would account for this deviation in factor structure. However, the presence of one factor may also indicate that self-disgust is a discrete, one-dimensional concept that involves disgust at one's body and one's behaviours and, collectively, one's self. However, it was interesting to note that the factors with the lowest loadings were items relating to disgust behaviour (i.e. Item 3, "I find the way I behave abhorrent"). This somewhat corresponds with Overton et al.'s (2008) conceptual distinction between disgust at the self versus disgust at one's behaviours, based on their original factor analysis.

The reverse-scored items using 'acceptance' as the behavioural opposite of disgust also loaded consistently on to the one-factor solution. All three items phrased in this manner achieved adequate factor loadings and sufficient correlations with other items on the scale. These findings provide initial evidence for the construct validity of these items and indicate that the construct of self-acceptance as an opposing construct to self-disgust performed well within the context of this study.

The SBDS was compared to a measure of disgust sensitivity in order to assess concurrent validity. A positive correlation was found between levels of disgust sensitivity (the intensity of disgust experiences) and self-disgust, indicating that these

constructs are related as expected. However, disgust propensity (the frequency of disgust experiences) did not correlate with self-disgust. The total scores on the DPSS-R also failed to significantly correlate with SBDS total scores. This finding firstly re-enforces suggestions that disgust sensitivity and propensity are distinct constructs (van Overveld et al., 2006) while further suggesting that self-disgust may relate to the intensity of disgust experienced, rather than the frequency. It is also possible that experiences of self-disgust may be more intense than disgust induced by external stimuli; further research will be necessary in order to clarify relationships between self-disgust and other disgust constructs, especially within clinical samples. It seems worth noting that experiences of self-disgust are likely to be triggered in different ways to externally elicited disgust.

Findings from the current study also provide initial evidence for an association between self-disgust and eating disorder symptoms, with positive, medium to strong correlations identified between scores on the SBDS and global EDE-Q scores and all sub-scale scores. Positive, moderate correlations were also yielded between self-disgust levels and EDE-Q diagnostic items assessing the presence of binge eating and purging episodes. Overall, these results suggest that increased levels of self-disgust are associated with increased eating disorder symptomatology in a non-clinical population. Such findings provide empirical support for previous qualitative investigations and clinical literature positing self-disgust as a relevant emotional experience in eating disorders (Espeset et al., 2012), with potential links to core eating disorder symptoms.

The robust correlations ($r_s > .50$) between SBDS total scores and both weight and shape concern subscale scores are also indicative of a specific association between levels of self-disgust and body dissatisfaction and over-evaluation, albeit in a non-clinical sample. Items included in the shape concern subscale also assess levels

of discomfort in response to the self and others viewing one's own body (e.g. item 27, "How uncomfortable have you felt seeing your body, for example seeing your shape in the mirror, in a shop window reflection, while undressing or taking a bath or shower?" and item 28, "How uncomfortable have you felt about others seeing your shape or figure, for example in communal changing rooms, when swimming or wearing tight clothes?"). Concern about viewing one's own body appears consistent with the idea of self-disgust manifesting as a feeling of revulsion in response to the body or a certain aspects of the self.

The absence of a significant correlation between SBDS total scores and BMI also suggests that levels of self-disgust appear to vary regardless of body mass, which fits with the current literature suggesting that feelings of self-disgust manifest in individuals across the weight spectrum (Espeset et al., 2012; McCrea, 1995). This finding also helps to support the distinction between general body dissatisfaction and self-disgust, as body dissatisfaction is found to correlate robustly and positively with BMI (van den Berg et al., 2007; Yates, Edman, & Aruguete, 2004).

In further support of the psychometric properties of the revised SBDS, examination of the scale's incremental validity as a predictor of global EDE-Q scores suggested that it improved prediction compared with existing scales (i.e. the DPSS-R). Furthermore, the SBDS was a greater predictor of global EDE-Q scores, over and above the DPSS-R. These results also point to the relevance of self-disgust as a potentially significant predictor of eating disorder symptomatology, again highlighting the need for further investigation of the role of this emotion in eating disorders.

Several limitations of the current study should be noted. First, the validation of this scale was based on a non-clinical sample, which may place limitations on its proposed applicability in a clinical population, particularly in regard to associations

with specific eating disorder symptoms. Further investigations using the SBDS in a clinical sample of eating disorder patients would address this. Levels of self-esteem and depression, both of which are found to correlate with self-disgust (Overton et al., 2008; Simpson et al., 2010), were also not accounted for in the current study's sample.

In conclusion, the SBDS appears to be an internally consistent, reliable measure of the emotion of self-disgust, based on a validation conducted in an undergraduate sample. Self-acceptance may also represent a valid opposing construct to self-disgust, potentially reflecting an opposition to disgust behaviours such as rejection and avoidance. Self-disgust also appears to be associated with increased levels of eating disorder symptomatology. Future studies may wish to extend investigations of the utility of the SBDS to clinical eating disorder populations, as well as investigate its relationship with specific eating disorder features where self-disgust may be relevant, such as weight and shape concern and restrictive eating.

Chapter 6: An Examination of Disgust and Self-Disgust in Women with Eating Disorders

RESEARCH PAPER

An Examination of Disgust and Self-Disgust in Eating Disorders

Submitted to: European Eating Disorders Review

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6.1 Abstract

This study explored experiences of disgust and self-disgust among individuals with eating disorders. While past research has implicated high disgust sensitivity among individuals with anorexia and bulimia nervosa, this study extended investigations to other variants of disgust, including disgust directed towards the body and self. Individuals with mixed eating disorder diagnoses (n=68), a healthy control sample (n=68) and two clinical comparison groups (major depressive disorder, n=64; social phobia, n=54) completed self-report measures of disgust sensitivity, disgust propensity and self-disgust. Contrary to prediction, the eating disorder group failed to report higher levels of disgust sensitivity and propensity in comparison to the healthy control group or other clinical groups. However, the eating disorder group reported the highest levels of self-disgust, followed by the clinical comparison groups, when compared to the healthy control sample. No differences in self-disgust emerged between specific eating disorder diagnoses. This study is one of the first to establish the presence of high self-disgust, including disgust at the body, among individuals with eating disorders. Future studies may wish to consider the role of self-disgust in core clinical behaviours such as such as restriction, purging and body viewing avoidance.

6.2 Introduction

Disgust is a universal, basic emotion characterised by a visceral experience of revulsion and aversion. It is associated with a distinct facial expression and is typified by rejection and avoidance behaviours. While Charles Darwin's preliminary account of disgust exclusively linked the emotion with food and eating, reflecting disgust's phylogenetic roots as a method of pathogen avoidance, modern researchers have broadened understandings of typical disgust elicitors (Rozin & Fallon, 1987; Haidt, McCauley & Rozin, 1994; Tybur, Lieberman & Griskevicius, 2009). Paul Rozin and his colleagues identified a number of disgust 'domains' such as animals, body products and death (Rozin & Fallon, 1987), which tend to elicit distinct qualia characterised by revulsion and abhorrence, and cognitions associated with the potential for contamination. Feelings of disgust can also be elicited through the violation of certain moral codes and cultural norms, a variant known as socio-moral disgust. The border between the self and other/non-self also becomes prominent in experiences of disgust; the emotion has sentinel function designed to protect the self from outside contamination and 'other-ness', both physically and morally.

Disgust has been implicated as a relevant emotion in a number of clinical conditions, including OCD, specific phobias and more recently, in eating disorders. Previous investigators have found increased levels of disgust across varying eating disorder diagnoses in comparison to non-clinical control samples (Aharoni & Hertz, 2012; Troop, Murphy, Bramon, & Treasure, 2000; Troop, Treasure, & Serpell, 2002), including atypical disgust responses to eating disorder-relevant stimuli such as food, the body and/or body products (Griffiths & Troop, 2006; Troop et al., 2000).

Past studies have typically focussed on assessing levels of disgust *sensitivity*, which can be defined as the intensity or strength of a disgust response (likened to anxiety sensitivity). The Disgust Scale (Haidt, McCauley & Rozin, 1994) is a self-

report questionnaire that assesses the strength of disgust responses to specific disgust elicitors (e.g. “How comfortable would you feel touching a dead body?”). The scale has been previously used to identify high disgust sensitivity among individuals with eating disorders (Aharoni & Hertz, 2012; Troop et al., 2000). However, further explorations of specific disgust constructs have reliably distinguished between disgust sensitivity and disgust *propensity*, which refers to the frequency of disgust experiences (van Overveld, De Jong, Peters, Cavanagh, & Davey, 2006), thus promoting the need to investigate these constructs separately. This has led to the development of an alternative self-report measure, the Disgust Propensity and Sensitivity Scale (DPSS-R), which assesses both constructs independent of specific disgust elicitors (e.g. “Disgusting things make my stomach turn”; Cavanagh and Davey, 2000). The DPSS-R has been subsequently used to assess disgust experiences among those with contamination fears (Cisler, Olatunji, Feldner, & Forsyth, 2010; Olatunji et al., 2007) spider phobia, and blood, injury/injection fears (Olatunji et al., 2007), with high disgust propensity identified as a unique predictor of these symptoms. However, no study has considered disgust sensitivity and propensity as distinct constructs in relation to eating disorders.

6.2.1 Self-disgust

Despite growing interest in the role of disgust in psychopathology, the construct of self-disgust remains a relatively little researched emotion. Until recently, definitions of self-disgust in the literature were varying and often conflated with other ‘self-conscious’ emotions such as shame and guilt (Powell, Simpson, & Overton, 2015; Power & Dalgleish 2007; Tracy & Robins, 2007). More comprehensive definitions characterise self-disgust as a dysfunctional extrapolation of the adaptive disgust response (Powell, Simpson, & Overton, 2013), where aspects

of the self, the body and/or one's behaviours become enduring sources of revulsion and abhorrence (Powell et al., 2015).

Initial research of self-disgust has primarily focused on major depressive disorder. Overton, Markland, Taggart, Bagshaw and Simpson (2008) identified high levels of self-disgust among individuals with depression using a newly developed self-report measure (the Self-Disgust Scale). Self-disgust has since been identified as a relevant antecedent to depressive symptoms (Powell et al., 2013), and a potential target for depression treatment (Powell, Overton, & Simpson, 2014). A recent study conducted by Ille et al. (2014) examined self-disgust levels among a range of mental health conditions including major depressive disorder, schizophrenia, borderline personality disorder and eating disorders. Collectively, individuals in these clinical groups displayed elevated levels of self-disgust in comparison to a healthy control sample. Further, individuals with eating disorders, along with those with borderline personality disorder, reported the highest levels of self-disgust.

Based on these preliminary findings, self-disgust may be of specific relevance in eating disorders. Expressions of disgust or revulsion at the body and self are commonly reported among individuals with eating disorders, and are thought to relate to central eating disorder characteristics such as body dissatisfaction and negative body image (Espeset, Gulliksen, Nordbø, Skaarderud, & Holte, 2012; Fox, 2009; Polivy & Herman, 2002; Troop & Baker, 2009). In a qualitative investigation of negative emotionality in eating disorders, Espeset, Gulliksen, Nordbo, Skaarderud and Holte (2012) identified frequent expressions of disgust at the self and body among a sample of individuals with anorexia nervosa. These expressions of disgust also appeared to precede restriction and compensatory behaviours, supporting the possibility that feelings of revulsion at the self may play a role in triggering specific

eating disorder symptoms. In light of the findings to date, further investigation of self-disgust in eating disorders appears needed.

6.2.2 The current study

While past studies have typically focussed on disgust responses to specific external stimuli, the current study was designed to expand investigations to other variants of disgust. An initial aim was to examine externally directed disgust in eating disorders, exploring disgust sensitivity and propensity as separate constructs. As high disgust sensitivity has been previously identified among individuals with eating disorders (Aharoni & Hertz, 2012), a consistent finding was predicted in the current study. It was also anticipated that propensity to experience disgust would be elevated in comparison to non-clinical control subjects.

The second aim of this study was to examine levels of self-disgust based on emerging evidence highlighting the potential relevance of this emotion in eating disorders (Ille et al., 2014). This study also expanded on Ille et al.'s (2014) investigation by exploring potential differences between specific eating disorder diagnoses (Anorexia Nervosa and Bulimia Nervosa) using a self-report scale designed to assess disgust at the body and self. In a previous study (Moncrieff-Boyd, Allen, Byrne & Nunn, 2014), Overton et al.'s (2008) Self-Disgust Scale was modified and successfully validated, with additional items included to assess specific 'body disgust' thought to be potentially relevant in eating disorders. This modified version of the scale was used in the current study. It was predicted that individuals with eating disorders would display elevated levels of self-disgust in comparison to a non-clinical control sample.

Along with a non-clinical control sample, a sample of individuals with major depressive disorder and social phobia were included as clinical comparison groups.

The relevance of self-disgust in major depressive disorder has been established in previous investigations (Overton, Markland, Taggart, Bagshaw, & Simpson, 2008; Powell et al., 2013; Simpson et al., 2010), with disgust at one's body and physical appearance also prominent among this clinical group (Powell et al., 2015). There have also been indications that social phobia may involve feelings of self-disgust (Gilbert, 2000; Olatunji & McKay, 2007), potentially relating to perceived negative evaluation and self-conscious negative emotion. It was expected that individuals with these conditions would exhibit higher self-disgust than healthy controls, but possibly to a lesser extent than those with eating disorders.

6.3 Methods

6.3.1 Participants

Females with clinically diagnosed eating disorders (n=68) were recruited from the Centre for Clinical Interventions, a public treatment centre in Perth, Western Australia. This group included individuals with a range of eating disorder diagnoses, including anorexia nervosa (AN; n=16), bulimia nervosa (BN; n=35) and other specified feeding or eating disorder (OSFED; n=17). Females with major depressive disorder (n=64) and social phobia (n=58) were recruited from the same site. All diagnoses were based on a Mini International Neuropsychiatric Interview 6.0, and made according to DSM-5 criteria. Consecutive referrals to the service were asked to participate and completed the study's questionnaires as part of a larger battery of questionnaires prior to treatment. The non-clinical control sample consisted of 68 female participants recruited from an undergraduate psychology course at the University of Western Australia. All participants from both sites were provided with information sheets and consent forms.

6.3.2 Materials

Self and Body Disgust Scale (SBDS; Overton et al., 2008)

The SBDS assesses the presence of self-disgust (see Appendix B; Moncrieff-Boyd et al., 2014). Validation of the original scale indicated that it has excellent internal consistency and test-retest reliability, and correlates with other measures of externally directed disgust (Overton et al., 2008). This study used the revised SBDS version, which was modified and validated in a previous study (Moncrieff-Boyd et al., 2014). The scale was developed and modified in order to assess visceral revulsion at the self (e.g. “I find myself repulsive”), the body (e.g. “Parts of my body are foul”), and one’s behaviours (e.g. “I often do things I find revolting”). Excellent internal consistency of this revised SBDS was established ($\alpha=.90$), as well as adequate test-retest reliability ($r=.73$; Moncrieff-Boyd et al., 2014). The revised version of the scale comprises 16 items constructed on a Likert scale (1=strongly agree, 7= strongly disagree). Scores can range from 10 to 70, with higher scores indicating greater levels of self-disgust.

The Disgust Sensitivity and Propensity Scale-Revised (DPSS-R; van Overveld et al., 2006)

The DPSS-R is a 12-item self-report measure designed to assess the distinct constructs of disgust sensitivity and disgust propensity. The original version was translated to English and revised by Olatunji et al. (2007). Validation of the revised version demonstrated excellent internal consistency (Cronbach’s $\alpha=.90$). Items are responded to on a scale ranging from 1 (“never”) to 5 (“always”). Sub-scores for Disgust Sensitivity and Propensity are calculated separately.

Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994).

The Eating Disorder Examination Questionnaire is a 28 item self-report questionnaire that assesses the presence of cognitive and behavioural symptoms commonly featured in eating disorders (Fairburn & Beglin, 1994). The questionnaire includes 22 items which are responded to using a seven level rating choice. These items make up four subscales assessing weight concern, shape concern, eating concern and dietary restraint experienced over the past 28 days. A global EDE-Q score (ranging from 0-6) was calculated from an average of the four subscale scores.

Rosenberg Self-Esteem Scale (Rosenberg, 1965)

The Rosenberg Self-Esteem scale is a widely used self-report measure that investigates global attitudes towards the self. It consists of 10 items constructed on a 4 point Likert scale ranging from *strongly agree* to *strongly disagree*.

6.3.3 Procedure

Participants in the clinical groups completed pencil and paper versions of questionnaires as part of a larger clinical battery. Individuals in the non-clinical control group completed online versions of the questionnaires. The complete questionnaire battery took 20-30 minutes to complete. All questionnaires were administered in a fixed order (DPSS-R, SBDS, Rosenberg Self-Esteem Scale, EDE-Q).

6.3.4 Statistical analysis

An Analysis of Variance with planned contrasts was used in order to compare group differences in self-disgust, disgust propensity and disgust sensitivity. Criteria for analysis of covariance (ANCOVA) were met for clinical groups only, as self-esteem was found to significantly differ between the control group and clinical groups, and could not be entered as a covariate in the main analysis of group differences in SBDS scores (Miller & Chapman, 2001). Thus, an analysis of

covariance (ANCOVA) with self-esteem scores as a covariate was conducted between clinical groups (eating disorders, major depressive disorder and social phobia) only.

Two participants from the non-clinical control group and one from the social phobia group were removed due to incomplete data. Three cases were identified as outliers and removed for the subsequent analysis.

Examination of Shapiro-Wilk scores and Q-Q plots indicated that some variables were non-normally distributed (disgust sensitivity subscale scores and DPSS-R Total scores for social phobia and eating disorder groups, and SBDS total scores in the non-clinical control group). However, as ANOVA is robust to violations of normality, it was determined that this method of analysis remained appropriate. Homogeneity of variance was assessed using Levene's statistic. As this assumption was violated for several cases, Welch's F statistics were used for relevant variables.

An A priori power analysis was conducted using the GPower software package (Faul & Erdfelder, 1998). Based on this analysis, the total sample size (N=258) was sufficient in order to obtain a 90% chance of detecting a moderate effect size (Cohen's d of .4; Cohen, 1992) between groups as significant at the .05 level.

6.4 Results

Age demographics for all participants are reported in Table 5. A significant between-group difference in age was identified, $F(3, 247)=45.50, p<.001, \eta_p^2=.36$. Planned contrast results are also presented in Table 5. The non-clinical group was significantly younger than all clinical groups, and significant age differences also emerged between clinical groups.

Table 5. Mean Age for non-clinical control, eating disorder, major depressive disorder and social phobia groups.

	Non-Clinical Control M(SD)	Eating Disorder M(SD)	Major Depressive Disorder M(SD)	Social Phobia M(SD)
Age	18.39 (2.45) ^a	23.85(6.93) ^b	36.78(14.41) ^c	31.59(11.19) ^d

^{a.b.c.d} Contrasts revealed significant group difference at .05 level

6.4.1 Disgust sensitivity and propensity

Significant between-group differences were identified for the DPSS-R total score, Welch's $F(3,131.99)=2.81$, $p<.05$. $\omega^2= .02$, and the disgust propensity subscale, Welch's $F(3,132.95)= 5.03$, $p<.01$ est. $\omega^2= .05$. Contrary to prediction, planned contrasts revealed higher DPSS-R total scores in the non-clinical sample in comparison to all clinical samples, $t(175.13)=-3.65$, $p<.001$, $d=-.55$, $r=.27$. The same pattern was identified for the disgust propensity subscale, $t(178.96)= -4.76$, $p<.001$, $d=-.71$, $r=.33$. No significant differences emerged on the disgust sensitivity subscale, $F(3,245)=.79$, $p=.50$. No group differences emerged between the eating disorder, social phobia or depression groups on the DPSS-R total or subscale scores.

Spearman's correlations were calculated between scores on the SBDS and the DPSS-R total and subscale scores. Correlations between the SBDS and the DPSS-R total scores approached significance, $r_s=.12$, $p=.05$. A significant correlation between SBDS scores and the disgust sensitivity sub-scale was identified, $r_s=.21$, $p<.01$. However, the SBDS did not correlate with the disgust propensity subscale, $r_s=.04$, $p=.56$.

6.4.2 Self-disgust

Means and standard deviations for all measures are provided in Table 6, arranged by group status.

A significant group difference was identified for scores on the SBDS, Welch's $F(3, 135.09) = 43.18$, $p < .001$ est. $\omega^2 = .33$. Planned contrasts indicated that the non-clinical control group had significantly lower self-disgust scores in comparison to the combined clinical groups, $t(154.50) = -11.19$, $p < .001$, $d = .80$, $r = .67$. Further, the eating disorder group reported higher scores in comparison to depression and social phobia groups, $t(113.20) = 2.65$, $p < .001$, $d = .50$, $r = .24$. No difference in scores was identified between depression and social phobia groups, $t(114.60) = -1.50$, $p = .14$.

Two items were included in the scale to assess the presence of 'body disgust', which was thought to be potentially specific to individuals with eating disorders. Differences in these specific items were examined between clinical groups. For item 6 ("Parts of my body are foul"), a significant group difference was identified, Welch's $F(2, 135.2) = 4.01$, $p = .02$ est. $\omega^2 = .03$, with planned contrasts revealing higher scores in the eating disorder group in comparison to depression and social anxiety groups, $t(118.64) = 2.71$, $p < .01$, $d = .50$, $r = .24$. For item 13 ("It sickens me to look at myself"), a significant difference was also identified, $F(2, 210) = 5.70$, $p < .01$, $\eta_p^2 = .05$, with planned contrasts also indicating higher scores in the eating disorder group in comparison to depression and social anxiety groups, $t(210) = 2.81$, $p < .01$, $d = .52$, $r = .25$.

A significant, positive correlation between scores on the SBDS and Rosenberg Self-Esteem Scale was obtained, $r = .66$, $p < .001$. Thus, scores on the Rosenberg Self-Esteem Scale were entered as a covariate in the comparison between clinical groups only (eating disorder, depression and social phobia). A significant difference in levels of self-disgust persisted, $F(2, 182) = 10.95$, $p < .001$, $\eta_p^2 = .11$.

Table 6. Means and standard deviations for control and clinical groups (eating disorders, major depressive disorder and social phobia) on self-report measures of disgust propensity, sensitivity and self-disgust.

	Control	Eating Disorder	Major Depressive Disorder	Social Phobia
DPSS-R	31.82(5.26) ^a	28.29(9.38) ^b	30.37(8.64) ^b	30.15(6.26) ^b
Propensity	17.85(2.77) ^a	15.42(5.21) ^b	16.49(4.37) ^b	16.45(2.83) ^b
Sensitivity	13.97(3.85) ^a	12.86(5.04) ^a	13.88(5.07) ^a	13.70(4.25) ^a
SBDS	25.90(8.70) ^a	44.50(13.40) ^b	40.75(10.71) ^c	37.73(10.56) ^c

^{a,b,c.} Contrasts revealed significant group difference

6.4.3 Comparisons between eating disorder diagnoses

Scores on the SBDS and DPSS-R were examined by diagnosis (AN, BN, OSFED) among individuals in the eating disorder group. No significant differences emerged on the SBDS, $F(2,65)=1.37$, $p=.26$. Similarly, on the DPSS-R, no group differences were identified for the total scores, $F(2,64)=.21$, $p=.81$, disgust propensity subscale scores, $F(2,64)=.127$, $p=.88$, or disgust sensitivity subscale scores, $F(2,64)=.96$, $p=.39$.

6.5 Discussion

This study investigated experiences of disgust and self-disgust among individuals with eating disorders. This is one of the first studies to explore self-disgust using a self-report scale modified to assess disgust at the self, the body and physical appearance, while also considering distinct components of externally-directed disgust in the form of sensitivity and propensity. Along with a non-clinical control group, two clinical samples (depression and social phobia) were included as comparison groups.

6.5.1 Disgust sensitivity and propensity

No differences in levels of disgust sensitivity were identified between eating disorder, non-clinical control and clinical comparison groups. This result contrasts with findings of other studies that have found increased disgust sensitivity among individuals with AN and BN, particularly in response to stimuli such as food and the body (Aharoni & Hertz, 2012; Troop et al., 2000, 2002). However, past studies have utilised alternative self-report scales that assess responses to specific disgust stimuli (i.e. The Disgust Scale), as opposed to the stimuli-independent scale employed in the current study. The variation in means of self-report measurement potentially account for the conflicting findings between the current and previous studies. However, it is similarly possible that elevated disgust sensitivity is not a feature of eating disorders outside specific, disorder-relevant stimuli. Further investigation is necessary in order to clarify such inconsistent findings.

Also counter to prediction, disgust propensity was higher in the non-clinical control sample than in all clinical groups. No difference in disgust propensity was identified between the eating disorders, depression and social phobia groups. The reduced external disgust propensity responses among clinical groups in this study

could reflect a general reduction in external experiences of disgust, possibly in favour of self-directed disgust responses. As previously stated, external disgust responses may only be elevated in relation to specific stimuli; in the case of eating disorders, the body and/or food. Furthermore, a reduction in the frequency of disgust experiences among eating disorder samples could be the result of ongoing exposure to disgusting stimuli (i.e. exposure to food, the body, body products as part of treatment). It is also possible that the increased disgust sensitivity identified in previous studies (Aharoni & Hertz, 2012) results in greater avoidance of situations and stimuli likely to induce disgust, thus reducing the overall frequency of disgust experiences. It should also be noted that the effect sizes for these differences were relatively small, and replication of these results is necessary in order to provide further verification of the nature of external, stimulus-independent disgust experiences in these clinical groups. Nevertheless, these findings suggest the possibility of specificity in regard to disgust responses in eating disorders, in favour of disorder-relevant stimuli, the self and the body.

6.5.2 Self-disgust

Individuals in the eating disorder group displayed the highest levels of self-disgust, with no significant differences identified between eating disorder diagnostic groups (AN, BN, OSFED). Individuals with depression and social phobia also exhibited increased self-disgust in comparison to non-clinical controls, but to a lesser extent than the eating disorder group. These results are consistent with previous evidence highlighting self-disgust as a relevant emotion in a number of psychological conditions, but particularly in eating disorders (Espeset et al., 2012; Ille et al., 2014). These findings also build on a previous investigation that administered the SBDS to a sample of undergraduate students (Moncrieff-Boyd et al., 2014), where levels of self-

disgust positively correlated with eating disorder symptomatology. When examining specific items on the SBDS assessing disgust at the body, the eating disorder group displayed higher scores than both depression and social phobia groups. This difference is consistent with suggestions that ‘body disgust’ may be more relevant in eating disorders in comparison to other clinical groups (Fox & Power, 2009).

When self-esteem was accounted for in the group comparisons, a significant difference between scores persisted. Despite the strong correlation between self-esteem and self-disgust, self-esteem did not account for clinical group differences in self-disgust. This is also in line with previous findings that identified low self-esteem and self-disgust as distinct constructs (Simpson et al., 2010), with self-esteem likely reflecting a global attitude towards the self, and self-disgust representing a distinct emotional state.

The above results have potential implications for eating disorder research and practice. While the function of self-disgust in eating disorder psychopathology remains unclear, it is possible that the emotion closely relates to specific eating disorder symptomatology, with the potential to motivate behaviours such as restriction and purging (Espeset et al., 2012). Common behavioural correlates of disgust may also manifest as self-rejection and avoidance behaviours such as mirror evasion and dissociation. Self-disgust has also been implicated in several aetiological models of AN (Moncrieff-Boyd, Byrne & Nunn, 2014; Nunn, Frampton & Lask, 2012). Specifically, it is possible that altered experiences of the bodily self, underpinned by altered interoceptive sensitivity, could give rise to a sense to ‘wrongness’ or ‘other-ness’, leading to self-disgust. Further investigation of the relationship between self-disgust and poor interoceptive awareness might provide an avenue for future research attempting to understand altered physical and emotional responses to the self in AN in particular.

The current study's findings also have potential implications in regard to eating disorder treatment. While past researchers have highlighted the need to address disgust responses towards food (Aharoni & Hertz, 2012), it may be similarly necessary to address disgust directed at the patient's body and broader sense of self. Espeset et al. (2012) argue that the concept of body dissatisfaction as it is known and applied to eating disorders may be an oversimplification of more complex, emotional responses to the body, and highlight the potential relevance of self-disgust in this response. It may prove important to disentangle these affective experiences in a clinical context, in order to deepen understandings of an individual's relationship with their own body and self. Moreover, food, representing the to-be-incorporated self, is a medium that has the potential to influence the experience of body and, by extension, the broader self. Thus, food restriction may become a way to modulate experiences of self-disgust (Moncrieff-Boyd, Byrne et al., 2014). Clearly, the role of self-disgust in eating disorders is likely to be heterogeneous and complex, and worthy of exploration in both a research and clinical context.

Findings in the depression and social phobia groups also correspond with previous investigations conducted by Overton et al. (2008) and Powell et al. (2014), who have consistently identified high self-disgust among individuals with major depressive disorder. Powell et al. (2014) have since conceptualised self-disgust in depression as an emotion schema, representing an enduring, developmentally influenced attitude towards the self. Alanazi, Powell and Power (2015) also proposed an explanatory model of depression that identifies self-disgust as a central emotional experience that, paired with sadness, leads to a depressive state. Accordingly, other relevant emotions such as shame, embarrassment and guilt represent emotional derivatives of disgust, which are directed at specific behaviours or aspects of self. Alanzi et al.'s (2015) model is based on the Schematic Propositional Analogical and

Associative Representation Systems (SPAARS) theory of emotion generation (Power & Dagleish), which highlights reciprocal coupling of emotions in the pathogenesis of various psychological conditions. The SPAARS theory has also been extended to eating disorders, describing a pairing between disgust and fear as underlying emotions in the conditions.

While the relevance of self-disgust has been previously established in relation to depression, this is the first study to identify elevated self-disgust in a sample of individuals with social phobia. Related self-conscious emotions such as shame have been associated with negative self-evaluations and negative appraisals of the self, which are thought to influence beliefs of inferiority and submissive behaviour that tend to characterise the condition (Gilbert, 2000). It is possible that self-disgust occupies a similar role, potentially linked to self-beliefs that reinforce fears associated with negative social evaluation. However, further exploration will be necessary in order to fully elucidate the role of self-disgust in social phobia.

6.5.3 Limitations and future directions

Several limitations of this study should be noted. First, this investigation employed self-report methods of emotion assessment. As such, responses to measures of disgust sensitivity, propensity and self-disgust will be influenced by variation in subjective emotional experiences. Secondly, the clinical and healthy groups were not matched in regard to age, with the control group significantly younger than all clinical groups. Powell, Overton and Simpson (2013) identified a small yet significant effect of age on self-disgust scores ($r_s = -.19$), suggestive of a potential decline in self-disgust scores as age increases. It is unclear whether age would influence levels of externally directed or self-disgust among participants in the current study; the age differences were likely attributable to the use of undergraduate

university students as a control sample. Future studies may need to account for potential age differences in future studies by recruiting a control sample of greater heterogeneity. Thirdly, the presence of comorbid depression and social phobia among the eating disorder group in this study was unavoidable, due to the high rate of depression among individuals with eating disorders. However, it was assumed that any theoretically increased effects of eating disorder symptomatology would still distinguish this group from the depression group in regard to levels of self-disgust.

Future studies may wish to clarify the role of self-disgust in relation to eating disorders, considering it as a potential emotional motivator of specific eating disorder behaviours. This could be achieved by comparing SBDS scores across behavioural rather than diagnostic groups (I.e. examining bingeing and purging versus restricting over-exercising groups). Such investigation was outside the remit of the current study, but may provide further information regarding the specific function of self-disgust in eating disorder symptomatology. Overton et al. (2008) highlighted self-disgust as a mediator of dysfunctional cognitions and depressed mood; the possible mediating or moderating role of self-disgust could also be considered within eating disorders. Addressing negative emotional responses to the body and self, including feelings of self-disgust, may also prove a relevant avenue for clinical intervention in eating disorders. More broadly, this study highlights self-disgust as an emotion of interest, distinct from general concepts such as self-esteem and also independent from other externally directed experiences of disgust. As such, continued investigation of this emotion and its relevance in clinical conditions, particularly eating disorders, appears warranted.

Chapter 7: Transcranial Magnetic Stimulation as a Novel Method of Disgust Measurement

7.1 Chapter Overview and Goals

This chapter will provide an overview of the physiological and neural basis of facial expressions evoked by emotion, with particular focus on the expression of disgust. A description is then provided of a novel psychophysiological tool that is employed in the final study included in this thesis. Transcranial Magnetic Stimulation (TMS) is introduced as a tool of interest, and the function and background of this tool is discussed. This chapter will consider the evidence in support of TMS as a means of assessing corticomotor excitability associated with facial expressions of emotion, specifically disgust. The details considered in this chapter provide a comprehensive background and rationale for the final study included in Chapter Eight, which involves the use of TMS as a means of measuring facial expressions of disgust.

7.2 The Facial Expression of Disgust

The work of Paul Ekman exploring the existence of cross-cultural facial expressions established the likelihood of universal signals of emotion. His research built on the seminal ideas expressed by Charles Darwin in *The Expression of Emotion in Man and Animals* (1878/2002) that considered the evolutionary and phylogenetic basis of emotion and emotional expression. Ekman (1969; 1992) went on to establish the existence of cross-cultural displays of specific facial movements and expressions, which appear to be indicative of the innate, universal nature of

certain emotions (Izard, 1994). Disgust represents one of the expressions found to be universally identifiable (Ekman, 1980; Ekman et al., 1969). Facial signals of disgust are typified by a wrinkling of the nose, the raising of the upper lip, and sometimes the protrusion of the tongue (Darwin, 2002; Rozin & Fallon, 1987). An example of the disgust facial expression can be seen in Figure 1. It is thought that this expression facilitates the avoidance of offensive odours and the expulsion of offensive items from the mouth (Rozin & Fallon, 1987).



Figure 1. Disgust facial expression

A body of research has used Ekman's work to establish understandings of the facial muscles involved in particular expressions of emotion. Ekman and Friesen (1976) created a Facial Action Code that could be used to analyse facial movements, including those indicative of emotional expression. Progress in the use of facial electromyography (EMG; Fridlund & Cacioppo, 1986) has also enabled the measurement of activity in muscles associated with particular facial expressions. A particular muscle thought to produce the "disgusted" face is the *levator labii superioris*, which is located alongside the nose, elevating the upper lip (see Figure 2; Vrana, 1993). Another muscle also implicated in the disgust facial expression is the *corrugator supercilii*, which is located above the eyebrows, drawing them downward. This muscle is activated in a number of facial expressions of negative

valence, including disgust, fear and anger (Vrana, 1993). The measurement of activity in both the levator labii and corrugator supercilii has subsequently been applied in research as a means of measuring the expression of disgust (Borg, de Jong, & Schultz, 2010; Stark, Walter, Schienle, & Vaitl, 2005; Wolf et al., 2005; Yartz & Hawk Jr, 2002).

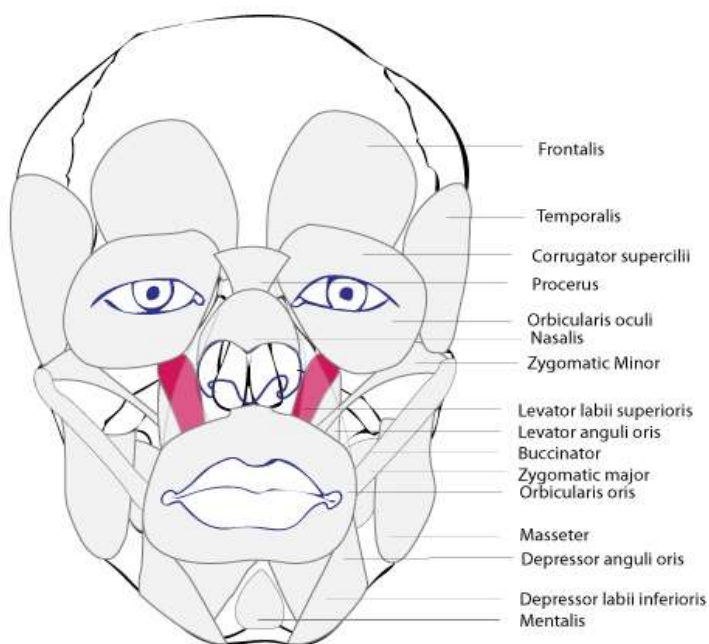


Figure 2. Levator Labii Superioris muscle (Human Muscular System, 2012)

7.3 The Representation of Facial Muscles in the Motor Cortex

Research in humans and primates has described the projections from the primary motor cortex (M1) to brainstem motor neurons that in turn project to facial muscles (Huang, Hiraba, & Sessle, 1989; Jenny & Saper, 1987; Paradiso, Cunic, Gunraj, & Chen, 2005). M1 is located anterior to the central sulcus, and contains a representation of the muscles in the body, also known as the ‘motor homunculus’.

Corticobulbar¹ projections from the facial area of the motor cortex extend to the brainstem and innervate muscles in the face, neck and head. Stimulation of facial areas in M1 is found to elicit a contraction in the corresponding contralateral facial muscle (Kobayashi, Théoret, Mottaghy, Gangitano, & Pascual-Leone, 2001; Pilurzi et al., 2013; Rinn, 1984). Upper facial muscles (those above the eyes) are consistently shown to receive bilateral cortical inputs (Benecke, Meyer, Schönle, & Conrad, 1988; Jenny & Saper, 1987). However, there is mixed evidence as to whether lower facial muscles are bilaterally innervated, or whether they receive contralateral inputs only (Benecke et al., 1988; Jenny & Saper, 1987; Kobayashi et al., 2001; Paradiso et al., 2005; Triggs, Ghacibeh, Springer, & Bowers, 2005). The facial area in M1 is implicated in pathways involved in both voluntary and spontaneous, emotional facial expressions (Hopf, Müller-Forell, & Hopf, 1992; Iwase et al., 2002; Korb, Grandjean, & Scherer, 2008; Morecraft, Louie, Herrick, & Stilwell-Morecraft, 2001; Rinn, 1984).

7.4 Transcranial Magnetic Stimulation

Transcranial Magnetic Stimulation (TMS) is a neurophysiological tool that stimulates cortical neurons using electromagnetic induction. TMS is administered via a device containing a conductive coil, which is connected to an electrical generator system. The coil is placed against the head and discharged to produce a transient magnetic field that permeates non-conductive tissue (scalp and skull). Cortical stimulation occurs as a result of depolarisation of cortical tissue located below the stimulation site, which excites output neurons through a network of interneurons in

¹ The corticobulbar tract is the pyramidal tract that controls movement in the face, neck and head. The corticospinal tract controls torso and limb movement. The term 'corticomotor' is used to refer to corticobulbar and/or corticospinal excitability.

the motor cortex (Groppa et al., 2012). The intensity of the magnetic current produced by the coil determines the strength of the stimulation.

The effect of TMS is influenced by a number of factors that affect tissue depolarisation. These include the position and spacing of neurons in the target cortical area (Groppa et al., 2012), and the positioning and orientation of the coil on the skull. The depth of penetration of the magnetic field produced decreases with distance from the coil. Therefore, neural structures that are located sub-cortically cannot be directly activated by TMS, but can be excited via secondary trans-synaptic effects. Individual differences in cortical structure and architecture also influence the optimal location of the TMS coil, as well as the intensity needed for effective stimulation (Groppa et al., 2012). For example, the position of target locations within cortical folds (sulci and gyri) will influence the intensity of the field needed to elicit excitation.

In psychophysiology research, TMS is frequently used to activate areas in the primary motor cortex, resulting in a burst of muscle activity, or motor evoked potential (MEP). MEPs can be recorded with surface electrodes over a target muscle and provide a measure of resulting muscle activity following TMS. MEP amplitude (size) provides a measure of excitability of the relevant corticomotor system, and the latency provides a measure of transmission time, determined by the length of the projection. MEP amplitude is a sigmoidal function of TMS intensity, and increases from threshold to an asymptote. Conversely, MEP latencies are fixed, and determined by synaptic path length and synaptic density (Groppa et al., 2012).

7.5 Recording MEPs from Facial Muscles

While experimental TMS studies have traditionally focused on muscular activity elicited in areas such as the hand, TMS has also been used, albeit to a lesser

extent, to assess the corticomotor excitation of facial areas. Specifically, TMS of the facial region in M1 evokes an MEP in the target facial muscle. This MEP can then be used to measure excitability of the corticobulbar projection. Facial muscles including the nasalis (Dubach, Guggisberg, Rösler, Hess, & Mathis, 2004), the orbicularis oris (Cruccu, Inghilleri, Berardelli, Romaniello, & Manfredi, 1997; Paradiso et al., 2005) and the levator labii (Laskawi, Damenz, Roggenkämper, Schröder, & Brauneis, 1990) are thought to be appropriate target muscle regions for TMS, while other areas are thought to risk interference due to diffuse muscle fibres as a result of close anatomical proximity (Groppa et al., 2012).

Evoking measurable MEPs in facial muscles is technically more difficult than in other muscles, such as those of the upper limb and hand. The facial region of M1 can vary in regard to location, increasing the difficulty identifying optimal coil positioning on the skull. TMS of facial areas often require a higher threshold intensity in order to elicit MEPs. Further, the production of consistent MEPs in a target facial muscle can be difficult to elicit when the muscle is relaxed, and voluntary contraction of the muscle is often required in order to elicit a response. A number of studies have failed to produce facial MEPs without voluntary muscle activation (Cattaneo & Pavesi, 2014; Rödel, Laskawi, & Markus, 1999) although some have had more success with muscles remaining at rest (Pilurzi et al., 2013). It is possible that such variability is influenced by the selection of specific facial muscles, the positioning of the TMS coil (Dubach et al., 2004; Rödel et al., 1999) or the upper threshold of stimulation used across studies (Pilurzi et al., 2013).

Previous studies using TMS of facial regions, have identified MEPs that are characterised by 3 components. A *short-latency* component is observable in some subjects at a latency <6 milliseconds (ms), and results from stimulation of peripheral nerves in the scalp, rather than a cortically generated response (Dubach et al., 2004;

Rödel et al., 1999). A second, *middle-latency* component with a typical onset of 11-14ms after the TMS pulse occurs as a response to excitation of the facial motor cortex (Cattaneo & Pavesi, 2014; Dubach et al., 2004; Rödel et al., 1999). Finally, a third, cortically generated *long-latency* component has also been identified in some subjects, and can occur >20-30 ms after the initial TMS pulse, with some temporal overlap with the middle latency responses (Rimpiläinen, Karma, Eskola, & Häkkinen, 1992; Rödel et al., 1999). This 3-component pattern of facial MEPs has been observed in ipsilateral and contralateral responses to the site of stimulation (Pilurzi et al., 2013). While the presence of specific components typically remains consistent within individuals, there is a level of variability across individuals, particularly for short and long latency components (Cattaneo & Pavesi, 2014; Dubach et al., 2004; Pilurzi et al., 2013; Rimpiläinen et al., 1992).

7.6 The Use of TMS in the Measurement of Corticospinal Excitability Associated with Emotion

TMS has been used in affective research as a means of detecting corticomotor activity indicative of defensive action preparation (Baumert, Sinclair, MacLeod, & Hammond, 2011; Coombes et al., 2009; Hortensius, de Gelder, & Schutter, 2016). Experiences of negative emotion such as fear are thought to activate corticomotor (specifically corticospinal) regions involved in defensive motor activity, such as movement that facilitates avoidance (Izard et al., 1994). Thus, a number of studies have used TMS to measure corticospinal excitability during exposure to negative emotional stimuli. Coombes et al. (2009) identified greater corticospinal excitability during exposure to unpleasant than neutral images, using MEP amplitude as an indicator of the strength of corticospinal activation. Baumert, Sinclair, McLeod and Hammond (2011) also identified increased modulation of corticospinal activity

during auditory exposure to negative emotional stimuli, with negligible effects observed during positive emotion conditions. A recent study also extended such investigations to an exploration of threat-related defensive responses during emotion perception (Hortensius et al., 2016). Corticospinal activity was found to increase during the perception of anger, over and above the perception of fearful or neutral expressions. Again, these results point to the likelihood of defensive motor activation during experiences of negative emotion, including increased corticospinal activity, likely originating in M1. Collectively, these studies also demonstrate the potential utility of TMS as a method of assessing activation of corticomotor areas involved in the expression, and perception of emotion

7.7 A Basis for TMS as a Means of Measuring Corticomotor Excitability Associated with Facial Expressions of Emotion

Based on findings supporting the utility of TMS as a means of measuring activity of motor outputs to facial muscles via stimulation of M1, it is possible that it could be used to measure corticomotor activity associated with facial expression. As described above, TMS has been used as a means of gauging modulated corticomotor effects of emotional responses, albeit focusing on corticospinal activity as an indicator of action preparation in response to threat (Baumert et al., 2011; Hortensius et al., 2016). Thus, it is possible that under emotion-inducing conditions, activity in the corticobulbar pathways involved in emotional facial expressions, as measured by the amplitude of MEPs, would be augmented in comparison to neutral conditions. For example, during experiences of disgust, excitability of the corticobulbar system would be increased in association with the preparation for producing an emotionally-congruent facial expression. This cortical recruitment, paired with activation of M1 generated by TMS, would result in augmented excitation of neuronal outputs

extending to the target muscle implicated in a disgust expression (i.e. the levator labii). The subsequent MEP elicited by the target muscle would be greater than during neutral conditions.

Based on this, the final study in this thesis explored potential utility of TMS as a means of assessing activation of cortical circuits associated with the facial expression of disgust, with specific focus on the levator labii. It is hoped that this study will provide an indication of the potential utility of TMS in broader emotion assessment research, as well as provide further knowledge of TMS of facial regions, including its ability to target specific, emotion-relevant facial muscles.

Chapter 8: Transcranial Magnetic Stimulation as a Means of Assessing Corticomotor Excitability during Facial Expressions of Disgust

8.1 Abstract

Objective

Transcranial Magnetic Stimulation (TMS) has been previously used to assess corticomotor excitability indicative of emotion-induced action preparation. The current study explored TMS as a means of assessing corticomotor excitability associated with emotional states, specifically disgust.

Methods

TMS of the left primary motor cortex was applied to 36 healthy participants while viewing emotion-inducing images. Three image conditions (disgust, fear and neutral) were included, with 16 images presented for each condition. TMS-induced motor evoked potentials were measured from the disgust-relevant levator labii muscle as an indicator of corticomotor excitability.

Results

Motor evoked potentials could be elicited in the right levator labii muscle in 21 participants. However, no difference in the magnitude of motor evoked potentials was observed between the disgust, fear and neutral conditions.

Conclusions

TMS-induced motor evoked potentials were successfully elicited in the majority of participants. However, no modulatory effects of disgust images were observed. Such findings did not support the efficacy of TMS as a means of gauging corticomotor activity associated with the emotional expression of disgust. A number of methodological refinements are suggested for future research in this area.

8.2 Introduction

Ongoing challenges exist in the field of emotion measurement. While many investigations continue to rely on self-report measures of emotion, the subjective nature of such methods has necessitated a movement towards psychophysiological tools that allow for an objective assessment of physical correlates of affective response. This form of measurement is particularly relevant for emotions with distinctive physiological markers such as autonomic patterns (Kreibig, 2010) and facial expressions (Ekman, 1984). Available measures of emotion physiology are able to accurately distinguish between the emotional dimensions of valence and arousal, in that they are able to ascertain experiences of positive or negative affect, and provide an indicator of the intensity of an affective response (Lang, 2003). However, when applied to specific emotions, further challenges arise; in particular it can be difficult to distinguish between emotions of the same valence using existing methods of psychophysiological assessment.

Disgust is regarded as one of the six universal, basic emotions (Ekman, 1984). It is characterised by a visceral experience of revulsion, aversion and abhorrence, and involves ideations concerned with contamination or the potential for contamination. It has a distinct facial expression that features wrinkling of the nose, raising of the lips and protrusion of the tongue (Ekman, 1980). While there is some cross-cultural variation in disgust elicitors, experiences of disgust tend to be evoked by stimuli falling under typical domains (e.g. food, animals, body products, death, hygiene; Rozin & Fallon, 1987).

Disgust has been considered in responses to typical aversive stimuli (Mataix-Cols et al., 2008; Shienle, Schafer, Stark Walter & Vaitl, 2005; Wilson, Kumari,

Gray & Corr, 2000) with its function in the gustatory system forming a particular focus of extant literature (Rozin & Fallon, 1987; Miller, 1998). Its role in shaping certain social and moral responses has also been examined (Haidt, Rozin, McCauley, 1997; Borg, Lieberman & Kiehl, 2008; Herz, 2012). Furthermore, disgust represents an emotion of interest in psychopathology research (Phillips, Fahy, David & Senior, 1998; Olatunji, Cisler & McKay, 2010). Augmented disgust responses to disorder-relevant stimuli have been identified in obsessive compulsive disorder (Olatunji & McKay, 2007), health anxiety (Olatunji, 2009), specific phobias (Olatunji, Cisler, Deacon, Connolly & Lohr, 2007) and eating disorders (Aharoni & Hertz, 2012; Troop, Murphy, Bramon & Treasure, 2000; Troop, Treasure & Serpell, 2002). The emotion has also been implicated in the pathogenesis of blood and injection phobias (Page, 2003; 2004), contamination-based obsessive compulsive disorder (McKay, 2006; Olatunji, 2010; Olatunji, Lohr, Sawchuk & Tolin, 2007) and vaginismus (Borg, de Jong & Shultz, 2010).

Several of the above studies (e.g. Borg et al., 2010, Wilson, Kumari, Gray & Corr, 2000) have used psychophysiological tools to measure affective responses indicative of disgust among study participants. In particular, measures such as the eye-blink/startle response and facial electromyography (EMG) have been used to assess facial responses in light of the universality of the disgust facial expression (Ekman, 1980; 1994) and the relative ease in which it can be elicited in laboratory settings (Aifanti, Papachristou & Delopoulos, 2010; Ekman, 1984).

The eye blink/startle response has been examined as a particular measure of facial signals of emotional reactivity. Augmented startle responses are typically observed during negative emotional states in comparison to positive emotions (VanOyen Witvliet & Vrana, 1995; Vrana, Spence, & Lang, 1988; Yartz & Hawke,

2002). However, there remains confusion as to whether startle responses occur broadly among emotions of negative valence, or whether they occur in response to fear alone (Yartz & Hawke, 2002). Some researchers have failed to identify modulatory effects on the startle response during experiences of disgust as found with fear (Balaban & Taussig, 1994), despite matching for arousal levels in both emotions. Others have found equivalent modulation of startle responses during exposure to both disgust and fear stimuli in comparison to neutral conditions (Yartz & Hawke, 2002). Based on such inconsistency, the validity of eye blink/startle modulation as an indicator of disgust is somewhat unclear. Further, the eye/blink startle response does not lend itself to a method of identifying specific responses of disgust among other emotions of negative valence.

An alternative method that has demonstrated promise as a psychophysiological tool is facial EMG, which measures electrical activity in target muscles during emotive facial expressions. Specific muscles associated with emotion valence (Ekman, 1980) such as the *corrugator supercilii*, located between the eyebrows and drawing them downward, are shown to be activated during negative emotions such as fear, sadness and disgust (Bradley, Cuthbert, & Lang, 1999; Dimberg, 1990). The *zygomaticus major* (ZM), located along the cheekbone and drawing the mouth upwards and out, has also been consistently implicated in the expression of positive emotions (Larsen et al., 2005). The *levator labii superioris* (LL) has been identified as a muscle specifically associated with the expression of disgust (Vrana, 1993). The LL is located alongside the nose extending to the cheekbone, raising the upper lip and wrinkling the nose. Yartz and Hawke (2002) investigated LL activity during participant viewing of disgust images taken from the International Affective Picture System (IAPS). They identified heightened LL

activity independent of disgust subtype (contamination-based or mutilation-based disgust), gender or reported level of arousal. Successive studies have identified increased LL activity during disgust conditions in comparison to neutral conditions (Schienle, Stark & Vaitl, 2001; Stark, Walter, Schienle & Vaitl, 2004). Facial EMG has been subsequently used as a measure of emotional responses among women with vaginismus (Borg et al., 2010) and individuals with spider phobia (de Jong, Peters & Vanderhallen, 2002), with specific LL recruitment used as an indicator of disgust. However, Wolf et al. (2004) identified a different pattern of facial responses during disgust, characterised by predominantly corrugator supercilii activation, leading to suggestions that LL activity may be sensitivity to high arousal disgust experiences only (Stark et al., 2004).

Taking the above evidence together, experiences of disgust appear to be characterised by eye-blink/startle augmentation as an indicator of general negative arousal, with evidence highlighting LL activity as a specific indicator of disgust. However, the inconsistent findings associated with these measures point to a need for further investigation of facial signals as a means of assessing disgust. The difficulties associated with the specificity of disgust measurement also exist on an autonomic level. In particular, it can be difficult to distinguish between the psychophysiology of disgust and other negative emotional states due to similarities in the autonomic activation patterns associated with these emotions, which can both involve sympathetic activation characterised by increased heart rate and skin conductance. While contamination-based disgust also involves parasympathetic co-activation, methods of measuring this, such as heart rate variability and vagal responses, have been shown to be inconsistent (Accurso et al., 2001; Demaree et al., 2006; Gerlach et

al., 2006). Considering its relevance in the field of psychopathology, alternative avenues of disgust measurement appear necessary.

8.2.1 Transcranial magnetic stimulation

Transcranial magnetic stimulation (TMS) is a neurophysiological tool that activates cortical neurons using electromagnetic induction. In psychophysiology research, TMS is typically used to activate cortical regions of the primary motor cortex (M1) resulting in excitation of corticomotor outputs, leading to muscle activity (a motor evoked potential; MEP). The MEP can be measured using electrodes placed on the surface of the skin over the target muscle, with the amplitude of MEPs providing a quantifiable index of the excitability of the corticomotor system, including target motor neurons in the brainstem and spinal cord.

TMS has previously been used as a means of assessing corticomotor (specifically corticospinal) activity as an indicator of physiological action preparation associated with emotion. This use was based on theories suggesting that experiences of negative emotion activate defensive systems that prepare the body for protective or avoidant action (Ekman & Davidson, 1994). A number of studies have identified increased corticospinal excitability during exposure to negative emotional content using both visual (Coombes et al., 2009; Hortensius, de Gelder & Schutter, 2016) and auditory modalities (Baumert, Sinclair, MacLeod, & Hammond, 2011). The magnitude of the TMS-evoked MEPs in hand muscles, including the abductor pollicis brevis (Hortensius et al., 2016) and first dorsal interosseous (Baumert et al., 2011), were used to quantify corticospinal excitability. While such studies have used TMS to explore changes in corticomotor excitability induced by emotion-based

defensive action, no extant study has applied TMS to an investigation to corticomotor excitability during emotion-based facial responses.

The majority of research using TMS has focused on excitability of corticomotor areas controlling limb and hand muscles, and relatively fewer studies have investigated the use of TMS in facial muscles. Nevertheless, researchers have successfully identified cortically generated MEPs in various upper and lower facial muscles (Cattaneo & Pavesi, 2014; Dubach, Guggisberg, Rösler, Hess, & Mathis, 2004; Rimpiläinen, Karma, Eskola, & Häkkinen, 1992; Rödel, Laskawi, & Markus, 1999). However, some researchers have experienced difficulties producing MEPs in some participants without voluntary activation of the target muscle. Others have failed to elicit any response in a sub-group of participants even with such voluntary activation (Cruccu et al., 1990; Paradiso et al., 2005; Rödel et al., 1999); a review of TMS over facial regions of M1 indicated that responses in a target muscle cannot be obtained in up to 20% of individuals (Cattaneo & Pavesi, 2014). These difficulties have been attributed to the location of facial muscle regions in M1, which can be buried in the sulci and therefore difficult to excite with external stimulation. Nevertheless, there is emerging evidence for TMS as an effective means of measuring the excitability of corticomotor projections to the face, and potential opportunities for expanding this psychophysiological tool into areas of emotion measurement.

8.2.2 The present study

The present study extended previous investigations by exploring TMS as a novel method of disgust measurement as indicated by the excitability of corticomotor (specifically corticobulbar) projections to the disgust-relevant LL muscle. Although facial EMG can be used to record voluntary muscle activation, it was thought that

TMS may allow for the detection of increased corticobulbar excitability without overt muscle activity. This would enable even the measurement of low intensity disgust responses with or without the presence of overt activation of facial muscles, which are typically required for EMG recording (Wolf et al., 2005; Stark et al., 2004) or facial expression rating scales (Ekman, 1980). In this way, the use of TMS adds to EMG measurements by capturing the effect of emotional stimuli acting on any part of cortico-affective circuitry without the need for overt muscle activation, as is required in facial EMG. As existing psychophysiological tools have shown varying promise as a means of differentiating emotions of negative valence, TMS was used to enable focal measurement of the LL in order to assess specific disgust responses.

TMS was applied to the facial area of M1 as a means of evoking cortically generated MEPs in the LL and ZM muscles during exposure to images taken from the IAPS, a standardised body of images used to elicit various emotional states. As the magnitude of MEPs will be sensitive to the changes in corticomotor excitability, it was expected that they would be modulated by the presentation of emotion-inducing stimuli. Specifically, it was predicted that the excitability of the corticobulbar projection to the LL muscle, as measured by the amplitude of MEPs, would be greater during exposure to visual disgust images than during exposure to fear or neutral images. It was also predicted that this excitability would be specific to the LL, and would not be exhibited in muscles that are anatomically close but not implicated in disgust responses (i.e. the ZM).

8.3 Methods

TMS was used to elicit MEPs in the LL and ZM muscles while participants viewed a series of images of everyday objects and situations designed to evoke disgust, fear and neutral responses.

8.3.1 Participants

Thirty one healthy individuals (17 females and 14 males) participated in the study. Participants were recruited from among undergraduate students at the University of Western Australia, who participated in exchange for course credit. Participants signed up for the study through an online system advertising available studies conducted through the School of Psychology. Medical exclusions applied to all prospective participants. All participants were given information sheets, and were required to sign consent and medical exclusion forms.

8.3.2 Image selection

Forty eight (16 fear, 16 disgust, 16 neutral) images were selected from the International Affective Picture System (IAPS) for use as stimuli in the current study. Disgust and fear images were matched for mean arousal levels using normative scores provided by Lang, Bradley and Cuthbert (2008).

8.3.3 Facial Electromyography

Electromyographic activity was recorded from the right LL and the right ZM using Ag/AgCl 10 mm disc electrodes. Facial EMG was recorded from the contralateral side only (i.e. the opposite side to stimulation), as previous facial TMS studies have inconsistent findings in regard to ipsilateral responses in lower facial muscles (Paradiso, 2005; Rodel et al., 1999), with the majority of findings indicating that projections to lower facial muscles are predominantly contralateral (Pilurzi et al., 2013). Electrodes were placed according to Fridlund and Cacioppo (1986). A ground electrode was placed on the forehead. EMG signals were digitised at 4kHz, amplified x1000 and bandpass filtered 10-1000Hz.

8.3.4 Transcranial Magnetic Stimulation

TMS was administered using a Magstim Model 200 stimulator with a figure-8 shaped coil (9 cm in diameter). The coil was positioned at a 45 degree angle to the mid-sagittal line of the left hemisphere, with the induced current running posterior to anterior. A cap marked with 1-cm grid points was used to position the coil and determine the position on the skull that would elicit the largest amplitude MEPs in the LL. A systematic approach was used to identify the optimal coil position, starting at a point 3 cm anterior and 5cm lateral from the vertex and moving laterally and anterior by 1cm increments. The optimal site for eliciting an MEP in the contralateral LL was determined as the site at which TMS elicited MEPS with the largest median amplitude over five successive stimulations. The threshold intensity required to elicit an MEP at the optimal site was determined as the intensity required to elicit MEPs with an amplitude of >50 microvolts (μV) on 5 out of 10 successive trials.

For a subgroup of participants ($n=7$), MEPs with an amplitude of >50 μV could not be achieved without voluntary activation of the target muscle. In this subgroup, participants were asked to wrinkle their nose in order to activate the LL (Rodel et al., 1999). The method of determining optimal site and threshold remained as above.

All test pulses were administered at the optimal site with the TMS intensity set at 1.2 times the threshold intensity.

8.3.5 Materials

The Disgust Sensitivity and Propensity Scale-Revised (DPSS-R; van Overveld et al., 2006)

The DPSS-R is a 12-item self-report scale that measures two distinct disgust constructs of propensity (the frequency of disgust experiences) and sensitivity (the

intensity of disgust experiences). The scale measures disgust responses independent of disgust elicitors. The original version of the scale was translated into English and revised by Olatunji, Cisler, Deacon, Connolly & Lohr (2007). This revised version is shown to have excellent internal consistency (Cronbach's $\alpha = .90$) and convergent validity. Items are responded to on a scale ranging from 1 ("never") to 5 ("always"). Sub-scores for disgust sensitivity and propensity are calculated separately.

8.3.6 Procedure

Participants were seated on an adjustable chair in front of a computer monitor at a distance of approximately 60cm. They were asked to watch all images presented to them. The TMS coil was placed in the predetermined optimal coil position; participants were informed that there would be a pulse in some, but not all of the trials.

Participants viewed all 48 images (20x10cm) presented on the computer screen. Images were presented in randomised order for 3 seconds (s), with a randomised inter-trial interval of 3 or 4s between each image. Participants were instructed to maintain focus on a fixation cross presented in the centre of the screen during each interval. TMS pulses were administered during a random subset of 24 images (8 from each emotion category). Following image presentation onset, the TMS pulse was automatically triggered following a randomly selected delay of 1000 or 1500ms from image onset. During trials where no pulse was discharged, the coil position was maintained during image presentation.

After all images were presented, participants were asked to complete arousal ratings for the images they viewed, followed by paper and pencil versions of the DPSS-R. For the arousal ratings, each image was re-presented in a newly randomised order for a period of 3s. Participants were instructed to rate each image using an on-

screen scale ranging from -10 to 10, depending on how positive or negative they found the image. Participants were then asked to select an emotion from an on-screen selection that best represented how they felt when viewing the image. They were asked to choose from a list of seven emotions (disgust, fear, sadness, happiness, anger, surprise, neutral).

8.3.7 Data analysis

8.3.8 MEPs were individually scored by hand offline from stored representations of the MEP traces. The scorer was blind to the experimental condition. On a trial-by-trial display of the MEPs, cursors were used to score the latency, area and peak-to-peak amplitudes of the individual MEP components. Vertical cursors were used to measure elapsed time from the TMS pulse (in milliseconds), by manually lining up one cursor with zero and one with the response onset. A third vertical cursor was lined up with the response offset in order to calculate the response duration (in milliseconds), as well as the area of the curve of MEP. Horizontal cursors were lined up with the minimum and maximum points of the response in order to calculate the amplitude (in millivolts). Statistical analysis

Statistical analysis was performed using SPSS 22 software. The data were assessed for multivariate outliers using Mahalanobis distance, with none identified. MEP area scores were used as they captured the duration magnitude that was evident in some responses. A repeated-measures ANOVA with simple contrasts was used to examine the effects of different image conditions (disgust, fear and neutral) on the LL mean MEP area scores. The assumption of sphericity was met for some but not all analyses. When this assumption was violated, the Greenhouse-Geisser correction was used. Within-subject standard deviations were calculated based on the method outlined by Loftus and Masson (1994).

Pearson correlations were used to assess the relationship between subjective valence and arousal scores for disgust images, and MEP areas for the disgust conditions. In order to do this, each MEP area was converted to a z-score using the grand mean and standard deviation for all image conditions, consistent with the

method used by Hortensius et al. (2016). Z-scores were then averaged across disgust, fear and neutral conditions. MEP z-scores were also correlated with measures of disgust sensitivity and propensity. Spearman's correlations were used for non-normally distributed data (i.e. the disgust propensity subscale on the DPSS-R).

An A priori power analysis was conducted using the GPower software package (Faul & Erdfelder, 1998). Based on this analysis, the total sample size (N=34) was sufficient in order to obtain a 90% chance of detecting a moderate effect size (Cohen's d of .4; Cohen, 1992) as significant at the .05 level.

8.4 Results

8.4.1 TMS of facial regions

TMS-evoked MEPs in the LL muscle were elicited in 21 out of 31 participants (68%). Of these 21 participants, 13 (62%) displayed MEPs in the LL when the muscle was at rest (this subgroup will be referred to as the 'Rest' subgroup). The remaining eight (38%) displayed MEPs in the LL only when the muscle was activated (the 'Active' subgroup). The mean optimal coil location for eliciting MEPs in the contralateral LL was 3.8 ± 0.5 cm anterior and 7.9 ± 0.8 cm lateral from the vertex. The mean resting threshold as a percentage of maximum stimulator output (MSO) for the Rest subgroup (n=13) was 56.70 ± 4.30 MSO. The mean threshold for the Active subgroup (n=8) was 58.71 ± 3.95 MSO. Measurable MEPs in the ZM muscle were obtained in six out of twenty one participants, suggestive of focal activation of the LL muscle in the majority of participants, without little co-recruitment of neighbouring muscles.

8.4.2 Polyphasic components of facial MEPs

Consistent with previous studies, participants showed polyphasic MEPs characterised by a pattern of 3 sequential components. This pattern included an initial component that occurred at a latency <6 ms after the TMS pulse as a result of peripheral nerve stimulation. This was followed by a middle-latency component occurring at a latency of 6-29 ms, representing cortically generated activation of the facial muscle. A cortically generated long-latency component was also observed in some participants, at a latency >30ms after the TMS pulse. As short-latency components are not cortically generated, the middle-latency and long-latency components were of particular interest in this study.

Table 7 shows the proportion of short-latency, middle-latency, and long-latency MEP components observed among participants. Across the two subgroups, three participants demonstrated MEPs showing all three components. Ten participants demonstrated consistent patterns of short-latency and middle-latency MEP components. Finally, two participants showed both middle-latency and long-latency MEP components, and the remaining four had middle-latency components only.

Table 7. Percentages of short-latency, middle-latency and long-latency MEP components for Rest and Active subgroups

	Short (<5ms)	Middle (5-30ms)	Long (>30ms)
Rest subgroup (n=13)	46%	100%	31%
Active subgroup (n=8)	47.5%	72%	12.5%

Total	42%	86%	24%
(n=21)			

There was typically within-participant consistency in regard to the presence of specific MEP components. Figure 3 depicts MEPs for two participants with a pattern of components that showed consistent, replicable MEPs over six trials.

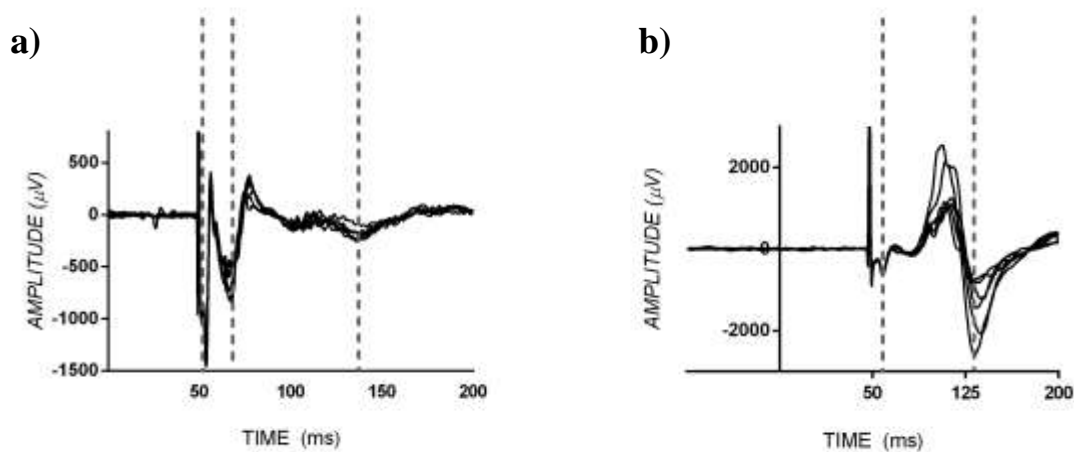


Figure 3. MEPs elicited for two participants in the contralateral LL muscle over a sample of six trials. Separate MEP components are indicated by dotted lines.

Participant a) shows consistent patterns of short-latency, middle-latency and long-latency components. In participant b) short-latency and middle-latency components can be observed.

Table 8 shows descriptive statistics for latencies of three successive MEPs components. Results are pooled across the two sub-groups (n=21) as both Rest and Active subgroups showed comparable MEPs for all components.

Table 8. Mean, standard deviation and range MEP latencies (in milliseconds) across short-latency, middle-latency and long-latency components for combined Rest and Active subgroups (n=21)

Latency Component	Mean	SD	Range
Short	2.90	.91	1.78-4.92
Middle	14.87	4.91	7.13-25.82
Long	44.9	9.16	32.54-54.09

8.4.3 Effect of emotion-inducing images

The sample was divided in to Rest and Active subgroups in order to carry out the within-subjects analyses on the middle-latency component MEP scores.

Subgroups were pooled for analyses of the long-latency component MEP scores, due to small sample size (n=5). Mean middle-latency and long-latency component areas for each participant for the three image conditions are presented in Figure 4. Bar values indicate grand means for the disgust, fear and neutral conditions, and line values show individual participant means across the three conditions. In the Rest subgroup, five participants (38%) showed the predicted pattern of larger MEPs in the disgust conditions in comparison to fear and neutral conditions. In the Active subgroup, three out of eight participants (37%) also displayed this pattern. In the long-latency component subgroup, three participants (60%) showed larger MEPs in the disgust condition, in comparison to fear and neutral conditions.

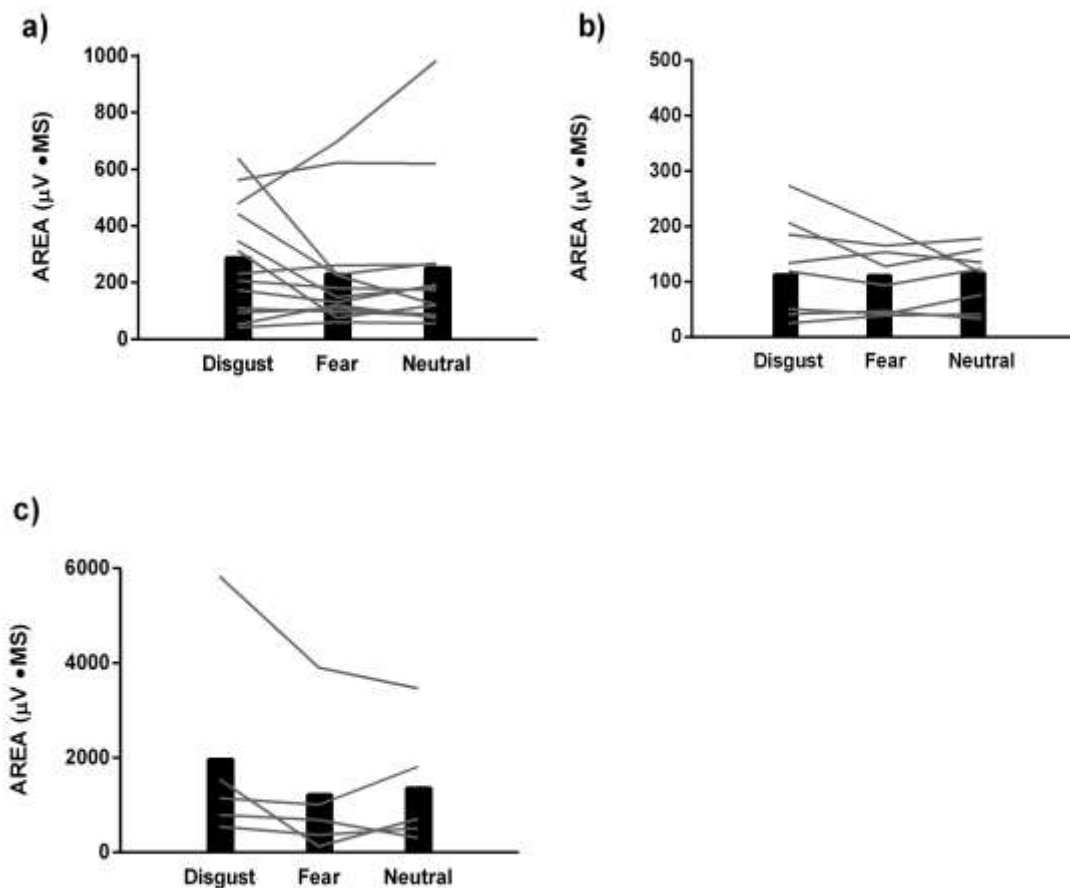


Figure 4. Mean MEP areas for disgust, fear and neutral conditions. Graph a) depicts the mean and individual scores of middle-latency MEP components for participants in the Rest subgroup (disgust $\bar{x}=284\pm124$; fear $\bar{x}=228\pm54$; neutral $\bar{x}=249\pm95$). Graph b) depicts the mean and individual scores of middle-latency MEP components for participants in the Active subgroup (disgust $\bar{x}=116\pm24$; fear $\bar{x}=114\pm24$; neutral $\bar{x}=119\pm10$). Graph c) depicts the mean and individual scores of long-latency components including both Rest and Active subgroups (disgust $\bar{x}=1972\pm643$; fear $\bar{x}=1220\pm301$; neutral $\bar{x}=1361\pm522$). Lines between data points are included to identify individual participant scores rather than an indication of a continuous relationship.

In the Rest subgroup, repeated measures ANOVA revealed no significant differences between mean MEP area for middle-latency components across the three image conditions, $F(2,24) = .77, p = .47$. In the Active subgroup, a repeated-measures ANOVA similarly revealed no significant differences between mean MEP area for middle-latency components across the three image conditions, $F(2,14) = 1.14, p = .35$.

In the combined Rest and Active group with long-latency component MEPs ($n=5$), no significant differences between the disgust, fear and neutral conditions was observed, $F(1,4) = 1.46, p = .29$. When scores for Rest, Active and long-latency component subgroups were pooled, a non-significant difference persisted, $F(2,50) = 2.31, p = .11$. No significant simple contrasts were identified in any of the above analyses.

8.4.4 Forced selection of emotion ratings

On average, study participants rated images in the disgust condition as “disgusting” 67% of the time. This suggests that participants were not experiencing disgust responses during every exposure to a disgusting image. Thus, the main within-subjects analyses were run using only the items that subjects individually rated as disgusting. However, non-significant differences persisted for the Rest subgroup, $F(2,18) = 2.99, p = .16$, and the Active subgroup, $F(2,14) = .44, p = .65$.

8.4.5 Subjective emotion ratings

A mean score indicating subjective valence and arousal was calculated for fear, disgust and neutral images. Negative scores were indicative of negative valence, and the magnitude of scores from $|0-10|$ specified arousal level, with higher scores indicating higher arousal. Median and percentile scores for each image condition (disgust, fear and neutral) can be observed in Figure 5.

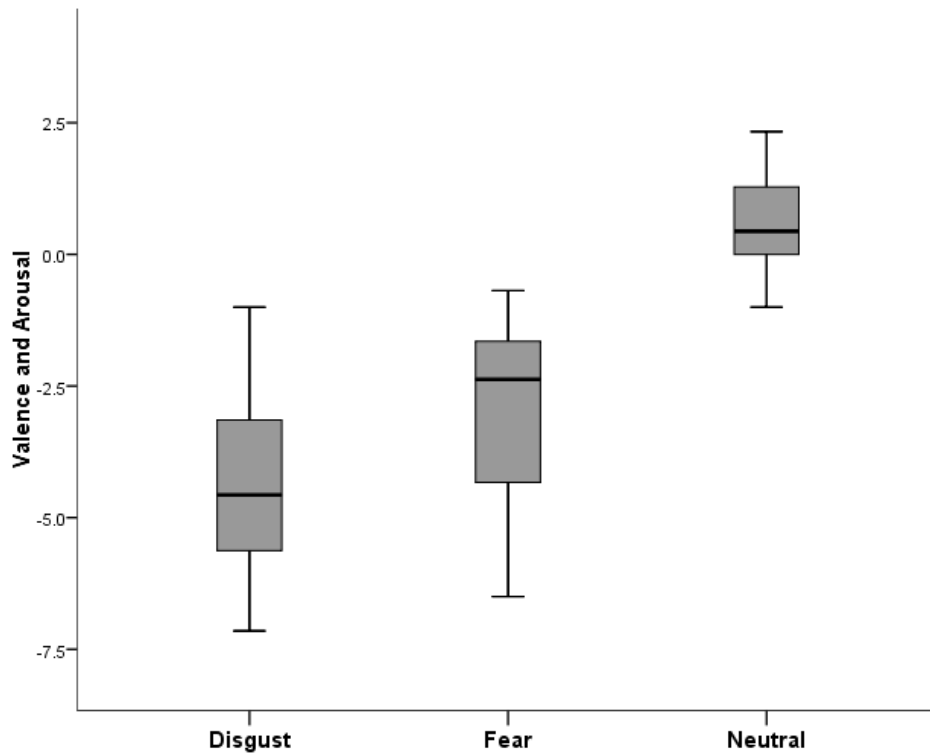


Figure 5. Median, 25th and 75th percentile scores of subjective valence and arousal levels for disgust, fear and neutral image conditions.

The mean total score for the DPSS-R was $\bar{x}=30.78\pm 6.48$. For the two subscale scores, the mean disgust propensity score was $\bar{x}=18.21\pm 4.06$, and the mean disgust sensitivity score was $\bar{x}=12.37\pm 3.50$.

Mean scores on the DPSS-R subscales were correlated with mean subjective valence and arousal scores for disgust images. Significant positive correlations were found between mean valence and arousal scores and the disgust propensity subscale, $r_s(19)=-.71$, $p<.05$, and the disgust sensitivity subscale, $r(19)=-.48$, $p<.05$.

Mean MEP area z-scores were correlated with mean valence and arousal scores for disgust images. A non-significant correlation of .04 ($p=.88$) was obtained, suggestive of a weak or no association between level of negative arousal and MEP area during viewing of disgust images. A non-significant correlation was obtained

between the MEP area z-score and the disgust propensity subscale, $r_s = -.05$, $p = .85$, and the disgust sensitivity subscale, $r = -.17$, $p = .48$.

8.5 Discussion

This study investigated using TMS as a means of assessing the excitability of corticomotor projections from the facial area of M1 during viewing of emotionally salient stimuli. Specifically, excitability of projections to the disgust-relevant LL muscle (Vrana, 1993), as measured by the amplitude of MEPs, was examined during exposure to disgust, fear and neutral images. It was expected that larger MEPs in the LL would be exhibited during the disgust condition in comparison to fear and neutral conditions. It was also expected that modulatory effects would be specific to the LL, and TMS of the optimal site of the LL would not activate anatomically close muscles such as the ZM.

8.5.1 Broader TMS findings

Previous investigations have had varied success eliciting consistent, measurable MEPs in facial muscles; the present study consolidated previous findings by successfully eliciting responses in the contralateral LL muscle. This result indicated that TMS was successfully applied to regions in the M1 with corticobulbar projections to the LL. This study is one of the first to establish TMS-evoked responses in this muscle (Rimpalainen et al., 1999). MEPs were evident in 21 out of 31 participants, but were not successfully or consistently produced in the remaining 10 participants at an intensity level that was acceptable for means of comfort (i.e. running intensity >85). The subgroup of participants without visible facial MEPs is consistent with findings from previous investigations, which typically failed to identify responses in up to 20% of participants (Catteano & Pavesi, 2014; Cruccu et al., 1997; Pilurzi et al., 2013).

In the present study, a subgroup of participants displayed MEPs when facial muscles were at rest (the Rest subgroup). Again, this is consistent with studies that have identified facial MEPs at rest in a proportion of participants (Catteano & Pavesi, 2014; Pilurzi et al., 2013). The remaining participants displayed MEPs only when the muscle was active (the Active subgroup).

The current study identified three successive components of the facial MEPs consistent with previous facial TMS studies, including a short-latency MEP component indicative of peripheral nerve stimulation, and middle-latency and long-latency components indicative of cortical activation (Rodel et al., 1999; Rimpilainen et al., 1992). As in other studies, the presence of these components varied between participants. However, there was within-participant consistency in regard to the presence of MEP components in each individual trial. Specifically, the majority of individuals who displayed short-latency or long-latency components displayed these responses on all or almost all trials. The mean latencies obtained across the three components were also consistent with previous studies (Catteano & Pavesi, 2014; Pilurzi et al., 2013; Rodel et al., 1999).

8.5.2 Modulatory effects of emotion

No significant differences in MEP area scores for the LL were found between the disgust, fear and neutral image conditions. These findings suggested that viewing images of disgust did not modulate MEPs elicited in the LL, in comparison to viewing fear and neutral images. A number of participants failed to identify the emotion they experienced during disgust image viewing as 'disgust'. However, a non-significant result persisted when the analysis was re-run using only MEPs from images subjectively identified as disgusting. These findings fail to support the hypothesis that TMS can be used to measure the excitability of the corticomotor

system associated with emotion-induced facial muscle activity. Such findings contrast with previous research that has used TMS in order to measure corticospinal excitability during experiences of fear and anger, identifying increased corticospinal activation indicative of action preparation during negative emotional states (Coombes et al., 2009; Hortensius et al., 2016). Based on subjective valence and arousal scores for disgust images included in this study, relatively few participants experienced an extreme negative arousal response to the disgust images (i.e. an average valence and arousal score > -5). It is possible that more arousing images may have led to a more extreme disgust responses, and thus larger MEP amplitudes. However, the correlation between subjective valence and arousal scores and MEPs for disgust images was non-significant, suggesting that MEP magnitudes did not increase as levels of negative arousal increased. This places further limitations on the possibility that levels of emotional arousal can be reflected in MEPs in the LL muscle, as a means of assessing excitability of relevant corticomotor projections from M1.

Moderate to strong, negative correlations were identified between mean subjective valence and arousal scores for the disgust images and disgust sensitivity and propensity sub-scores on the DPSS-R. This suggested that greater levels of trait disgust sensitivity (the strength of disgust arousal) and propensity (the frequency of disgust experiences) were associated with increased negative arousal during viewing of disgust images. No significant correlations were found between disgust propensity, sensitivity and MEP z-scores, indicating no significant relationship between levels of trait disgust sensitivity and propensity, and the level of corticomotor excitability when viewing disgust images.

It is conceivable that laboratory conditions in this study interfered with the elicitation of spontaneous emotional facial movements. Specifically, electrodes attached to the face may have functioned to increase awareness of facial movements, and thus attenuate movement during exposure to emotion-inducing images. A number of participants also described TMS as aversive; the anticipation of a TMS pulse may have been sufficient to distract participants during the image viewing phase, and may have attenuated affective responses to presented stimuli. Qualitative experiences of individual participants were not investigated in this study. However, as previous studies that have successfully employed TMS as a means of assessing emotion-related defensive action (e.g. Hortensius et al., 2016), it appears unlikely that emotional responses are inhibited by TMS conditions. Nevertheless, future studies may wish to consider whether subjective aversive experiences of TMS have the potential to influence the integrity of responses to emotional stimuli.

Although this study's methodology involved eliciting TMS pulses at two randomised time intervals following image presentation, it was beyond the scope of this study to investigate specific effects of pulse timing on subsequent MEPs. However, it is possible that pulses delivered at a later onset into image viewing could yield greater response modulation, as the participant would have a longer time period in which to view and respond to the image's emotional content. This may represent an area of future study for researchers wishing to examine the use of TMS during affective responses further.

There is some evidence suggesting that facial expressions are exhibited more strongly on the left side of the face (Borod, Haywood & Koff, 2003; Triggs, Ghacibeh, Springer & Bowers, 2005). The mechanisms underlying this asymmetry are unclear (Triggs et al., 2001) with some arguing that this pattern occurs in

voluntary facial expressions (Rinn, 1984), and may not be evident in emotion-induced expressions. In the current study, all measures were taken from the right side of the face only. Future investigations may wish to consider an exploration of bilateral facial muscles, in order to account for the possibility of asymmetry of expression, whether voluntarily or emotionally induced.

8.5.3 Limitations and future directions

Several limitations in this study should be noted. TMS pulses were only elicited in eight out of sixteen images for each emotion condition, subsequently limiting the robustness of MEP amplitude measures. Future studies may wish to include a larger sample of active conditions in order to exhaustively verify patterns of responses among participants. Furthermore, as previously stated, the mean subjective disgust valence and arousal scores indicated that few participants were experiencing highly arousing disgust responses, placing further load on the ability for TMS to be sensitive to low intensity or sub-threshold disgust responses. Further, participants identified the emotion they experienced during viewing of the disgust images as “disgust” 67% of the time. While these images were selected from the IAPS, a widely researched collection of images used to elicit emotional states, there was clearly variability in regard to the emotional responsiveness among participants in this study. These limitations are possibly attributable to a failure to determine disgust response levels to selected images in the same or a similar sample prior to their use in the current study. Future investigations seeking to refine the use of TMS as a potential measurement tool may wish to preselect images that consistently produce disgust responses within their sample. As disgust responses are shown to be resistant to extinction (Olatunji, Smits, Connolly, Willems & Lohr, 2007), repeated

presentations of the same or similar images would be unlikely to interfere with the level of disgust arousal among participants.

While the results in this study were unable to demonstrate the use of TMS as a means of measuring modulation of corticomotor excitability while viewing disgust images, further examination of the utility of TMS in affective measurement studies may still be useful. As this study was the first to conduct this line of investigation, it remains exploratory, and a number of methodological refinements would be suggested for any future replications or emulations. The inclusion of a greater range of emotion-evoking images selected to evoke higher arousal levels would be recommended. An assessment of the effect of time delays on discharging the TMS pulse following image presentation would also be suggested. Finally, future studies may wish to explore qualitative experiences during viewing of emotion-inducing stimuli under TMS conditions.

In conclusion, TMS-induced MEPs were successfully elicited in the LL muscle for the majority of participants. However, modulatory effects on MEPs in the LL as an indicator of corticomotor excitability during exposure to disgust images were not identified in this study. There appears ongoing need for further exploration of psychophysiological measures that are able to find signals of specific emotions such as disgust.

Chapter 9: General Discussion

9.1 Chapter Overview and Aims

This chapter will integrate the findings of the three empirical studies included in this thesis, and provide a consideration of the broader implications of these findings. First, a summary and overview of the main findings will be presented. Second, the collective outcomes with respect to the measurement of disgust and self-disgust will be considered. Third, both theoretical and clinical implications of the findings relating to disgust sensitivity, propensity and self-disgust will be explored, with particular focus placed on the implications with respect to eating disorders. Finally, the limitations of this thesis, and directions for future research, will be discussed.

9.2 Overview of Main Findings

The emotion of disgust has increasingly gained attention within psychopathology literature. In particular, interest in disgust lies within the possibility of a hijacked or dysfunctional recruitment of the disgust system that facilitates abnormal or exaggerated disgust responses to external stimuli, such as in the case of contamination-based OCD, specific phobias, and blood, injury and injection fears. Self-disgust has been characterised as an inappropriate recruitment of the disgust system, in that the self, parts of the self or the body, become the sources of disgust (Powell, Simpson & Overton, 2015). Self-disgust remains an emerging area of research and the studies in this thesis represent a contribution to the understanding of self-disgust as a concept, as well as its applicability to the field of psychopathology, particularly eating disorders. Experiences of disgust and self-disgust in eating

disorders represented a specific focus in this thesis due to the prominence of expressions of disgust towards the self and body that appear in eating disorder qualitative literature (Espeset et al., 2012), as well as in subjective, experiential accounts from individuals. There are also recent suggestions more broadly that emotions, particularly disgust, need to become a primary focus in the aetiological models and treatment approaches for eating disorders (Fox, Grange, & Power, 2015; Fox & Power, 2009).

The field of disgust *measurement* represents another area worthy of further empirical consideration. In particular, there is a need for measures designed to assess self-disgust in order to facilitate future research in the area. While Overton, Markland, Taggart, Bagshaw and Simpson's (2008) Self-Disgust Scale represented an initial step in the area of self-report self-disgust scales, this thesis included the development of a revised self-report scale (the Self and Body Disgust Scale; SBDS). The revised scale was designed to measure self-disgust including revulsion at the bodily self, in order to facilitate its applicability as an assessment tool in eating disorders and other disorders of body image.

There is also a need for further consideration of novel psychophysiological measures of emotion that are able to measure discrete affective experiences, due to ongoing difficulties distinguishing between emotions of the same valence (i.e. disgust and fear). The use of psychophysiological measures of emotion also present benefits over self-report assessments, as they are not limited by subjective interpretation. Thus, this thesis attempted to explore a novel method of assessing physiological signs of emotion; namely using Transcranial Magnetic Stimulation (TMS) to measure corticomotor excitability associated with facial expressions of disgust.

Study One attempted to progress the field of disgust and self-disgust measurement by revising and validating a self-report scale that incorporated items assessing disgust at the self, body and physical appearance. It was thought that body disgust may be particularly relevant in eating disorders, which primarily involve extreme shape and weight concern and negative evaluation of body image. An associated aim of Study One was to determine whether self-disgust was related to eating disorder symptomatology in a non-clinical population. The revised SBDS was found to have sound psychometric properties, including strong internal consistency, test-retest reliability, and correlations with measures of disgust sensitivity. Furthermore, levels of self-disgust, as measured by the SBDS, were positively correlated with eating disorder symptoms in a non-clinical sample. Study Two built on these findings, using the validated SBDS in a clinical sample of individuals with diagnosed eating disorders. Findings again supported the relevance of disgust as a key emotional experience among individuals across eating disorder diagnoses. Furthermore, Study Two allowed for comparisons between eating disorder patients and other clinical groups, with high self-disgust emerging among individuals with major depressive disorder and social phobia in comparison to healthy controls, albeit to a lesser extent than in eating disorders.

Finally, Study Three attempted to advance the operationalised measurement of disgust by investigating a novel method of emotion assessment using TMS. While the use of TMS successfully elicited cortically generated motor evoked potentials (MEPs) in disgust-relevant muscles for the majority of participants, a modulatory effect of disgust-inducing images was not identified. However, these preliminary findings add valuable knowledge to the area of facial TMS and its potential utility in affective measurement.

9.3 Implications for Disgust and Self-Disgust Measurement

9.3.1 Developing a revised self-report measure for self-disgust

The results from Study One provided evidence for the sound psychometric properties of the SBDS as a revised scale designed to assess self-disgust. The internal consistency and test-retest reliability of the SBDS was established using a large non-clinical sample, and a one-factor structure of the scale was identified. While the factor structure obtained for this modified questionnaire differed from the original Self-Disgust Scale (Overton et al. [2008] identified two factors; the disgusting self and disgusting behaviours), a comprehensive conceptualisation of self-disgust remains in its infancy, and the findings in Study One add to understandings of self-disgust as an overarching experience of revulsion or aversion triggered by a number of aspects of self, including the body and one's behaviours. This embodiment of emotion represents both classical, bottom-up theories of emotion (i.e. the James-Lange theory) and more recently emphasises on the somatic components of emotion, in contrast with more cognitive or "top-down" approaches alone.

Based on the findings of Study One, the SBDS holds particular promise as a measure for future research-based use in clinical populations where disgust at the body and other aspects of physical appearance may be of particular relevance, such as in eating disorders, bodily dysmorphic syndromes and gender-related disownership experiences. This was supported by the findings in Study Two, where individuals with clinically diagnosed eating disorders displayed the highest levels of self and body disgust in comparison to other clinical groups and healthy controls. Further, disgust at the body and physical appearance have been identified as prominent features of self-disgust in other psychological conditions (Ille et al., 2014; Powell et al., 2014), and the SBDS may have additional utility in these clinical

groups. In support of this, the findings from Study Two also identified elevated scores on the SBDS among individuals with major depressive disorder and social anxiety in comparison to healthy controls.

While the SBDS was used in this thesis for research purposes, the scale may hold concurrent value as a clinical assessment tool, with scores providing an indication of the relevance of self-disgust on an individual basis. The future development of standardised norms for the SBDS may be necessary in this context, in order to assist clinicians in making meaningful interpretations of the scale. However, results from the large non-clinical sample used in Study One may provide some guidance regarding average levels of self-disgust in non-clinical populations.

9.3.2 Exploring TMS as a novel means of assessing disgust responses

Study Three explored a different avenue of disgust measurement in comparison to Study One, namely, TMS as a novel psychophysiological measure of emotion. Broadly, this study added to previous work establishing the use of TMS in order to evoke motor potentials in facial regions via corticobulbar pathways projecting from the facial area in the primary motor cortex, which has been previously explored by only a handful of studies. Study Three also extended prior work by examining a broader range of facial muscles, including the *levator labii* (LL) and *zygomaticus major* (ZM). However, there was some difficulty obtaining reliable, measurable MEPs from all participants included in the study. This difficulty obtaining facial MEPs has been commented on previously, with past studies indicating that MEPs will not be produced in approximately 20% of individuals (Cattaneo & Pavesi, 2014). In Study Three, 36% of participants demonstrated negligible responses in the LL and ZM. This difficulty obtaining useable results in all participants may place limitations on any potential utility of TMS as an emotional

measurement tool. However, MEPs were successfully produced in the majority of participants while the target muscles were both active and at rest states. Furthermore, Study Three identified polyphasic MEP components that were consistent with previous studies (Cattaneo & Pavesi, 2014; Dubach et al., 2004; Pilurzi et al., 2013) further establishing the existence of these patterns that appear to typify TMS of facial regions.

However, the results obtained did not support the utility of TMS as a potential means of measuring increased corticomotor excitability associated with disgust. The presentation of disgust images during TMS did not modulate the MEP amplitudes obtained in the disgust-specific LL muscle, when compared to images designed to evoke fear or neutral experiences. Several methodological factors that may have accounted for this were explored in depth in the discussion section of Chapter Eight. However, there may be some premise for further investigations of TMS as a means of gauging emotion-induced facial responses. Other psychophysiological measures designed to assess facial signals of emotion are plagued by difficulties, the most relevant being challenges discriminating between emotions of the same valence, for example fear and disgust. In Study Three, it was argued that TMS could offer a greater level of specificity than other methods such as eye-blink/startle responses, and may have proved more sensitive to minor expressions of emotion than tools such as facial electromyography, which is thought to be affected by arousal level (Stark et al., 2005). Thus, Study Three represents an initial exploratory investigation of applying this neurophysiological tool to psychophysiology, and may hold some utility that is worthy of further exploration.

9.4 Disgust and Self-Disgust in Eating Disorders

9.4.1 Theoretical implications

The findings of Studies One and Two provide empirical support for the prevalence of self-disgust among individuals with eating disorders. Study One established a strong association between self-disgust and eating disorder symptomatology in a non-clinical population, with particularly strong relationships identified between high scores on the SBDS and items on the Eating Disorder Examination Questionnaire (EDE-Q) that assess weight and shape concern. Furthermore, the results of Study Two suggest that self-disgust is a common experience among individuals with clinically diagnosed AN, BN and OSFED, in comparison to healthy controls and other clinical groups. This finding builds on the previous literature that has examined self-disgust in major depressive disorder (Overton et al., 2008; Powell et al., 2014; Simpson et al., 2010), and others such as Ille et al., (2014), who initially established the prominence of the self-disgust experience across a range of psychopathology. As such, it seems important to examine self-disgust in eating disorders further. In particular, it may be appropriate to explore how disgust could function to elicit behaviours such as restriction and purging. Experiences of self-disgust are likely accompanied by behavioural correlates typical of disgust, such as rejection and avoidance, which may well manifest as rejection and avoidance of the self and body, and drive a desire to diminish or modify the self through dietary restriction, purging or even excessive exercise.

The findings relating to disgust sensitivity and propensity also add relevant knowledge to extant literature. Previously, there has been conflicting findings as to whether eating disorders are characterised by exaggerated, externally-directed

disgust experiences across typical disgust stimuli (Aharoni & Hertz, 2012), or whether augmented disgust is observed in response to disorder-relevant disgust stimuli only (Troop, Treasure, & Serpell, 2002). Further, previous studies of disgust in eating disorders have considered disgust sensitivity alone. In Study Two, elevated levels of disgust sensitivity and propensity in a clinical eating disorder sample were predicted but not found. In fact, the reverse was identified, with individuals in the clinical eating disorder group demonstrating lower levels of disgust propensity, and equivalent disgust sensitivity in comparison to non-clinical controls.

While such findings appear to add further complexity to current understandings of disgust experiences in eating disorders, several conclusions can be drawn from them. A methodological deviation in the present thesis from previous studies was the decision to use the Disgust Propensity and Sensitivity Scale (DPSS), instead of traditionally used Disgust Scale (Haidt et al., 1994). This decision allowed for the subsequent measurement of both disgust sensitivity and propensity. Further, it facilitated the measurement of these constructs using a stimulus-independent format, and thus did not assess disgust with respect to specific disgust elicitors. As such, the results in Study Two are perhaps more in support of the findings of earlier studies such as Troop, Treasure and Serpell (2002), suggesting that *specific stimuli*, i.e. food and the body or body products, may in fact be important in experiences of disgust in eating disorders.

The broader findings of this thesis also build on understandings of eating disorders from an emotional perspective. First, they establish disgust, specifically self-disgust, alongside other emotions such as fear and anxiety (Pallister & Waller, 2008) as a relevant emotional experience in these conditions. Second, they point to the potential need to consider specific emotions, rather than looking at generalised

emotional concepts such as emotion regulation alone. The relevance of disgust in other clinical conditions such as obsessive compulsive disorder (OCD) has been increasingly elucidated, and there are arguments that poor treatment outcomes in this condition may be attributable to resistant disgust responses in contamination-based OCD in particular (Olatunji, 2010; Wolitzky-Taylor, Horowitz, Powers, & Telch, 2008). Olatunji et al. (2009) also considered the complex interaction between fear and disgust in OCD, suggesting that they are likely to function in a bi-directional manner. In a consideration of the relationship between fear and disgust, Woody and Teachman (2002) underline the similarities of the two emotions as protective affective experiences with common behavioural correlates. They also discuss an emotion 'synergy' model, broadly applied to anxiety conditions, where disgust and fear can act to augment each other by triggering increased vigilance and arousal levels. Further, they discuss the potential for threat appraisals to incite a number of emotions, and argue for the consideration of the co-occurring nature of specific emotional responses (Woody & Teachman, 2002). Extending this model to eating disorders, it is possible that certain stimuli, such as body parts perceived as fat, become threatening and elicit both fear and disgust. Subsequently, the synergised relationship between these emotions means that one may function to amplify or produce the other (resonating and mutually reinforcing). While such ideas remain purely theoretical, they point to the need to consider disgust alongside other relevant emotions in eating disorders. A number of prominent clinicians have called for the conceptualisation of eating disorders as anxiety-based conditions (Pallister & Waller, 2008); it may be important to include the role of disgust in such considerations as well.

9.4.2 The experience of self in anorexia nervosa

The emergence of self-disgust as a relevant emotional experience in eating disorders consequently prompts a consideration of the nature and experience of self in these conditions. Specifically, it raises questions regarding how disgust, typically an adaptive, sentinel emotion, can be directed at the self. This issue was considered in depth in Chapter Three, which proposed a model of AN potentially underpinned by a disturbance of self-ownership. This was then associated with disgust, an emotion inherently connected to the distinction between self and non-self. The adaptive function that disgust serves was highlighted; disgust becomes an aspect of the behavioural immune system (Schaller, 2005), and thus relies on the accurate ability to discriminate between self and non-self in order to preserve the self from harm by outside contamination and violation of bodily integrity. As in cases of autoimmune disease, self-disgust could be viewed as ‘behavioural autoimmunity’, where the self, or parts of the self, become reviled, rejected and experienced as “other”, thus giving rise to affective experiences of disgust at the self.

In a recent phenomenological analysis of experiences of self-disgust among women with major depressive disorder, Powell, Overton & Simpson (2014) highlighted the discrepancy some participants made between their “disgusting self” and their “disgusted self”. They suggested that this may reflect a level of dissociation among these individuals, which may in fact characterise experiences of self-disgust. Taken further, it is possible that this again reflects a level of self-rejection or disownership, where a part of self (the disgusted, self) rejects or disowns another part of self (the disgusting self). In other qualitative examinations, individuals with AN have also distinguished between their ‘anorexic self’ and their ‘rational self’, again reflecting dualities in the experience of self that appear prevalent in this condition (Williams & Reid, 2010). Many individuals also describe experiencing an ‘anorexic

voice’, which can initially be benevolent and encouraging but often develops into a critical and punitive force, reinforcing restrictive behaviour and the importance of maintaining control over eating (Tierney & Fox, 2010). This experience of an ‘anorexic self’ or ‘anorexic voice’, in conflict with the rational self is also thought to be a factor underpinning experiences of ambivalence regarding recovery that are common among many individuals during treatment (Tierney & Fox, 2010).

The findings of this thesis can be viewed as an initial step into the exploration of self-ownership in eating disorders, particularly AN, which is characterised by features that would compromise the experience of self, such as low interoceptive awareness (Fassino, Piero, Gramaglia, & Abbate-Daga, 2004; Pollatos et al., 2008) and alexithymia (Bourke, Taylor, Parker, & Bagby, 1992; Schmidt, Jiwany, & Treasure, 1993). In Sachdev, Mondraty, Wen and Guillford’s (2008) neuroimaging study of healthy controls and women with AN, participants showed differential patterns of brain activation during viewing of self versus non-self images when compared to healthy controls, again highlighting the likely distortion of self-processing that occurs among those with AN in particular. Chapter Three also discussed of the possibility of disturbed neural representations of the body leading to a conscious experience of “otherness” or “wrongness” about the bodily self. In conscious, affective awareness, self-disgust has the potential to create a sense of inescapability from the self, possibly leading to a sense of hopelessness. Metaphorically, the body becomes the harness for the person, where the body cannot be avoided or escaped. Thus, methods are used to alter the experience of the body and self through modulation and manipulation of the body. Food is a medium that directly affects the body. It can change the bodily experience rapidly (reducing

hunger, changing temperature) and over time (weight loss or weight gain). The manipulation of food intake is also likely to increase a conscious experience of control into the helplessness that self-disgust may induce (Seligman, 1975). While self-disgust is likely one component of the conscious, affective experience of self in conditions like AN, the findings from this thesis evoke the need for considerations of the nature and experience of the body and self in eating disorders, and potentially highlight the need to investigate the underpinnings of these factors further.

Conceptualisations of anorexia nervosa as a condition shaped a distortion of self have also been explored in feminist and psychodynamic literature. According to psychodynamic perspectives, in early experience, the self is not separate from the bodily self, and body represents the vehicle through which the self and non-self interact (Sugarman, 1991). This is followed by a process of individuation of self and bodily self during early childhood, involving the development of other self-representations (i.e. psychological self), where parts of the bodily self are integrated into such representations (e.g. the integration of female genitals into self as female; Edgumbe, 1984). Sugarman (1991) suggested that in BN in particular, there is a failure of individuation of body and self, and consequent failures of body integration into particular representations of the self. This can arise as a result of unavailable or emotionally detached parenting styles, which inhibit the child's ability to develop emotional communication skills in a symbolic (verbal) manner, suppressing their development of 'self' and fixing it at this bodily level. Subsequently, during puberty, emotional experiences and conflicts are enacted at the bodily level, manifesting as symptoms such as bingeing and purging (Sugarman, 1991). Among psychoanalytic perspectives, it is likewise suggested that eating disorder behaviours arise due to intrapsychic conflict, which can also be regarded as conflict between different

aspects of the self (Rivto, 1988). These conflicts include sadomasochistic conflict (i.e. bingeing and purging as self-punishment), or gender-role conflict (i.e. maintaining low body weight as a means of maintaining a masculine physique; Rivto, 1988).

Building on other feminist writings, Lester (1997) argued that the concept of ‘self’ often proposed in psychological and biomedical literature fails to capture the inherent influence of society and gender. She asserted that the self becomes separated from the material body as a consequence of medicalised models focusing on physical emaciation and other medical consequences of the illness. The consequence of this is a perspective that assumes a “disembodied self”, where the self is separated from the physical body, and subsequently effaces subjective, ‘embodied’ experiences among sufferers of AN. Lester (1997) concluded that conceptualisations of the self and body in AN require far more elaborate and nuanced understandings of the “embodied self”, that are currently under-recognised in medical models of anorexia nervosa in particular.

9.4.3 Implications for explanatory models of eating disorders

The findings from these studies may have implications for aetiological models of eating disorders that feature self-disgust. Specifically, the findings of this thesis establish self-disgust as a prominent emotional experience for individuals with eating disorders, and thus lend support to models that feature self-disgust in the pathogenesis of these conditions. One such model is the Schematic, Propositional, Analogical and Associative Representational Systems for Eating Disorders (SPARRS-ED) model, proposed by Fox and Power (2009), which highlights disgust in the coupled emotional experiences that are purported to underlie relevant aspects of eating disorder pathology. The model suggests that coupled emotions interact in

ways that lead to the development of clinical symptoms, with anger and disgust constituting the paired emotions in eating disorders. In a further refinement of the model, Fox, Grange and Power (2015) stated that the primary experience of disgust in eating disorders may be self-directed, in that features of the self and the body become particular sources of disgust. Consequently, the findings of Studies One and Two offer an initial step towards establishing the relevance of the Fox et al. (2015) model, in that it supports the assumption that self-disgust is a prevalent feature among individuals with eating disorder pathology.

Another model that implicates disgust in eating disorder pathogenesis is Nunn, Frampton and Lask's (2012) noradrenergic model of AN. This model stipulates that dysfunction in the insular cortex, as a consequence of noradrenergic dysregulation, can potentially account for the cluster of key clinical symptoms observed in AN, including, primarily, a disrupted experience of self, gustatory disturbance, and extreme experiences of disgust (Nunn, Frampton, Fuglset, Torzok-Sonnevend & Lask, 2011; Nunn, Frampton & Lask, 2012). The insula is regarded as the central neural substrate responsible for both the perception and experience of disgust. The possibility that altered experiences of disgust are signals of insular dysfunction have also been suggested by Aharoni & Hertz (2012), in their study of disgust sensitivity in AN. The findings from this thesis add further support to this, with high self-disgust potentially indicative of insular dysfunction. However, there is clearly a need for further investigation of these models of eating disorders in regard to their broader features. Similarly, further replication and subsequent investigation of self-disgust in eating disorders, as well as externally-directed disgust, appears necessary before any clear causal links can be established.

9.5 Clinical Implications

9.5.1 Self-disgust and body image

The findings of Studies One and Two have clinical implications for the phenomenology and potential treatment of eating disorders. These studies are among the first to identify self-disgust as a relevant emotion in these conditions, representing an aspect of the complex emotional fabric that makes up the eating disorder experience. Self-disgust, by its description, is a visceral, self-directed emotion that is likely to have implications for one's self-regard, esteem and body image.

Body image is understood to involve several perceptual, cognitive and emotional components which cumulatively form an internal picture of the body, as well as our response towards this picture (Slade, 1994). Body image disturbance is common in eating disorder presentations, and is a core symptom of AN. However, 'poor' body image is a term also applied to the general appearance and body dissatisfaction that is common among women in western countries. Up to 70% of women report being dissatisfied with their appearance and body (Gagne et al., 2012; Miller et al., 2000; Watson et al., 2010). However, there appears to be a distinction between the 'normative discontent' experienced among the majority of women with poor body image, and those who go on to develop an eating disorder. In Study One, results from a large undergraduate sample suggested that the majority of individuals did not identify with the experience of self-disgust. This finding points to a potential distinction between the more typical experience of poor body image common in a non-clinical population, and the level of body image disturbance experienced in clinical eating disorder populations, which appears to involve visceral experiences of

disgust at the self and body. Future investigations of body image in eating disorders could potentially consider the role of “body disgust” in order to further establish this.

9.5.2 Implications for eating disorder treatment

Findings relating to disgust and self-disgust have potential implications for future eating disorder treatment approaches. There are a number of psychological treatments currently used to address eating disorders, with interventions typically targeting specific eating disorder behaviours and maintenance factors such as self-esteem and perfectionism. However, some clinicians in the field point to the need for further consideration of emotional components in the treatment of both AN and BN. Fox, Federici and Power (2012) highlighted the role of emotional processing and regulation in eating disorders, as well as the potential utility of emotion-centred treatment options, such as Dialectical Behavioural Therapy and Emotion Focused Therapy. It is possible that one such emotional component in need of attention is self-disgust. In particular, it may be useful to explore potential associations between experiences of self-disgust and specific eating disorder behaviours such as restriction, bingeing and purging. However, the precise relationship between self-disgust and specific clinical features of eating disorders is yet to be ascertained. These questions may be the focus of exploration in a clinical setting, or be addressed in further empirical research.

While Study Two failed to identify augmented, stimulus-independent disgust sensitivity and propensity among individuals with eating disorders, it remains possible that individuals with eating disorders may experience greater disgust sensitivity, potentially in response to particular disorder-relevant stimuli such as food and body parts (Aharoni & Hertz, 2012; Troop et al., 2002). Thus, it is interesting to consider how atypical disgust responses could be addressed clinically. One potential

approach would be to treat disgust sensitivity using exposure and extinction methods (Aharoni & Hertz, 2012). This approach is an expansion of exposure methods used in the treatment of atypical fear responses, which are consistently found to be effective in the extinction of specific phobias (Wolitzky-Taylor et al., 2008) and as a means of addressing avoidance behaviours in social anxiety disorder (Beidel & Turner, 2007; Feske & Chambless, 1995) and OCD (Abramowitz, 1996). However, emerging evidence suggests that disgust may, in fact, be resistant to extinction (Mason & Richardson, 2010, 2012; Olatunji, Smits, Connolly, Willems, & Lohr, 2007) and that exposure may result in further sensitisation to disgusting stimuli (Webb & Davey, 1992). The mechanism behind fear extinction is primarily related to the relevance of learning during exposure to fearful stimuli, such that the individual re-learns that the stimuli is non-threatening, and that their assumptions of harm are not met (Mason & Richardson, 2010). However, it is unclear whether this re-learning occurs in a similar way during exposure to disgusting stimuli. Mason and Richardson (2012) suggest that one factor that may interfere with the efficacy of exposure processes in disgust is the law of contagion. The law of contagion refers to the fact that once a “vehicle of contagion” (Rozin & Fallon, 1987, p29) comes into contact with an object, that object is tainted and thus continues to be a source of disgust: “once in contact, always in contact” (Haidt et al., 1994, p 702). This may be a factor that overrides any learning that occurs during disgust exposure processes, where an object is inherently contaminated and thus remains a threat. The permanency of contamination has also been demonstrated in disgust research; Haidt et al. (1994) referred to the fact that individuals will still refuse to drink out of a glass that has contained dog faeces, despite repeated washing and sterilisation. Thus, it is arguable whether using

exposure techniques in order to address disgust in eating disorders represents a viable means of treatment.

The potential utility of exposure in relation to self-disgust in AN was discussed in Chapter Three. Specifically, techniques such as mirror exposure or self-viewing were suggested as a means to expose and habituate individuals to their physical self and appearance. Some clinicians already advocate for the use of exposure techniques as a means of addressing body image in eating disorders. Waller et al. (2007) describe the benefits of mirror or video exposure techniques in order to address body anxiety and avoidance behaviours, promoting the use of exposure hierarchies similar to those employed in other fear exposure treatments. A pilot study of mirror exposure techniques in AN treatment also found improvements in levels of body image dissatisfaction and a reduction in avoidance behaviours when compared to treatment as usual (Key et al., 2002). However, following on from above, it is unclear whether such methods would ameliorate experiences self-disgust, or whether they could function to distress individuals further. Aspects of treatment that increase body awareness and potentially distress, such as weekly weighing, can also be subjects of contention in the clinical literature (Cooper & Fairburn, 2011; Ogden & Evans, 1996; Lask & Frampton, 2009) despite being seen as a core part of current evidence-based (cognitive-behavioural) treatments.

The results from Study One potentially point to an alternative treatment avenue for addressing self-disgust. As self-acceptance was identified as an opposing experience to self-disgust (as demonstrated by consistent factor loadings of items assessing self-acceptance in the SBDS), a method of addressing self-disgust in eating disorders may involve targeting levels of self-acceptance. A number of eating disorder prevention initiatives have already focussed on improving self and body

acceptance using dissonance-based treatment approaches (Stice, Shaw, Becker, & Rohde, 2008). Dissonance-based theory suggests that by facilitating cognitions that are inconsistent with original beliefs and attitudes, a shift towards the counter-attitudinal stance can occur (Festinger, 1962). These approaches are also purported to be potentially more successful as they do not involve directly challenging an individual's self-concept (Stice et al., 2008). Based on the findings of a phenomenological analysis of self-disgust in women with major depression, Powell et al. (2014) suggested that one potential means of reducing experiences of self-disgust was through the promotion of positive aspects of self. A subsequent study identified that participants engaging in an exercise affirming trait kindness resulted in a reduction in reported self-disgust levels, particularly disgust towards physical appearance, when compared to controls (Powell, Simpson & Overton, 2015). It was suggested that engaging in exercises that promote and re-affirm a valued personality trait may be an effective means to attenuating experiences of self-disgust. As such, addressing self and body acceptance in treatment may be a relevant avenue for self-disgust treatment, rather than (or opposed to) attempting to target disgust directly.

9.6 Limitations and Future Directions

9.6.1 Challenges in emotion measurement

Studies One and Two both involved the use of self-report measures of disgust and self-disgust. Self-report scales can be somewhat limited as measures of emotion, as they are influenced by the subjective interpretation of feeling states. This type of measurement cannot account for individual interpretations of a semantic label applied to a subjective experience, and thus, can result in greater response variability compared to more objective measures of emotion, such as psychophysiological measures. However, it is beyond the scope of this thesis to determine whether the

prevalent expressions of self-disgust among individuals with eating disorders involve a pure experience of disgust at the self and body, or whether responses to this scale also captured a general level of negativity towards to self. As suggested in the discussion of Study Two, it is possible that individuals with eating disorders exhibit negative bias towards themselves and their bodies, and thus may strongly endorse items on questionnaires that assess negative qualities of the self. Nevertheless, the items of the revised SBDS were designed in an attempt to assess experiences specific to, or synonymous with, disgust, rather than more generalised expressions of dislike towards the self.

Future studies may wish to address these issues by exploring self-disgust using broader means of assessment that incorporate both subjective and objective measures of emotional response. Chapter Four discussed the possibility of measuring self-disgust by applying similar methods of psychophysiological measurement used in externally-directed disgust, such as facial electromyography or other autonomic measures. The difficulties, both practical and ethical, associated with the measurement and elicitation of self-disgust in laboratory conditions, were also considered. An initial goal for future studies may be to establish whether self-disgust does indeed result in the same pattern of physiological response observed in general disgust responses. In regard to eliciting self-disgust, findings of Studies One and Two, together with prior research (Espeset et al., 2012), point to the possibility of using some form of body or self-viewing technique, such as mirror-viewing, that may be sufficient to induce a transient state of self-disgust among individuals with eating disorders, and potentially other conditions that also feature body disgust (i.e. body dysmorphic disorder, major depressive disorder). However, the ethical concerns associated with an approach such as this would still require mitigation.

9.6.2 Future explorations of self-disgust

Based on the findings of this thesis, developing understandings of the nature and function of self-disgust in eating disorders represents an avenue worthy of further research. In particular, future studies may wish to examine self-disgust in eating disorders at a qualitative, experiential level. In Powell et al.'s (2014) phenomenological investigation of self-disgust among women with major depressive disorder, the authors described common features of the emotion that typically involved an overwhelming, enduring, visceral experience of revulsion at the parts of the self and body, and often the self as a whole. Participants in the study also consistently expressed a desire to remove or purify the body and self of disgusting features, but a paradoxical inability to do so. It may be informative to compare these descriptions of self-disgust to those from an eating disorder population, in order to deepen understandings of the subjective experience. Such research would also assist in the broader consolidation of theoretical understandings of the self-disgust feeling state, which remains in its infancy.

It may be important to consider potential links between self-disgust and behavioural features of eating disorder pathology. As suggested earlier, experiences of self-disgust have the potential to drive rejection and avoidance behaviours, which, in eating disorders, may manifest as clinical symptoms such as restriction or purging. Certainly, Espeset et al.'s (2012) qualitative examination of negative emotions in AN suggested that disgust may serve such a function. Self-disgust could also represent an emotional motivator, as well as a consequence, of binge and purge behaviours. Binge/purge cycles are often described as emotion regulation strategies (Jeppson, Richards, Hardman, & Granley, 2003; Schupak-Neuberg & Nemeroff, 1993), and binge eating is commonly followed by emotions such as guilt and shame (Sanftner, Barlow, Marschall, & Tangney, 1995), triggering a compensatory response.

Similarly, purging has sometimes been characterised as a method of ‘purification’ or ‘cleansing’ (Boskind-Lodahl, 1976; Cross, 1993), both physically and morally. This description fits with a disgust-related experience of attempting to purify the body and self following contamination (Rozin & Fallon, 1989). Taking these descriptions together, it is possible that bingeing and purging could result in a self-disgust ‘spiral’, where bingeing elicits disgust at the self, and purging is used as a method to relieve disgust. However, further research will be necessary in order to elucidate the precise function of self-disgust in binge/purge behaviours, as well as broader eating disorder pathology.

The studies conducted here did not go so far as to determine whether self-disgust is modulated by treatment or by recovery. This would likely represent an additional avenue for further research in the area of self-disgust in eating disorders, and may shed light on whether self-disgust persists across varying stages of eating disorder illness and recovery. One feature of eating disorders that is said to commonly persist, often for years after remission, is a negative sense of body image. Self-disgust and concurrent body disgust are likely to be an emotional companion of negative experiences of body image, and as such, raise the possibility that they may persist even after weight restoration or eating disorder remission.

The findings from Study Two also highlighted the increased prevalence of self-disgust among those with major depressive disorder and social phobia. While a number of studies have already considered self-disgust in major depression (Powell et al., 2014; Simpson et al., 2013; Overton et al., 2008), future research could be extended to other conditions that typically involve negative evaluations of self, such as social phobia as studied here.. Self-disgust may have particular relevance among individuals who have experienced trauma and abuse, particularly sexual abuse, but

possibly extending to physical, emotional abuse and domestic violence (Harman, 2005; Ille et al., 2014). Previous studies of emotional responses among those with Post Traumatic Stress Disorder (PTSD) have consistently identified expressions of disgust among other self-critical emotions in victims (Harman, 2005; Rusch et al., 2011). Complex emotional responses to one's own body often arise following abuse experiences, and clinical descriptions often describe patients' expressions of revulsion or disgust at one's own body. Similarly, borderline personality disorder (sometimes referred to as complex PTSD) also emerges as a clinical group where previous experiences of trauma and abuse often lead to self-descriptions characterised by disgust. One study established links between disgust and self-concept among a sample of women with borderline personality disorder and a history of trauma and abuse (Rusch et al., 2011). The findings of Ille et al., (2014), which highlighted the prevalence of self-disgust in borderline personality disorder, appear consistent with this. Self-harm behaviours are often prevalent among this clinical group, and could be considered a behavioural response to self-disgust. There may also be a precedent for considering whether previous experiences of trauma and abuse potentially underpin broader expressions of self-disgust among other clinical groups, including among those with eating disorders. The potential utility of the SBDS in a clinical context also arises here, as it may provide a marker for explorations of factors underlying experiences of self-disgust, and facilitate necessary targeted therapeutic intervention. There is also emerging research implicating experiences of self-disgust among individuals diagnosed with some forms of cancer (Azlan, Overton, Simpson, & Powell, 2016; Powell, Azlan, Simpson, & Overton, 2016). As such, there may be a precedent for future

investigations of this emotion in broader pathology, including both psychological and medical conditions.

9.6.3 Future explorations of TMS as an emotion measurement tool

The exploratory nature of Study Three can be considered both a strength and limitation in this thesis. The investigation of TMS as a means of assessing facial signals of emotion was a highly novel premise, and offered potential as a tool that could add further specificity to existing psychophysiological measures of emotion. However, due to its exploratory nature, a number of methodological limitations arose. Nevertheless, this study has added further refinements to understandings of methodological designs needed in order to induce desired responses in disgust-relevant muscles such as the LL.

Despite the non-significant findings in Study Three, there may still be some value in the continued exploration of TMS as an emotion measurement tool. Future studies may wish to use the findings of Study Three as a preliminary point from which to attempt to establish whether TMS could be used as a reliable means of gauging emotional responses in relevant facial muscles. Future studies may consider investigating the effect of TMS on muscles other than the LL, such as the corrugator supercillii or the orbicularis oculi, both of which are associated with emotions of negative valence (Vrana, 1993; Yartz & Hawke, 2002).

9.7 Concluding Remarks

Disgust is an emotion with a curiously powerful, yet often under-recognised role in our daily existence. The role of disgust in psychopathology is often concurrently undervalued, with the majority of clinical and investigative focus typically placed on emotions such as fear. However, like fear, disgust functions to protect the safety and integrity of the self; both the physical self as a “guardian of the

mouth” (Rozin et al., 1994, p702), and the psychological, moral and ethical self. Equally, the disgust system can become dysfunctional in that disgust responses become exaggerated or misdirected towards stimuli that have become perceived as threatening.

Self-disgust emerges as an insidious aspect of disgust dysfunction, where the object of revulsion and abhorrence becomes the self, the body and one’s behaviours. Self-disgust has specific relevance among individuals with clinically diagnosed psychopathology, and based on the findings of this thesis, appears particularly prevalent among those with eating disorders. As such, this thesis has considered potential implications of self-disgust in regard to understandings of emotion in eating disorders, which appear in need of further emphasis placed on disgust alongside other relevant emotions. Considerations of self-disgust have also led to reflections on the nature and experience of self in eating disorders, particularly in AN, which appears to feature deficits that might undermine bodily awareness, and thus give rise to disownership, feelings of “other-ness”, and subsequent revulsion of the self. Finally, the clinical implications of self-disgust were considered, including the possibility of addressing self-disgust using dissonance-based treatment approaches, which may circumvent the difficulties associated with disgust extinction through exposure.

Based on the findings of this thesis, it can be concluded that disgust and self-disgust warrant further consideration in psychological research and practice. In particular, continued exploration of these emotional experiences in eating disorders appears necessary. This thesis also attempted to progress the operationalised measurement of disgust and self-disgust, in order to assist this process. Ultimately, the findings from this research may be expected to add theoretically and practically

to further explorations of disgust and self-disgust in eating disorders and more generally.

Chapter 10: References

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Appendix A: The Self and Body Disgust Scale

This questionnaire is concerned with how you feel about yourself. When responding to the statements below, please circle the appropriate number according to the following definitions: 1= Strongly agree, 2= Very much agree, 3= Slightly agree, 4= Neither agree nor disagree, 5= Slightly disagree, 6= Very much disagree, 7= Strongly disagree.

	<i>Strongly agree</i>			<i>Strongly Disagree</i>			
	1	2	3	4	5	6	7
1. I find myself repulsive.	1	2	3	4	5	6	7
2. I accept who I am.	1	2	3	4	5	6	7
3. I find the way I behave abhorrent.	1	2	3	4	5	6	7
4. I enjoy the company of others.	1	2	3	4	5	6	7
5. I accept the way I look.	1	2	3	4	5	6	7
6. Parts of my body are foul.	1	2	3	4	5	6	7
7. I enjoy being outdoors.	1	2	3	4	5	6	7
8. I find the way I behave acceptable.	1	2	3	4	5	6	7
9. I do not want to be seen.	1	2	3	4	5	6	7
10. I am a sociable person.	1	2	3	4	5	6	7
11. I often do things I find revolting.	1	2	3	4	5	6	7
12. Sometimes I feel happy.	1	2	3	4	5	6	7
13. It sickens me to look at myself.	1	2	3	4	5	6	7
14. Sometimes I feel sad.	1	2	3	4	5	6	7
15. I hate aspects of my personality.	1	2	3	4	5	6	7
16. When I walk around, I feel revolting.	1	2	3	4	5	6	7

Scoring

Self-disgust (total score): Reverse code seven items (1, 3, 6, 9, 11, 13, 16), then the sum of items 1, 2, 3, 5, 6, 8, 9, 11, 13, 16. All other items are filler items.

The minimum score is 10, and the maximum score is 70. High scores indicate high levels of self-disgust.

Main Reference: Overton, P. G., Markland, F. E., Taggart, H. S., Bagshaw, G. L., & Simpson, J. (2008). Self-disgust mediates the relationship between dysfunctional cognitions and depressive symptomatology. *Emotion, 8*(3), 379-385

The Self-disgust Scale (Original; Overton et al., 2008)

	<i>Strongly agree</i>					<i>Strongly disagree</i>	
1. I find myself repulsive.	1	2	3	4	5	6	7
2. I'm proud of who I am.	1	2	3	4	5	6	7
3. The way I behave makes me despise myself.	1	2	3	4	5	6	7
4. I hate being me	1	2	3	4	5	6	7
5. I enjoy the company of others.	1	2	3	4	5	6	7
6. I like the way I look.	1	2	3	4	5	6	7
7. Overall, people dislike me	1	2	3	4	5	6	7
8. I enjoy being outdoors.	1	2	3	4	5	6	7
9. I feel good about the way I behave	1	2	3	4	5	6	7
10. I do not want to be seen.	1	2	3	4	5	6	7
11. I am a sociable person.	1	2	3	4	5	6	7
12. I often do things I find revolting.	1	2	3	4	5	6	7
13. Sometimes I feel happy.	1	2	3	4	5	6	7
14. I am an optimistic person- filler.	1	2	3	4	5	6	7
15. It bothers me to look at myself.	1	2	3	4	5	6	7
16. Sometimes I feel sad.	1	2	3	4	5	6	7
17. I detest aspects of my personality.	1	2	3	4	5	6	7
18. When I walk around, I feel revolting.	1	2	3	4	5	6	7

Scoring

Self-disgust (total score): Reverse code nine items (1, 3, 4, 7, 10, 12, 15, 17, & 18), then the sum of items 1, 2, 3, 4, 6, 7, 9, 10, 12, 14, 15, 17, & 18. All other items are filler items.

The minimum score is 13, and the maximum score is 91. High scores indicate high levels of self-disgust.

Appendix B: Classics Revisited: Anorexia Nervosa (Apepsia Hysterica, Anorexia Hysterica), Sir William Gull, 1873

CLASSICS REVISITED PAPER

Anorexia Nervosa (Apepsia Hysterica, Anorexia Hysterica), Sir William Gull, 1873. *Advances in Eating Disorders*, 4(1), 112-117.

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Introduction

The paper “Anorexia Nervosa (Apepsia Hysterica, Anorexia Hysterica)” was originally written and presented in an address by Sir William Gull in 1873. Gull, 1st Baronet of Brook St, Queen’s physician and Jack the Ripper suspect, provided a succinct yet comprehensive description of the central features appearing to characterise the newly identified condition, focussing on three case descriptions and concluding with suggestions for potential treatment. Gull’s assertions followed a number of similar observations made earlier in the 19th Century by other physicians across Europe, who likewise described a condition specific to young women that involved a failure or refusal to eat resulting in severe, prolonged emaciation and associated medical effects. Gull’s seminal paper coined the initial establishment of the term Anorexia Nervosa (AN), while similarly marking the emergence of a modern perspective of the condition as it continues to be understood today.

The phenomenon of Anorexia Nervosa: Then and now

It is thought-provoking to compare the phenomenological features of AN as they were described over a century ago, to modern phenomena as seen and currently understood. Gull identified the occurrence of the condition to be most predominant in young women between the ages of 16 and 23, mirroring current AN epidemiology where the prevailing number of cases continue to fall within this gender and age group. Three cases are described in detail, the first relating to “Miss A”, a 17 year old girl who remained under Gull’s care for over 2 years. Gull remarked on her extreme emaciation and amenorrhoea despite normal vital and abdominal signs, concluding that her case was one of “simple starvation”. A lack of appetite leading to starvation and emaciation became the model for all patients subsequently discussed. “Miss B” presented a remarkably similar clinical picture to “Miss A”, and experienced similar

progressive recovery of weight loss through treatment consisting of “a nourishing diet”. In the paper’s addendum, Gull also mentioned a third case of a 15 year old girl who is again described as emaciated with no other abnormal symptoms. The refeeding prescribed by Gull and subsequent weight restoration of “Miss C” is documented through correspondence between Gull and the referring physician. In a final letter one year on, the patient is described as “plump and rosy as of yore”. Gull also mentioned that the condition can be observed, but to a lesser extent, in males, again reflecting the less common but still existent male AN variant. He similarly cited one case that ended in fatality, echoing the high mortality rate that still unfortunately remains associated with this disorder, the highest of all mental health conditions.

The similarities between 19th century descriptions and modern diagnostic criterion are also noteworthy. Gull described the physical characteristics of emaciation, and ascribed certain medical observations including oedema, bradycardia and amenorrhoea, to secondary side effects associated with the starvation state. He commented upon the resolution of these symptoms upon weight restoration as evidence that they could be attributed to underlying medical pathology such as a digestive disease (previously reflected in use of the term *aepsia*, meaning ‘without digestion’), or consumptive complaint suggested in the original referrals (it is also worth noting that some modern accounts suggest that Gull may have mis-diagnosed one of his described patients, who was likely to have suffered from hyperemesis gravidarum during pregnancy). While a specific fear of weight gain in the patients is not mentioned, behaviours that interfere with weight gain are described, most centrally an aversion to food and failure to eat and drink, thus giving rise to Gull’s use of the term *Anorexia* taken from Greek meaning ‘without appetite’. Gull, as well

as his correspondent physician in the paper's addendum, described the patients as obstinate in attitude and resistant to re-feeding. This obstinacy led to Gull's assertion that "the patient's inclinations must in no way be consulted". He clarified this statement by expressing his own moral struggle between not wanting to "force food", but ultimately being unable to ignore the dangers associated with ongoing starvation, a dilemma that continues to be experienced to date by many clinicians and treatment teams regarding the use of parenteral refeeding approaches. Finally, Gull commented on the likelihood that the state of starvation appeared to have developed from a "morbid state of mind", thus proposing the use of the term *Nervosa* as a more accurate term than *hysterica*.

While these descriptions are marked in terms of similarity to modern expressions of Anorexia Nervosa, our attention is also inevitably raised to the differences and gaps. Shape and weight disturbance, currently regarded as a central feature of AN, are absent from Gull's descriptions. It is unclear whether this is purely due to Gull's failure to assess or comment on his patient's experience of their shape and weight, or the actual absence of this clinical feature. Similarly, Gull did not refer to any specific weight control behaviours outside food restriction. There are no descriptions of specific eating patterns, food choices or food rules that might provide some understanding of contemporaneous disordered eating. Little depiction of patients' emotional state is offered, with descriptions limited to one patient who was "peevish of temper", and possible behavioural indicators of anxiety or depression such as sleeplessness and agitation. The histories of the patients are also unknown, offering frustratingly little insight into the medical, familial, social and other contextual factors that may have been involved in the pathways leading to these Victorian cases of AN.

Treatment

Gull made several recommendations for the treatment of this new condition. His recommended ‘first line’ of treatment remains the same today: refeeding. Gull specified that a nourishing diet was sufficient to reverse the medical effects associated with starvation and that food should be delivered to the patient at regular intervals. He made specific suggestions of certain foods, such as milk and chicken, perhaps purposefully or inadvertently pointing towards calorie rich foods. Gull suggested that family members may be “the worst attendants”, striking a difference from many modern outpatient re-feeding practices for adolescents such as Family-Based Therapy, where parents are supported to re-feed their child.

A further, slightly more obscure treatment suggestion also made by Gull is application of external heat. Gull’s proposal to apply heat through a tube of warm water placed down the length of the patient’s spine seemed to stem from referenced suggestions that it can assist with digestion. While the application of heat as a treatment in AN now seems somewhat anomalous, the suggestion has not been completely dismissed by modern research. In fact, several case series as well as a randomised control trial have assessed heat as a treatment in AN. Guitierrez and Vasquez (2001) report on several case series where heat was applied in different forms (e.g. a heating vest and sauna visits), resulting in a decrease in excessive activity and exercise followed by a progressive increase in weight gain. However, the following RCT identified no increases in the rate of weight gain among individuals who wore heating vests for 3 hours a day over 3 weeks (Birmingham, Gutierrez, Jonat, & Beumont, 2004). While Gull’s second treatment suggestion has not been completely ignored by modern research, it is still unclear whether it is a treatment worth ongoing revisitation.

Gull on Excessive Physical Activity

A characteristic of these cases that Gull repeatedly highlighted is the restlessness and excessive physical activity he observed in all of his patients. He commented on the apparently paradoxical nature of this excessive activity, stating that “it seemed hardly possible that a body so wasted could undergo the exercise which seemed agreeable”. While descriptions of excessive restlessness and physical activity take centre stage in Gull’s characterisation of AN, and are a central feature of other 19th Century descriptions of AN, this contrasts with the majority of modern conceptualisations. While excessive physical activity in the form of driven exercise is routinely assessed and managed clinically, it is often regarded as a method of deliberate weight control. Similarly, signs of hyperactivity or compulsive motor behaviour in AN patients have been linked with potential comorbid conditions such as Obsessive Compulsive Disorder and ADHD.

However, the focus in Victorian descriptions supports alternative modern assertions that excessive physical activity represents a fundamental feature of AN (Davis et al., 1997; Hebebrand et al., 2003; Kron, Katz, Gorzynski, & Weiner, 1978). Similarly, it raises questions regarding whether excessive exercise is a deliberate weight control method, or whether there is a potentially irrepressible level of restlessness and activity, which is then exhibited and reinforced through driven/compulsive exercise. The existence of ‘adventitious movements’ in AN, for example unconscious and repeated foot and leg jiggling, is widely observed and referenced clinically. In research, studies have identified similar patterns of hyperactivity in animal models of Activity Based Anorexia using rats and mice (Dwyer & Boakes, 1997; Routtenberg & Kuznesof, 1967), which differs from the normal suppression of physical activity in response to starvation. Bio-behavioural

explanations of excessive activity in AN suggest that it may be a response to disturbed thermoregulation (Gutierrez & Vazquez, 2001) or altered hormonal production secondary to food restriction (Hebebrand et al., 2003). Regardless of potential mechanisms, it is interesting to re-consider the relevance and nature of this common feature of AN, perhaps attending to Gull's primary assertion as we move forward in our research and practice.

The origins of Anorexia Nervosa

While Gull's paper marks one of the first usages of the term Anorexia Nervosa, an examination of historical accounts of the condition inevitably raises our awareness to the origins of the condition itself. Does Gull's description represent an early step into the medicalization of cases of self-starvation, which was previously conceptualised as ascetic fasting or demonic possession? Are the fasting saints and 'possessed' maidens seen as early as the 12th century historical cases of Anorexia Nervosa? Or did Anorexia Nervosa actually 'emerge' in the Victorian period, where it was identified and defined by physicians such as Gull?

While we have moved past understandings of eating disorders as 20th Century conditions purely brought on by modern social-cultural pressures to be thin, historical accounts of AN are yet to be reconciled. A number of individuals have been retrospectively labelled as sufferers of Anorexia Nervosa, including Saint Catherine of Siena and Joan of Arc. Alternatively, others suggest that these past 'cases' cannot be considered as incidences of AN as it is understood today, arguing that instances of self-starvation and food abstinence are essentially culture-bound and cannot be separated from their socio-cultural context (Brumberg, 1988). In 'Fasting Saints and Anorexic Girls', Vandereycken and Van Deth (1994) argue that AN as it currently exists emerged in the Victorian Period, influenced and produced through

changes in family relationships and changing definitions of beauty, among other factors. This coincided with the increased medialisation of abnormal physical and psychological phenomena (Vandereycken & Van Deth, 1994). This line of thought supports the notion that these European physicians such as Gull (Laseque, the French physician, should also be mentioned here) did indeed identify a novel, emerging pathology in the late 19th century. Despite such unresolved arguments in regard to its exact origins, Gull's paper certainly indicates that a recognisable form of AN was in existence in Victorian England.

Theoretical Implications

Can an examination of Gull's 19th century description of AN support modern aetiological theory? While we have the luxury of applying modern aetiological models to these retrospective cases of AN, there is sadly little in Gull's descriptions that can confirm or deny current explanations. Nevertheless, taking the generally accepted bio-psycho-social model, the existence of AN cases in the 19th century could be taken as evidence of the biological origins of the condition; that it must have an biological basis as it transcends time periods and shifts in culture. The similar epidemiology also lends support to this. Such arguments might also promote the opinion of other historical cases of AN prior to the Victorian period, even as far back as the Middle Ages. However, others might argue that Gull's descriptions lend greater support to the social arm of the bio-psycho-social model; that AN was and remains predominant among white, Western women who are exposed to particular culturally determined standards of beauty.

Gull's paper may also lend support to epigenetic arguments; that certain genetic and biological potential needs a specific environmental 'key' to unlock it. AN, as it was first identified in the 19th Century and as it continues to be observed,

could well be attributed to this. Such theories also make room for alternative historical views of AN, where possibly some genetic potential to tolerate food restriction was merely expressed in different ways, based on cultural and environmental contexts.

Gull's paper is also ultimately a reminder that the theoretical models and labels we apply are just that: labels and models. We are currently looking at that we call 'Anorexia Nervosa' through a specific medical and psychological lens, which in itself is bound by culture and time.

Research Implications

While underlying causes and treatments of AN continue to be exhaustively researched, and new knowledge emerges every day, Gull's paper can be taken as a general reminder that in research, it can be as useful to look back as much as it is to look forward. Work such as Gull's, while purely descriptive, offer researchers a chance to identify and investigate AN phenomena that have stood the test of time. Similarly, such work can continue to provide fertile ground for contemporary research, as we have seen with the studies of external heat treatments, as well as the continued investigation of mechanisms behind excessive physical activity.

Clinical Implications

Gull's paper represents one of the earliest clinical case studies of AN. Three cases are followed from assessment to post-treatment; images of the patients before and after re-feeding are included to demonstrate weight re-gain (we have moved on for ethical and scientific reasons to reporting pre and post-treatment Body Mass Index). On a much broader level, Gull's paper is also representative of the medicalised approach to abnormal patterns of eating and weight change that took hold in the 19th Century and continues to prevail. During the 20th Century, this

expanded to a psychological approach, and various methods of clinical treatment were developed and revised. Gull's paper can be taken as a reminder of the continued importance of medical stabilisation and re-feeding; yet it can also remind us that we have since learned the importance of the patient's internal, psychological world, and that an outward appearance of weight restoration is a brittle indicator of AN recovery.

Conclusion

The field of eating disorders owes much more to Gull than simply identifying and naming Anorexia Nervosa. In many ways, the work done by Gull and his contemporaneous colleagues also represents the origins of the development and growth of much of modern understanding, research and treatment of a condition that has continued to affect many thousands of individuals over the past 150 years. In light of this, Gull's 1873 paper can be considered one of *the* classic works in the field of eating disorders, which has most certainly stood the test of time.

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