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From deontology to disorder: an examination of moral and pathological disgust

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FROM DEONTOLOGY TO DISORDER: AN EXAMINATION OF MORAL AND PATHOLOGICAL DISGUST

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Disgust is expressed in response to sources of contamination and disease, and also arises in response to violations of moral norms. The overlap in these two functions had led some theorists to suggest that moral disgust may be an example of exaptation – the evolutionary process whereby the function of a trait shifts to serve a secondary purpose. This has important implications for our understanding of moral reasoning as it suggests that moral judgments may be driven by early affective processes, rather than by more recently evolved higher order cognitive functions. However, critics argue that disgust expressed in a moral context may simply be used either metaphorically to convey anger or to draw similarities with acts that are prototypically offensive. Therefore, the first aim of the current research was to examine whether disgust was uniquely implicated in moral judgment, over and above the emotion of anger. Using a variety of assessment tools, including facial electromyography, the first study in this thesis examined the specificity of the link between disgust and morality. Results showed that physical disgust at the trait, state and physiological level was more closely associated with moral transgressions than anger, indicating that expressions of disgust in moral contexts is not simply metaphorical. Building on this, the next two studies provided a further examination of the link between disgust and morality within the context of obsessive-compulsive disorder (OCD) - a psychological disorder that is often characterised by heightened disgust and moral rigidity. Results showed that individuals with OCD experience stronger disgust than those with other forms of anxiety, and that trait disgust has a distinct impact on moral reasoning in individuals with OCD compared to individuals with other anxiety disorders. In the final two studies a clinical approach was adopted, providing the first investigation into the effects of a novel cognitive bias modification paradigm on disgust responding. The findings outlined in the five studies of this thesis provide novel evidence in support of an exaptation model of moral disgust, as well as a crucial first step in investigating novel adjuncts to the treatment of pathological disgust.

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Abstract

Disgust is expressed in response to sources of contamination and disease, and also arises in response to violations of moral norms. The overlap in these two functions had led some theorists to suggest that moral disgust may be an example of exaptation – the evolutionary process whereby the function of a trait shifts to serve a secondary purpose. This has important implications for our understanding of moral reasoning as it suggests that moral judgments may be driven by early affective processes, rather than by more recently evolved higher order cognitive functions. However, critics argue that disgust expressed in a moral context may simply be used either metaphorically to convey anger or to draw similarities with acts that are prototypically offensive. Therefore, the first aim of the current research was to examine whether disgust was uniquely implicated in moral judgment, over and above the emotion of anger. Using a variety of assessment tools, including facial electromyography, the first study in this thesis examined the specificity of the link between disgust and morality. Results showed that physical disgust at the trait, state and physiological level was more closely associated with moral transgressions than anger, indicating that expression of disgust in moral contexts is not simply metaphorical. Building on this, the next two studies provided a further examination of the link between disgust and morality within the context of obsessive-compulsive disorder (OCD) - a psychological disorder that is often characterised by heightened disgust and moral rigidity. Results showed that individuals with OCD experience stronger disgust than those with other forms of anxiety, and that trait disgust has a distinct impact on moral reasoning in individuals with OCD compared to individuals with other anxiety disorders. In the final two studies a clinical approach was adopted, providing the first investigation into the effects of a novel cognitive bias modification paradigm on disgust responding. The findings outlined in the five studies of this thesis provide novel evidence in support of an exaptation model of moral disgust, as well as a crucial first step in investigating novel adjuncts to the treatment of pathological disgust.

Contents

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Publications and Presentations

A number of the studies reported in this thesis have been published, or submitted for publication, and disseminated at conference presentations as outlined below:

PUBLICATIONS

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Chapter 3:

Whitton, A.E., Henry, J.D. & Grisham, J.R. (in press). Moral rigidity in obsessive-compulsive disorder: Do abnormalities in inhibitory control, cognitive flexibility and disgust play a role? *Journal of Behavior Therapy and Experimental Psychiatry*.

Chapter 4:

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Chapter 5:

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Whitton, A.E., Henry, J.D., Rendell, P.G. & Grisham, J.R. (2012). Turning one's nose up at the wrong and the rancid: Disentangling the effects of anger and disgust in physiological responses to moral transgressions. *International Journal of Psychophysiology, 85*, 364-365.

CONFERENCE PRESENTATIONS

Whitton, A.E., Henry, J.D. & Grisham, J.R. (July, 2013). *Cognitive and affective correlates of moral rigidity in obsessive-compulsive disorder.* Paper presented as part of a symposium at the 7th World Congress of Behavioural and Cognitive Therapies, Lima, Peru.

Whitton, A.E., Henry, J.D., Grisham, J.R. & Rendell, P.G. (September, 2012). *Pathological disgust and the basal ganglia: An examination of disgust responding in obsessive-compulsive disorder.* Poster presented at the 16th World Congress of Psychophysiology, Pisa, Italy.

Whitton, A.E., Henry, J.D., Rendell, P.G. & Grisham, J.R. (September, 2012). *Turning one's nose up at the wrong and the rancid: Disentangling the effects of anger and disgust on physiological responses to moral transgressions.* Poster presented at the 16th World Congress of Psychophysiology, Pisa, Italy.

Whitton, A.E., Henry, J.D., Grisham, J.R. & Rendell, P.G. (November, 2011). *Subjective and psychophysiological disgust responding in obsessive-compulsive disorder.* Poster presented at the Society for Neuroscience (SfN) Annual Meeting, Washington DC, USA.

Whitton, A.E., Henry, J.D., Grisham, J.R. & Rendell, P.G. (November, 2011). *The psychophysiological profile of 'pathological disgust'*. Poster presented at the Association for Behavioural and Cognitive Therapy (ABCT) Convention, Toronto, Canada.

Whitton, A.E., Henry, J.D., Grisham, J.R. & Rendell, P.G. (October, 2011). *The psychophysiology of 'pathological' disgust.* Paper presented at the Australian Association for Cognitive Behavioural Therapy (AACBT) Annual Conference, Sydney, Australia.

Whitton, A.E., Henry, J.D., Rendell, P.G. & Grisham, J.R. (April, 2011). *Disentangling the role of anger and disgust on moral judgment: Toward a physiological profile of 'moral disgust'*. Paper presented for the Outstanding Postgraduate Research Award Finalists competition at the Society for Australasian Social Psychologists (SASP) Annual Convention, Sydney, Australia.

Whitton, A.E., Henry, J.D., Rendell, P.G. & Grisham, J.R. (November, 2010). *The role of disgust in moral judgment.* Poster presented at the Australasian Cognitive Neurosciences Conference, Melbourne, Australia.

Whitton, A.E., Henry, J.D., Rendell, P.G. & Grisham, J.R. (November, 2010). *The role of disgust in moral judgment.* Paper presented at the Third Annual Sydney Postgraduate Psychology Conference, Sydney, Australia.

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"Disgust makes beauty and ugliness a matter of morals"

- William Ian Miller

Chapter 1

GENERAL INTRODUCTION

Disgust is elicited both by sources of contamination and acts that violate social or moral norms, an overlap which suggests that physical disgust may have evolved into a separate moral form. Contaminant-based disgust constitutes one component of a multifaceted behavioural immune system designed to protect against disease, whereas moral disgust exists across all cultures yet its foundation remains uncertain. Both forms are particularly acute in individuals with obsessive-compulsive disorder (OCD), as there is evidence that heightened physical disgust and moral rigidity can co-occur in individuals with the disorder. This overlap between physical and moral disgust has led some theorists to suggest that moral disgust may represent an example of exaptation, the process by which the function of a trait shifts to adopt another role although the basic form of that trait remains unchanged. Feathers, for instance, evolved for insulation and display but were later co-opted for flight. Similarly, disgust evolved to protect the body against sickness and infection, but may now also underpin our visceral responses to depravity. This has important implications for our understanding of morality, as it suggests that moral reasoning may draw on early evolutionary precursors rather than being the result of more recently evolved higher cognitive processes. Critics argue, however, that disgust expressed in the moral sense may in fact be used metaphorically to convey anger. This too has implications for our understanding of moral behaviour, as disgust and anger have biologically opposing motivational tendencies – disgust is characterised by passive avoidance and anger by active approach.

CHAPTER 1

Research examining disgust's role in morality has increased exponentially over the past decade. Although prior work has made important contributions to establishing a link between physical disgust and moral judgment, methodological shortcomings limit inferences about whether this link is unique. This is at least partially because past research relies heavily on the use of self-report of emotional experience to draw similarities between physical and moral disgust. Given the high degree of semantic overlap between the emotional labels 'disgust', 'anger' and 'moral disgust', this method of assessing emotional experience lacks the precision needed to determine whether exposure to contaminants elicits the same emotion as exposure to moral transgressions. Furthermore, no research to date has examined whether heightened physical disgust is related to moral rigidity in individuals with OCD. Establishing a link between disgust and morality in the context of a psychological disorder with established biological underpinnings would provide further evidence that moral disgust may represent a biological expansion of physical disgust into the moral domain.

Therefore, the first aim of the current program of research was to evaluate the specificity of the link between physical disgust and morality. Sensitive physiological measures were used to index emotional responding in four of five studies. The first in this series of experiments examined whether responses to moral transgressions are best defined as an expanded form of physical disgust or if they are instead more closely related to anger. The second experiment assessed whether individuals with OCD showed evidence of psychophysiological disgust responses that extend beyond normative disgust responses, and the third experiment examined if trait levels of disgust responding relate to the moral rigidity often observed in those with the disorder.

The presence of pathological disgust in psychiatric disorders also has important clinical implications. This is because disgust responses are slower to extinguish using

conventional exposure-based treatments and are typically more resistant to direct cognitive challenge. In light of such findings, the second aim of this program of research was to design and evaluate a novel adjunct to treatment that may aid in the amelioration of maladaptive disgust responses. The goal of the final two experiments in this series was therefore to evaluate the effectiveness of a novel paradigm, known as cognitive bias modification of interpretation (CBM-I), for reducing disgust responses in both non-clinical individuals and those with OCD.

Outline of introduction

The first part of this introductory chapter will provide an overview of the origins and sources of disgust as a basic emotion, as well as influential models of the function and evolution of the disgust response. Following this, there will be a discussion of the evidence implicating disgust in morality, competing models of moral disgust, and the implications each has for our understanding of moral reasoning and behaviour. Limitations of existing research will then be identified, with a particular focus on the methodological factors that limit inferences about whether the link between disgust and morality is unique. This will then be followed by an outline of how the current program of research will address these limitations through the use of psychophysiological measures of emotional responding, appropriate comparison control stimuli and by examining links between disgust and morality in the context of OCD.

The second part of this chapter will review evidence for the unique role of disgust in OCD, independent of anxiety. Theories regarding the method by which disgust responses may become pathological and contribute to obsessive-compulsive symptoms will then be outlined. Limitations of existing treatment models will be

discussed, and the potential applicability of CBM-I training as an adjunct to the treatment of disgust-based symptoms will be outlined. This will be followed by a brief overview of CBM-I research and a proposal of how a novel CBM-I program may be used to modify disgust responses.

Origins of disgust

Disgust is recognised as one of the six basic emotions, described by Darwin as "something offensive to the taste" (Darwin, 1872/2000, p. 123). The word disgust literally means 'bad taste' and was considered by early theorists to aid in restricting sexual fantasies to socially acceptable practices (Freud, 1953), or as a primary reaction against unwanted intimacy (Tomkins, 1963). However, more recent theorists align with Darwin, conceptualising disgust as a guardian of the mouth (Haidt, Rozin, McCauley, & Imada, 1997) that elicits a sense of "revulsion at the prospect of oral incorporation of an offensive object" (Rozin & Fallon, 1987, p. 23). Since Rozin and colleagues' pioneering work (Rozin & Fallon, 1987), research into the varieties, structure, function and treatment of disgust has increased dramatically, with some researchers suggesting that disgust may be the primary emotion of interest for the 21st century (Power & Dalgleish, 1997). Since beginning this program of research in 2009 nearly 400 articles have been published on the topic of disgust and in 2012 the first conference solely dedicated to disgust research was held, which highlights the current importance and widespread interest in this emotion.

Common sources of disgust

Disgust appears to be universal, as it is experienced across every culture. Darwin himself observed this when he was traveling in South America and a Tierra del Fuego native examined the texture of the cured meat that he was eating. Darwin describes how the native "plainly showed utter disgust at its softness; whilst I felt utter disgust at my food being touched by a naked savage" (Darwin, 1872/2000, p. 123). Although Darwin uses this experience as evidence of disgust crossing cultural divides, it is noteworthy that each found distinct elements of the situation disgusting.

There is huge variation in the objects, sensations, people, places and activities that elicit disgust at both the cultural and the individual level. Among the most common sources of disgust are: bodily secretions such as faeces, vomit, sweat, saliva, blood, pus and sexual fluids; body parts, including nail clippings, hair, wounds, dead skin and corpses; cues signalling decay, such as spoiled meat, mould and garbage; specific animals, particularly those that are perceived to carry disease like cockroaches, lice, maggots, worms, rats, snakes and pigs; surfaces that may be contaminated, including public toilets, rubbish, other people's clothes or bed sheets; and certain groups of people, such as the ill, the deformed and those of low social status. Sensory cues alone can also be strong elicitors of disgust, including unpleasant smells or tastes as well as textures that feel slimy or gritty. Even temperature can elicit disgust, particularly climates that feel moist, clammy, or lukewarm. These are, as Miller (1997) describes, "those ranges in which life teems…sufficient to get the old life soup bubbling, seething, wiggling, and writhing, but not so great as to kill it." (p. 64).

CHAPTER 1

The function of disgust

A response culturally evolved from distaste

One of the pioneers in disgust research, Paul Rozin, argues that the disgust response has its origins in food rejection but has expanded through a process of cultural evolution to include anything that reminds us that we are fundamentally biological creatures (Rozin, Haidt, & McCauley, 2008). Although disgust is still expressed via the basic distaste system, he proposes that the disgust response has expanded to include ideational components of the source, such as its origins and social history. One of the key functions of this response, which Rozin terms 'animal-reminder disgust', is to create a sense of revulsion that forces us to avoid contemplating the most threatening aspect of our 'animalness': our own mortality (Rozin et al., 2008). Rozin and colleagues posit that the existence of specific types of disgust elicitors – such as body fluids, inappropriate sexual acts, poor hygiene, gore, deformity and death – provide support for this theory, as each can be conceptualised as a reminder of our animal nature (Rozin et al., 2008). Furthermore, they note that many culturally learned disgust-based social practices – including norms surrounding the consumption and preparation of foods, sexual taboos, as well as hygiene practices – evolved through a process of civilisation in order to widen the gap between human beings and animals (Haidt et al., 1997).

A biologically evolved disease-avoidance system

Other theorists argue that the disgust response evolved purely through a process of biological evolution constituting part of an adaptive psychological, physiological and behavioural repertoire designed to promote biological fitness (Curtis, Aunger, & Rabie, 2004; Curtis, Barra, & Aunger, 2011; Curtis & Biran, 2001; Fessler, Eng, & Navarrete, 2005; Fleischman & Fessler, 2011; Nesse & Williams, 1995; Oaten, Stevenson, & Case, 2009; Olatunji & Sawchuk, 2005; Pinker, 1998; Stevenson & Repacholi, 2005; Tybur,

Bryan, Magnan, & Hooper, 2011; Tybur, Lieberman, Kurzban, & DeScioli, 2013; Tybur, Merriman, Hooper, McDonald, & Navarrete, 2010). Indeed, many of the stimuli that elicit disgust pose a risk for disease, such as body waste or spoiled food, while others can be linked to the threat of reduced biological fitness, such as incest (Fessler & Navarrete, 2004). Nesse and Williams (1995) argue that disgust motivates the avoidance of excrement and contagious people because it is a response designed to ensure that we maintain our distance from pathogens. Similarly, Pinker (1998) conceptualises disgust as a form of naturally selected 'intuitive microbiology' that allows us to detect substances and environments which are likely to have a high pathogen loading. One of the most recently proposed theoretical models posits that disgust operates in three distinct domains: pathogens, sex and morality. Each of these domains can be conceptualised as defences against threats to our biological fitness: pathogens pose threat for disease, selecting inappropriate sexual partners (e.g., siblings) may lead to biologically inferior offspring, and immoral acts threaten societal cohesion.

Theories of disgust as a disease-avoidance system more heavily weigh the influence of natural selection than does Rozin's account (Rozin et al., 2008), which more strongly emphasises cultural influences. Indeed, Tybur and colleagues contest Rozin's theory that disgust elicitors classified under his domain of animal-reminder disgust, such as blood or death, elicit disgust because they are reminders of our animal nature, instead arguing that each can be explained as a form of pathogen avoidance. Furthermore, they posit that one of the key responses that fall under the guise of animal-reminder disgust - avoidance of corpses - is not a uniquely human behaviour, and can be better explained as a protective response against infectious microbes that may colonise corpses (Tybur et al., 2013).

Rozin rejects the idea that disgust evolved entirely as a disease-avoidance mechanism and notes that not all decaying things elicit disgust (Rozin & Fallon, 1987). He also notes that purely biological accounts of disgust fail to account for the variation in the nature and social practices surrounding disgust across different cultures (Rozin & Haidt, 2013). Furthermore, he argues that religions, which are inherently culturally-derived constructs, often prescribe practices relating to disgust-based behaviour - including food, hygiene and sex - and are also motivated in part by helping us to cope with our own mortality. In response, Curtis and Biran (2001) note that decaying foodstuffs that do not elicit disgust are usually those that do not pose a high threat for disease. For example, mouldy cheese poses a low risk for illness and elicits substantially less disgust than decaying meat, which is more likely to harbour the kinds of pathogens that would pose a threat to our physical health. This provides further support for a disease-avoidance model of disgust, because food-based disgust responses are seen to vary in accordance with the pathogen loading of different types of food.

As is evident, theories surrounding the function of the disgust response have only emerged very recently in the literature. Despite the apparent universality of this emotion and the power it has over behaviour at the individual and cultural level, research into the factors that have shaped disgust's expansion beyond distaste is still in its infancy.

CHAPTER 1

Disgust as a moral emotion

The growing body of research into the function of disgust has also led to an interest in its function as a more complex moral emotion. Three lines of research of research now show evidence of a link between disgust and moral judgment, the first of which are studies showing that moral transgressions elicit disgust. This line of research is comprised of studies that typically show evidence of disgust's relationship with morality either by measuring self-report of emotional experience, through theory-driven classification systems of disgust elicitors, or by measuring facial expressions of emotion in response to moral transgressions.

Moral transgressions elicit disgust

Self-report based studies

In the most basic form, studies that have presented participants with moral transgressions have shown that they elicit increased self-reported disgust. Thus, disgust is reported in response to acts that are deemed to be morally unacceptable, such as cannibalism, paedophilia, incest, hypocrisy, servility and betrayal (Haidt et al., 1997; Miller, 1997). Furthermore, individuals of low moral standing are often viewed as polluted or impure, and others experience aversion at the thought of coming into contact with them or handling things that they have owned or touched (Rozin, Markwith, & McCauley, 1994)

The expression of disgust in response to violation of moral norms appears to be a phenomenon that exists across cultures. For example, using responses from 251 passengers at Athens International Airport replying to an open ended question of what they found disgusting, Curtis and Biran (2001) found five broad categories of disgust

elicitors could be discerned: bodily excretions and body parts; decay and spoiled food; particular living creatures; certain categories of 'other people'; and, notably, violations of morality or social norms.

Theory-driven classification systems

The large degree of heterogeneity in sources of disgust has led some researchers to propose theory-driven classification systems that group specific elicitors into discrete domains based on their function. Several of these systems include a moral domain. Rozin and colleagues (2008), for example, classified disgust elicitors into four broad categories pertaining to core, animal-reminder, interpersonal and socio-moral disgust. Socio-moral disgust was described as a domain that represents a reaction to specific moral transgressions that indicate that a person is morally corrupt or possesses socially unacceptable motivations. As mentioned previously, Tybur and colleagues' (2013) model also includes a domain of moral disgust. In support of their model, Tybur, Lieberman and Griskevicius (2009) showed that scores on a measure of primary psychopathy (a trait characterised by social norm violation, disinhibition and aggression) were negatively related with the moral disgust domain but not with the pathogen domain. These results were replicated in a large undergraduate sample and a community sample, and were interpreted as evidence that a core component of disgust sensitivity may relate to moral behaviour.

Studies of facial expression

Further evidence that moral transgressions elicit disgust comes from studies that have used facial expressions of emotion to index emotional responding to moral transgressions. Typically, facial expressions of emotion are measured using a coding system where trained coders categorise movements into specific facial motor action

units that pertain to individual expressions. Rozin, Lowery and Ebert (1994) conducted a study in which participants were presented with a series of photographs of faces comprising different combinations of facial motor action units that depicted variations of the disgust expression - including the mouth gape, upper lip raise and nose wrinkle - as well as expressions of fear, anger and surprise. Participants were asked to choose which of the expressions they would associate with a set of disgust elicitors. Different motor units of the disgust face were found to be associated with different forms of disgust: the nose wrinkle was associated primarily with unpleasant smells and tastes; the gape with oral irritation; and the upper lip retraction with reminders of animal origins, interpersonal contamination, and moral offence.

More recently, facial expressions of emotion have been measured using a technique known as facial electromyography (EMG), which involves placing small sensors over the facial muscles that detect and amplify electrical signals emitted from the facial muscles as they contract. Muscle activity over the *levator labii superioris* (the muscle next to the nose which causes the upper lip to retract during facial expressions of disgust) has been proposed as a possible indicator of moral disgust and has been shown to be especially active when participants are exposed to unfairness (Chapman, Kim, Susskind, & Anderson, 2009). The results of a recent study that used facial EMG to assess physiological responses to the five moral foundations proposed by Graham, Haidt and Nosek (2009) support this hypothesis. Comparing activation of the *levator labii* muscle, with that of the *corrugator supercilii* (the muscle which draws the brow in when frowning) and the *zygomaticus major* (the muscle which retracts the corners of the mouth when smiling), Cannon, Schnall and White (2011) found that *levator labii* muscle activity correlated most strongly with condemnation of moral purity violations.

The authors interpreted these data as evidence that moral transgressions elicit facial expressions of disgust.

Disgust influences moral transgressions

The second line of research linking disgust to morality comes from studies showing that increasing feelings of physical disgust impacts on the severity of moral judgments. For example, higher trait disgust sensitivity has been shown to be associated with increased moral hypervigilance (Horberg, Oveis, Keltner, & Cohen, 2009; Jones & Fitness, 2008; Tybur et al., 2009), social conservatism (Inbar, Pizarro, Knobe, & Bloom, 2009) and in-group favouritism (Hodson & Costello, 2007). Similarly, triggering feelings of disgust with specific words via hypnotic suggestion has been shown to enhance condemnation of the actions of individuals described in vignettes that contain those words (Wheatley & Haidt, 2005). Inducing disgust via an unpleasant odour (Schnall, Haidt, Clore, & Jordan, 2008; Ugazio, Lamm, & Singer, 2012), ingesting an unpleasant drink (Eskine, Kacinik, & Prinz, 2011), sitting at a dirty table, imagining a disgusting situation (Schnall, Haidt, et al., 2008) and viewing a disgusting film clip (Horberg et al., 2009; Schnall, Haidt, et al., 2008; Ugazio et al., 2012) have all been shown to increase condemnation of moral violations (Horberg et al., 2009).

The reverse has also been found with respect to physical cleansing, with studies showing that engaging in washing behaviour makes moral judgments more lenient and that exposure to moral transgressions increases the desire to wash (Helzer & Pizarro, 2011; Schnall, Benton, & Harvey, 2008; Zhong, Strejcek, & Sivanathan, 2010). For example, participants who were asked to contemplate personal transgressions showed

priming for washing-related words (e.g., soap) and displayed a preference for antiseptic wipes when offered a choice of gifts (Zhong & Liljenquist, 2006). This has even been shown to extend to specific motor modalities, where participants who lied to another person via voicemail showed a preference for mouthwash whereas those who lied via email showed a preference for hand sanitiser (Lee & Schwarz, 2010).

These findings therefore suggest that inducing heightened levels of state physical disgust in a manner that makes no reference to moral themes appears to influence the severity and intensity of responses to subsequently presented moral transgressions.

Heightened physical disgust and moral rigidity co-occur in OCD

The third line of evidence linking disgust to morality comes from the observation that symptoms indicative of heightened physical disgust and behaviours indicative of moral rigidity both co-occur in individuals with OCD. OCD is a heterogeneous disorder with a lifetime prevalence rate of 2.3% (Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012). It is characterised by the presence of chronic obsessions and compulsions that are time consuming and cause marked distress or functional impairment, despite being recognised by the sufferer as being excessive or unreasonable. The current Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2000) defines obsessions as persistent thoughts, ideas, impulses or images that are experienced as intrusive, inappropriate or uncontrollable. Compulsions, on the other hand, are defined as repetitive behaviours or mental acts that the person feels driven to perform, and are designed to reduce anxiety or distress. Some of the most common obsessions include repeated thoughts about

contamination, fear of contracting an illness, and preoccupation with cleanliness. Contamination-based obsessions are also frequently accompanied by compulsive washing and behavioural avoidance of people, places and objects that are perceived to be unclean.

In addition to heightened levels of anxiety, heightened disgust responses may play a key role in the aetiology and maintenance of OCD. Numerous studies have shown that increased levels of trait and state disgust are associated with increased obsessive-compulsive (OC) symptomatology, and this has been demonstrated using self-reported measures of disgust (Berle et al., 2012; Cisler, Brady, Olatunji, & Lohr, 2010; Cisler, Olatunji, Sawchuk, & Lohr, 2008; Mancini, Gragnani, & D'Olimpio, 2001; Muris et al., 2000; Olatunji, 2010; Olatunji, Cisler, Deacon, Connolly, & Lohr, 2007; Olatunji, Sawchuk, Lohr, & De Jong, 2004; Schienle, Stark, Walter, & Vaitl, 2003; Thorpe, Patel, & Simonds, 2003; Tolin, Woods, & Abramowitz, 2006), as well as through behavioural avoidance tasks (Deacon & Olatunji, 2007; Olatunji, Lohr, Sawchuk, & Tolin, 2007; Tsao & McKay, 2004).

Studies show that at least 50% of all individuals with OCD report contamination fear and washing symptoms (Mataix-Cols et al., 2002), with 47.6% of patients from published treatment outcome studies reporting contamination/washing symptoms as their primary complaint (Ball, Baer, & Otto, 1996). Thus, heightened disgust responding has been particularly implicated in contamination fear and washing compulsions (Berle & Phillips, 2006; Cisler, Olatunji, & Lohr, 2009; Muris et al., 2000; Olatunji, Ebesutani, David, Fan, & McGrath, 2011; Olatunji et al., 2004; Schienle, Schäfer, et al., 2003; Thorpe et al., 2003; Tolin et al., 2006; Woody & Teachman, 2000) and those with clinical OCD with primary contamination concerns score more highly on measures of trait disgust than non-anxious control participants, and marginally higher

than those without primary contamination concerns (Woody & Tolin, 2002). However, heightened trait disgust has also been found to be associated with a range of other OCD symptom dimensions, suggesting that in addition to driving washing symptoms the emotion may be implicated in OCD more generally. For example, self-reported disgust has been found to be positively correlated with severity of checking, ordering, neutralising, obsessing (Berle et al., 2012; Schienle, Schäfer, et al., 2003) and hoarding symptoms (Olatunji, Ebesutani, et al., 2011), as well as with specific obsessional content like religious obsessions (Olatunji, Tolin, Huppert, & Lohr, 2005).

Interestingly, OCD has also been characterised as a disorder of morality (Shapiro & Stewart, 2011), as the symptoms of OCD are associated with moral sensitivity (Harrison et al., 2012) and inflated perceptions of personal responsibility for preventing harm (Mancini & Gangemi, 2004). One correlational study by Doron, Kyrios and Moulding (2007) found that young adults who reported greater sensitivity to self-relevant morality were more likely to report OCD-relevant cognitions and OC symptomatology. Similarly, individuals with OCD (particularly those with contamination symptoms) have been found to report greater sensitivity to self-domains of morality than individuals with other anxiety disorders, indicating that OC symptoms may be associated with heightened moral concern (Doron, Moulding, Kyrios, & Nedeljkovic, 2008). Further, individuals with OCD are more likely to draw negative moral inferences about themselves on the basis of their intrusive thoughts than are individuals with other anxiety disorders (Ferrier & Brewin, 2005).

The reverse relationship has also been found, where intensifying feelings of guilt increases behaviours similar to those observed in individuals with OCD (Mancini, D'Olimpio, & Cieri, 2004; Mancini & Gangemi, 2004). For example, in a study examining the causal link between threat to moral self-perceptions and OC

contamination behaviours, Doron, Sar-El and Mikulincer (2012) found that priming perceptions of moral incompetence increased OC contamination behavioural tendencies when compared to a neutral or morally-irrelevant condition. Heightened OC behaviours were also associated with negative information about one's own morality, and the association was not better accounted for by variations in self-esteem, stress, anxiety or depression. The researchers interpret this as evidence that moral self-perceptions are implicated in the aetiology and maintenance of OC symptoms. However, this research was only conducted in non-clinical samples and further research using participants with clinical OCD is needed to confirm that the findings generalise to clinical populations.

Taken together, these findings show that moral transgressions elicit disgust, and that inducing disgust impacts on the severity of moral transgressions. They also show that heightened physical disgust and moral rigidity co-occur in OCD. Together, this provides evidence of a link between physical disgust and morality.

Is moral disgust a biologically expanded form of physical disgust?

Some theorists suggest that the expansion of disgust into the moral domain may represent a compelling example of exaptation (Chapman & Anderson, 2013; Rozin et al., 2008), the process whereby the function of a trait evolves without changing the fundamental form of that trait (Bock, 1959; Mayr & Tax, 1960). Oaten and colleagues (2009) argue that the moral dimension of disgust seems to have evolved by virtue of the influence that the burden of disease has had in shaping cultural norms. This could explain why many moral norms pertain to factors closely linked with risk for disease, such as the care of those most susceptible to disease (e.g., children), sexual practices, and food.

CHAPTER 1

Research supporting an exaptation model of moral disgust

Several studies are cited in support of an exaptation model of moral disgust. However, as will be discussed, methodological factors limit inferences about whether moral transgressions elicit the same emotional experience as exposure to contaminants. In the first study to use facial EMG to examine affective responses to moral transgressions, Chapman and colleagues (2009) examined whether bitter tastes, images of physical contaminants, and unfair treatment in an economic game evoked facial expressions of disgust. Specifically, they used facial EMG to measure activity over the *levator labii* muscle, which is involved in the key components of the disgust expression, namely the raised upper lip and nose wrinkle. Using this method, Chapman and colleagues (2009) observed striking similarities between the facial motor activity evoked by the experience of distaste (i.e., ingesting a bitter liquid), viewing images of physical contaminants, and being treated unfairly in an economic game. They interpret their findings as evidence that it is the same emotion elicited by each.

In a critique of Chapman and colleagues' (2009) study, Rozin argues that measurement of the *levator labii* muscle alone is insufficient to determine whether bitter tastes, physical contaminants and unfairness elicit the same emotion, because other negative emotions such as anger are accompanied by facial movements that may also involve the *levator labii* (Rozin, Haidt, & Fincher, 2009). Thus, concurrent measurement of the *corrugator*, as used by Cannon and colleagues (2011), is needed to determine whether patterns of facial muscle activity more closely resemble angry or disgusted responses. Rozin also argues that it is unclear whether the same emotion is elicited by each, as it is possible that unfairness and physical disgust may be processed by two entirely different evaluation systems which happen to activate a common element of the output system (Rozin et al., 2009). Rozin notes that studies using a

variety of dependent measures that can reliably capture other emotional responses, such as anger, are needed to clarify this issue.

The second series of studies that are cited in support of an exaptation model of moral disgust are those that have shown that exposure to moral transgressions elicits neural activity in a region of the brain that is necessary for processing physical disgust. The anterior insula has been posited as a neural marker of disgust (for a review see Chapman & Anderson, 2013), and activity in this region is observed when participants are exposed to disgusting image stimuli (Schienle, Schäfer, Stark, Walter, & Vaitl, 2005; Wright, He, Shapira, Goodman, & Liu, 2004), disgusting films (Harrison, Gray, Gianaros, & Critchley, 2010) or when viewing others' disgusted facial expressions (Jabbi, Bastiaansen, & Keysers, 2008; Phillips et al., 1997). There is some evidence that the insula may also subserve forms of moral disgust. For example, self-reports of disgust expressed in response to social outgroups are also accompanied by activation of the insula (Harris & Fiske, 2006), and there is evidence that the insula may become active during perception of inequity (Hsu, Anen, & Quartz, 2008).

Although these studies may be taken as evidence that moral transgressions evoke physical disgust, as Chapman and Anderson (2013) note, the insula is activated by a range of other emotional processes - such as anger (Damasio et al., 2000), anxiety (Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004), and pain (Peyron, Laurent, & Garcia-Larrea, 2000) - as well as perceptual decision making (for a review, see Craig, 2009). Therefore, it is not possible to infer on the basis of these studies, that insula activation observed in reaction to moral transgressions indicates that the perceiver is experiencing disgust, rather than any of the other emotional experiences that are subserved by the insula.

Three studies to date have adopted the more promising approach of examining the neural correlates of physical and moral disgust in the same individuals. If sources of physical disgust and moral transgressions elicit overlapping patterns of neural activation, this would provide evidence that physical and moral disgust may be processed in a similar manner in the brain. Using stimuli comprised of written vignettes depicting physical disgust and moral transgressions, Moll and colleagues (2005) found that the medial and lateral orbitofrontal cortex, as well as cortical regions associated with olfactory processing and appetitive olfactory learning, became active when participants read scenarios depicting physical disgust as well as scenarios depicting indignation, but not when they read neutral scenarios. Similarly, relative to neutral statements, statements depicting pathogens, incestuous acts and sociomoral transgressions have been found to elicit increased brain activation in the amygdala (Borg, Hynes, Van Horn, Grafton, & Sinnott-Armstrong, 2006). Furthermore, regions of overlap in brain activation have been observed in response to disgusting, harmful and dishonest moral vignettes (Parkinson et al., 2011). These studies provide more robust evidence that physical disgust and moral disgust may be processed in a similar manner in the brain. However, an important caveat to this research is that none of these studies included a second emotional comparison condition. Although these findings indicate that physical and moral disgust recruit overlapping neural regions, it is unclear whether this is due to shared processing with disgust or negative emotionality more generally, as is pointed out by Chapman and Anderson (2013).

Lastly, given that OCD is a disorder with significant neural and biological underpinnings (for a review, see Insel, 1992), evidence that heightened physical disgust may be related to moral hypervigilance in individuals with OCD would provide support for the biological expansion of disgust into the moral domain. Only one study to date

has shown evidence that OC symptoms may be associated with a tendency to process sources of physical disgust and moral transgressions in the same manner. Again using written vignettes depicting a scene of physical disgust (an old man vomiting) and a moral violation (consensual incest), Ottavani and colleagues showed that OC symptoms were associated with increased autonomic responses to both physical disgust stimuli and moral transgressions (Ottaviani, Mancini, Petrocchi, Medea, & Couyoumdjian, 2013). This suggests that the presence of OC traits may lead to similar processing of physical disgust and moral transgressions. However, this study did not control for anxiety or general negative affect. This means that the heightened autonomic responses to physical and moral disgust in those high on OC symptoms may simply be the result of heightened anxiety. No study to date has examined whether moral rigidity in individuals with OCD is related to heightened physical disgust, or is simply the result of heightened anxiety more generally.

Research opposing an exaptation model of moral disgust

As is evident, several studies have shown evidence for some degree of overlap in the facial expressions, neural substrates and psychopathological symptoms associated with physical disgust and moral transgressions. However, as is also evident, methodological aspects limit the degree to which we can conclude that pathogens and moral violations elicit the same emotion. As discussed, some critics argue that use of the term 'disgusting' in response to moral transgressions is merely used metaphorically to draw a comparison with things that are prototypically offensive (Royzman & Sabini, 2001). Some support for this claim is found in research showing evidence of discontinuity between physical and moral disgust.

CHAPTER 1

In their development of the Disgust Scale, a measure designed to assess sensitivity to several discrete domains of disgust elicitors, Haidt, McCauley and Rozin (1994) had to omit items assessing sensitivity to moral disgust elicitors because they showed only weak correlations with other disgust domains. Differences have also been observed in the rates of habituation to sources of physical and moral disgust. In a study examining the validity of including a moral domain in tests of disgust sensitivity, Simpson, Carter, Anthony and Overton (2006) examined the kinds of emotions evoked by moral transgressions by presenting participants with pictures designed to elicit core (i.e., pathogen) or socio-moral disgust, and asked them to rate the level of anger, disgust, fear, happiness and sadness they felt in response to each. They found that socio-moral disgust elicitors evoked similar levels of disgust to the core disgust elicitors, but higher levels of anger and sadness. They also found that responses to core disgust stimuli habituated over time, whereas responses to socio-moral disgust sensitised. Furthermore, they found gender differences in response to core disgust but not socio-moral disgust elicitors. Specifically, whereas females showed a larger disgust response to core disgust elicitors (a finding that has been replicated a number of times, e.g., Curtis et al., 2004; Druschel & Sherman, 1999; Haidt et al., 1994), there were no gender effects in disgust responses to socio-moral pictures. On the basis of these findings, Simpson and colleagues (2006) concluded that core disgust and socio-moral disgust may be functionally distinct constructs. Several methodological concerns question the validity of these data however, as the authors used only a small number of items to index disgust responses (8 pictures) and included only 13 male participants.

Differences have also been observed in the physiological responses elicited by sources of physical and moral disgust. The results of Ottavani and colleagues showed that vignettes describing physical disgust and moral disgust elicited opposite cardiac

responses (Ottaviani et al., 2013). The physical disgust vignettes enhanced activity of the parasympathetic nervous system (as indexed by increased heart rate variability), whereas the moral disgust vignettes elicited a decrease in parasympathetic activity accompanied by sympathetic nervous system dominance. Furthermore, although heart rate remained unchanged from baseline in the physical disgust condition, heart rate significantly increased in the moral disgust condition. Ottavani and colleagues (2013) argue that their findings run counter to the hypothesis that moral disgust is an expanded form of physical disgust and instead suggest that the two responses may only be linguistically analogous.

Finally, individuals with Huntington's Disease are known to be impaired in their experience and expression of physical disgust (Hayes, Stevenson, & Coltheart, 2009), therefore if moral disgust is an expanded form of physical disgust then individuals with Huntington's Disease should show more lenient moral judgments due to their impairment. In fact, the opposite has been found, with participants with Huntington's Disease generating significantly more examples of moral transgressions than non-clinical control participants (Hayes, Stevenson, & Coltheart, 2007). This again shows evidence of a discontinuity between physical and moral disgust.

Some theorists further argue that moral disgust may be used metaphorically to convey anger (Bloom, 2004; Nabi, 2002). In support of this notion, evidence indicates that anger can arise in response to factors that may be pertinent to moral judgment, such as physical discomfort, goal blockage, unfairness or hostile intent (Berkowitz & Harmon-Jones, 2004; Kuppens, Van Mechelen, Smits, & De Boeck, 2003; Kuppens, Van Mechelen, Smits, De Boeck, & Ceulemans, 2007). Researchers have also found anger to be a prominent emotion elicited by moral transgressions. For example, Shweder and colleagues (Shweder, Much, Mahapatra, & Park, 1997) found that anger

mapped onto transgressions that primarily involved violations of an individual's personal autonomy (i.e., acts that cause harm). Rozin and colleagues (Rozin, Lowery, Imada, & Haidt, 1999) found evidence to support this, showing that facial expressions of anger - as coded using the Facial Action Coding System (FACS) - were most commonly associated with perceptions of harm coming to others, whereas facial expressions of disgust were more often mapped onto divinity violations (i.e., taboo breaking). A third study revealed that individuals who reported stronger feelings of anger in response to vignettes describing moral transgressions were also more likely to make the presumption of harm across all contexts – including, importantly, objectively harmless situations (Gutierrez & Giner-Sorolla, 2007). This relationship was not found with individuals who reported higher levels of disgust, which indicates that anger is an emotion that may be especially linked with increased perceptions of harm.

Although these findings provide some support for the notion that moral disgust may be either a metaphor for anger or some blend of anger and disgust, assessing emotional responses to moral transgressions via self-report alone is problematic because of the considerable semantic overlap between labels of 'disgust' and 'anger'. In fact, the lay meaning of disgust usually extends beyond that used by psychologists and incorporates a component of anger (Nabi, 2002). Reports of anger and disgust also often co-occur and are used interchangeably (Johnson-Laird & Oatley, 1989; Russell & Fehr, 1994; Shaver, Schwartz, Kirson, & O'connor, 1987), suggesting that measuring emotional reactions via self-report alone may not be accurate enough to tell whether physical and moral disgust are qualitatively the same, and if they are unique from anger.

Russell and Giner-Sorolla (2013) note that although anger and disgust may both have a key role as moral emotions their distinct roles are unclear, as research has primarily examined the link between moral judgment and each emotion singularly

rather than in contrast to each other. They argue that it is important to clarify the role that each has in moral judgment because disgust appears to be a more unreasoned and inflexible emotion than anger, which is more regulated by context and reasoning. Russell and Giner-sorolla (2013) cite three ways in which this occurs: firstly, disgust tends to be associated with categories of objects or acts rather than their meaning or consequences; secondly, disgust appears to be insensitive to context; and thirdly, disgust is commonly justified using tautological reasons (i.e., "it disgusts me because it is revolting") and is less likely to be justified using objective external evidence. Russell and Giner-Sorolla (2013) argue that if responses to moral transgressions more closely resemble disgust than anger, this may be problematic to the functioning of a liberal society as it will result in a disregard for factors that are important to judgments based on fairness, justice and intentionality.

As is evident, there are discrepancies in the literature surrounding the claim that moral disgust is a biologically expanded form of physical disgust, and further research is needed to clarify this issue. Specifically, most of this literature is limited by the absence of an appropriate comparison with another emotion, such as anger, to determine the uniqueness of the link between disgust and morality. Additionally, measures of emotional responding more sensitive than self-report are needed to accurately disentangle negative affective states that may occur in response to moral violations. Lastly, although numerous studies have shown that inducing physical disgust has the effect of increasing the severity of moral judgment, it remains to be established whether other candidate moral emotions such as anger produce similar effects. Were the induction of anger to produce similar effects then it would call into question the uniqueness of the link between disgust and moral judgment.

Implications for our understanding of moral reasoning and behaviour

The role of emotion in moral judgment has been the subject of debate for centuries, and if moral disgust is an example of exaptation then there are important implications for our understanding of moral reasoning. Philosopher Immanuel Kant held that all moral reasoning is driven by a process of rational thought (Kant, 1981). Conversely, philosopher David Hume claimed that reason is "the slave of the passions" and that moral judgments stem from the moral emotions such as guilt, shame, embarrassment and pride (Hume, 1969). If moral disgust is an evolutionarily adapted form of physical disgust then human moral sense may draw upon early affective evolutionary precursors, rather than being driven solely by more recently evolved higher order cognitive functions (Greene & Haidt, 2002; Haidt, 2007). Conversely, if reactions to moral transgressions more closely resemble anger then there are important implications for our understanding of moral behaviour, as anger and disgust have opposing motivational tendencies. Disgust is associated with a withdrawal motivation, which produces behaviour designed to create distance between the self and the source (Rozin et al., 2008), whereas anger is associated with an approach motivation, which promotes behaviours revolving around the desire to attack (Carver & Harmon-Jones, 2009). Furthermore, as Russell and Giner-Sorolla (2013) note, disgust responses are less reasoned and less influenced by factors such as context and consequences than is anger. These are important factors to consider when making moral judgments surrounding harm, intentionality and justifiability.

Therefore, the first aim of the current program of research was to evaluate the specificity of the link between disgust and morality by determining whether the association between physical disgust and moral transgressions is stronger than the association between anger and moral transgressions. The link between heightened

physical disgust and moral rigidity was also examined in OCD, as this disorder is known to have a significant biological component and provides an ideal context in which to examine the impact of abnormally (and potentially biologically) enhanced disgust responses on moral reasoning.

Disgust in psychopathology

In addition to the growing interest in the role of disgust in moral judgment, the literature surrounding disgust's role in psychopathology has also expanded rapidly over the past few years. In particular, there has been an increased focus on the role of heightened disgust responses in OCD.

As mentioned previously, feelings of disgust have been consistently linked with activation of the insular cortex in non-clinical samples. Similar results have been found in samples high on contamination fear, where viewing disorder-relevant images elicits greater insula activation (Phillips et al., 2000; Shapira et al., 2003) relative to amygdala activation (which would be more indicative of a fear response). The same has been observed in individuals meeting diagnostic criteria for OCD. For example, Schienle, Schafer, Stark, Walter and Vaitl (2005) presented individuals with OCD disorder-relevant images and found enhanced insula but not amygdala activation. Similarly, Maitaix-Cols and colleagues (2004) found that insula activation during a contamination fear-provoking task correlated with a self-report measure of contamination fear.

Although typically conceived of as an anxiety disorder, evidence suggests that disgust may contribute uniquely to OCD independently of anxious symptomatology. For example, the link between disgust and OC symptoms remains significant after controlling for other facets of the disorder that may drive heightened disgust responses,

such as heightened anxiety, depression and negative affect (Mancini et al., 2001; Olatunji, Ebesutani, et al., 2011). This indicates that heightened disgust responses in OCD are not simply due to increased negative psychopathology more generally. The link also remains after controlling for demographic variables known to impact disgust responding, such as age and gender (Mancini et al., 2001; Olatunji, Ebesutani, et al., 2011). Furthermore, when examining the subjective experiences of individuals with OCD who experience disgust-based obsessions, such as intrusive thoughts surrounding contamination, individuals most often report that these intrusive thoughts are accompanied by strong feelings of disgust as opposed to fear (Tallis, 1996). This is also the case when individuals with OCD are exposed to physical stimuli related to such intrusive thoughts – such as public toilets, door handles and money (Phillips et al., 2000) - indicating that disgust may play a key role in the development and maintenance of certain OCD symptoms over and above fear.

What causes pathological disgust?

Co-occurring fear

Some researchers have suggested that elevated disgust responding in OCD may arise due to a fear of experiencing disgust (e.g., Cisler, Reardon, Williams, & Lohr, 2007; Cougle, Wolitzky-Taylor, Lee, & Telch, 2007) or an inability to tolerate feelings of disgust (Quigley, Sherman & Sherman, 1997). Others have suggested that OCD arises when feelings of disgust are misinterpreted as a signal for danger (Brady, Adams, & Lohr, 2010). Cougle and colleagues (2007) have shown that contamination fearful individuals appraise contamination-related situations as disgust-eliciting (i.e., 41% of the sample endorsed a primary contamination threat of being overwhelmed by feelings of disgust) but also dangerous (37% endorsed a primary threat of being concerned with

illness or harm to the self), indicating that fear may co-occur with, and even heighten, disgust responses in individuals with OCD.

Faulty reasoning

Empirical evidence suggests that at least part of the pathological disgust response occurs because a set of implausible beliefs that accompany normative disgust responses becomes heightened and maladaptive. Rozin and Fallon (1987) posit that disgust is often brought about by two sets of implausible beliefs about the transmission of contagion, which both fall under the principles of 'sympathetic magic'. In the context of disgust responses, sympathetic magic refers to a style of illogical thinking based on imitation and correspondence. The first principle of sympathetic magic is the law of contagion. This law represents an irrational belief about how contamination is transmitted and operates on the premise of 'once in contact, always in contact' (Rozin & Fallon, 1987). The law of contagion has been demonstrated in a number of empirical studies, the most seminal of which found that participants rated a glass of juice with a dead yet sterilised cockroach placed in it less appealing to drink than a glass without a cockroach, even though the threat of disease was exactly the same for both juices (Rozin, Millman, & Nemeroff, 1986). Similarly, Rozin, Markwith and McCauley (1994) found that college students were less willing to wear a thoroughly laundered jumper after it had been worn by a man with AIDS than a man without, even though they were aware that AIDS could not be transmitted this way.

The second law of sympathetic magic is the law of similarity, which posits that anything that closely resembles a disgust elicitor tends to take on the contaminating properties of that elicitor, despite the fact that it is contamination-free. The law of similarity has been demonstrated by Rozin and colleagues (1986) in a study showing

that participants were less willing to touch fudge shaped like dog faeces to their mouth than fudge in a disc shape. Similarly, participants were less likely to touch fake rubber vomit to their mouth than a rubber stopper. Oaten and colleagues (2009) propose that disgust must be overcautious to be effective as a disease-avoidance mechanism, as the cues used to detect contamination are often unclear.

Another line of faulty reasoning that has been associated with disgust is the looming vulnerability to threat (Riskind, 1997; Riskind & Williams, 2006), which refers to the tendency to construct dynamic mental scenarios involving the perceived movement, approach, spread or escalation in risk of potentially contaminating stimuli. In a similar way to the laws of sympathetic magic, looming vulnerability may help to ensure that disgust serves its function as a disease-avoidance mechanism because it biases an individual to imagine scenes of contamination as actively spreading and rising in risk, ensuring that the source and any object immediately in contact with it will be avoided.

Evidence has shown that individuals with contamination-related OCD (C-OCD) show a stronger law of contagion than those without contamination fear. Tolin, Worhunsky and Malby (2004) asked individuals with C-OCD to identify the most contaminated object in a building, which the experimenter then rubbed a pencil on. The experimenter then rubbed the original pencil onto a new, clean pencil and asked the participants to rate how contaminated the new pencil was. This process was repeated for 12 pencils and the findings showed that anxious and non-anxious participants evidenced nearly a 100% reduction in appraisals of contamination, while the C-OCD patients only showed a 40% reduction. Additionally, students with subclinical OCD show evidence of a looming vulnerability bias to scenes of contamination (Riskind, Abreu, Strauss, & Holt, 1997). Looming vulnerability may therefore lead to the

development of pathological disgust responses through its biasing effects on the perceived threat of contamination (Williams et al., 2009).

Disgust-relevant appraisals and beliefs

In their discussion of disgust-based appraisals, Woody and Teachman (2000) propose an interesting parallel to Salkovskis' (1996) discussion of primary and secondary appraisals in OCD. They argue that primary disgust appraisals reflect beliefs about the disgusting properties of an object or the degree to which a situation or object will elicit disgust, whereas secondary disgust appraisals revolve around an individual's beliefs about the consequences if the primary disgust appraisal is true. Rozin and colleagues (2008) also note that the interpretive component involved in the secondary appraisal can involve beliefs relating to the threat value of the stimulus, as well as concerns about one's own behavioural and physiological reactions to the stimulus.

Evidence suggests that distorted beliefs commonly observed in individuals with OCD may magnify disgust responses and related avoidance behaviour via their impact on secondary disgust appraisals. For example, self-report studies using a measure of obsessive beliefs (OBQ; OCCWG, 2003, 2005) have found that beliefs that overestimate the likelihood of threat and beliefs relating to an inflated sense of responsibility for preventing harm are both positively correlated with contamination/washing symptoms in clinical and non-clinical samples (Myers, Fisher, & Wells, 2008; OCCWG, 2003; Tolin, Brady, & Hannan, 2008; Tolin et al., 2006). Other evidence indicates that cognitive distortions such as intolerance of uncertainty, may prevent individuals with OCD from ignoring the possibility that something may be contaminated (Woody & Teachman, 2000). Appraisals and beliefs are suggested to result in pathological behaviour because they increase the likelihood that an individual

will perceive an experience of disgust as in some way dangerous or personally meaningful (Teachman, 2006). This increases the level of distress experienced and also the compensatory behaviours designed to alleviate the unwanted sensations.

Information processing biases

In addition to eliciting a unique set of appraisals, feelings of disgust are associated with specific information processing biases that may be associated with heightened contamination concerns. For example, Charash and McKay (2002) found that priming disgust in individuals high on disgust sensitivity resulted in longer response latencies for disgust-relevant words on the Stroop task. These findings demonstrate that increasing feelings of disgust can induce an attentional bias for disgust-relevant words. Similarly, Davey, Bickerstaffe and MacDonald (2006) found that participants showed a bias toward interpreting ambiguous homophones in a threatening way when a disgusted mood state was induced, suggesting that state disgust may produce a negative interpretation bias similar to that observed when fear is induced.

Although very few studies have examined information processing biases in individuals with OCD, there is preliminary evidence that individuals with OCD may demonstrate an attentional bias for contamination-related stimuli (Foa, Ilai, McCarthy, Shoyer, & et al., 1993; Tata, Leibowitz, Prunty, Cameron, & Pickering, 1996) and for threat more generally (Foa & McNally, 1986; Lavy, van Oppen, & van den Hout, 1994). One study has also shown that individuals with C-OCD show enhanced memory for contamination stimuli relative to non-anxious control participants (Radomsky & Rachman, 1999). However, some studies have also failed to demonstrate evidence of a memory bias in individuals with the disorder (e.g., Ceschi, Van der Linden, Dunker, Perroud, & Brédart, 2003; Foa, Amir, Gershuny, Molnar, & Kozak, 1997).

Exposure-based treatments are less effective for disgust

In addition to a growing body of research examining the role of disgust in anxiety disorders, evidence now indicates that standard exposure-based treatments that are effective for anxiety may be less effective in reducing disgust. This evidence consists of three lines of research: firstly, studies in nonclinical samples examining extinction of learned disgust responses; secondly, studies examining exposure conducted in analogue samples high on clinical traits but which do not meet diagnostic criteria for a formal diagnosis; and thirdly, a small number of studies examining disgust's resistance to exposure in clinical samples.

Fear responses are typically thought to arise through a process of Pavlovian conditioning, where an innocuous conditioned stimulus (CS) is paired with an aversive consequence (the unconditioned stimulus; US) and over repeated pairings the CS comes to elicit a conditioned fear response (CR; LeDoux, 2000). In terms of disgust, this model proposes that the aversive US comes in the form of a disgust-evoking consequence (for a review, see Mason & Richardson, 2012). Exposure works on the premise that repeatedly presenting the CS in the absence of the aversive US eventually causes fear of the CS to decrease, because the association between the CS and US decreases. This explains why patients with anxiety show decreasing fear during exposure therapy, where they are exposed to their feared stimuli in the absence of the feared outcome. Evidence now indicates that, unlike fear, disgust responses may remain even when the association between the CS and US decreases over the course of exposure.

The first study to show that disgust CRs were more resistant to extinction than fear-based CRs was conducted by Olatunji, Forsyth and Cherian (2007). In their study,

neutral words were used as the CS and images depicting scenes of mutilation served as the US. During the conditioning phase the CS was paired with the US 12 times, and during the extinction phase the CS was presented in the absence of the US eight times. Throughout this process, participants were asked to rate their levels of fear and disgust following each presentation of the CS. Results showed that disgust responses to the CS in the absence of the US remained high whereas fear responses decreased, indicating that disgust may be more resistant to extinction than fear. In an extension of this study, Mason and Richardson (2010) paired one CS with disgusting images of vomit and faeces and another with neutral images. During the extinction phase, they found that the CS that had been previously paired with the disgusting images continued to be rated as aversive, even though it was no longer paired with these images. Moreover, the CR elicited by the CS that had been paired with the disgusting images was just as strong as a group of participants who underwent the same conditioning process but did not undergo any extinction training.

Consistent with these data, a number of studies using clinical analogue samples have shown that disgust responses do not decline to the same extent as fear responses during exposure. For example, Smits, Telch and Randall (2002) asked spider-fearful participants to provide self-report ratings of disgust and fear during exposure to a tarantula. Although they observed declines in the level of both fear and disgust over the course of exposure, the decline in disgust was much slower than the decline in fear. Similar findings have been observed for individuals with blood phobias when exposed to images of needles (Olatunji, Smits, Connolly, Willems, & Lohr, 2007). Finally, studies using analogue OCD samples have also found that ratings of disgust decline significantly less than fear during exposure to contamination stimuli (Broderick, Grisham, & Weidemann, 2012; Olatunji, Wolitzky-Taylor, Willems, Lohr, &

Armstrong, 2009). Only one study to date has found similar declines in fear and disgust responses following exposure in an analogue sample of OCD washers (Cougle et al., 2007). Given the greater evidence to the contrary this finding is difficult to interpret.

A small number of studies have found that disgust responses in clinical samples are also more resistant to extinction than fear responses. Using a sample of individuals with clinical OCD with and without primary contamination obsessions, McKay (2006) found that both groups showed a similar decline in anxiety following exposure to anxiety and disgust-evoking stimuli, however those with contamination concerns habituated more slowly and to a lesser extent to the disgust-evoking stimuli than those without primary contamination concerns.

Taken together, these findings indicate that standard exposure-based treatments are less effective at reducing disgust responses than anxiety or fear responses.

Why exposure may not work for disgust

An explanation as to why current exposure-based treatments may be less effective in treating disgust-based symptoms than fear and anxiety can be found in research examining the differences in how fear and disgust responses are acquired.

The acquisition of maladaptive fear and anxiety responses is typically described with reference to Pavlovian conditioning. Although some researchers propose that disgust responses can similarly be acquired via standard Pavlovian conditioning (Rozin & Fallon, 1987), others have suggested that disgust responses may be acquired via a specific process of Pavlovian conditioning called evaluative conditioning (Olatunji, Forsyth, et al., 2007; Schienle, Stark, & Vaitl, 2001; Woody & Teachman, 2000). Instead of the CS serving primarily as a signal for the US, the CS in evaluative

conditioning acquires a change in the valence in affective response it elicits as a result of being presented simultaneously with the US. It usually also involves a process whereby the neutral stimulus comes to be either liked or disliked (Baeyens, Eelen, Van den Bergh, & Crombez, 1992). That is, whereas standard Pavlovian conditioning results in the CS eliciting an expectation of a real US occurring, the CS in evaluative conditioning elicits a reference to the US without the expectation that it will occur (De Houwer, Thomas, & Baeyens, 2001).

The process of evaluative conditioning has been demonstrated using a variety of stimulus types across visual, auditory, gustatory and olfactory modalities (Baeyens, Crombez, Van den Bergh, & Eelen, 1988; De Houwer, Baeyens, Vansteenwegen, & Eelen, 2000; Hammerl & Grabitz, 1993; Levey & Martin, 1987; van Reekum, vann de Berg, & Frijda, 1999). However, one of the most robust examples of evaluative conditioning is conditioned taste aversion (Garcia & Hankins, 1975; Rozin & Kalat, 1971). Studies designed to elicit conditioned taste aversion typically involve a pairing of a taste with nausea. In rats, a taste that has been paired with nausea will result in the rat disliking the taste, and when it is subsequently ingested it will cause the rat to display behavioural signs of distaste such as grimacing and avoidance behaviour. However, pairing this same taste with a shock only elicits avoidance behaviour and not grimacing (Pelchat, Grill, Rozin, & Jacobs, 1983), suggesting that evaluative conditioning may be specifically associated with disgust.

Some authors have argued that the process of evaluative conditioning differs from Pavlovian conditioning because it can occur without explicit awareness of a CS-US contingency (Baeyens et al., 1988; Baeyens, Eelen, & van den Bergh, 1990), suggesting that the process occurs automatically and non-cognitively. This distinguishes it from other forms of conditioning where an explicit knowledge of the

CS-US contingency is present. As a result of being acquired through an automatic non-cognitive process, evaluative conditioning is thought to be much more difficult to modify than other forms of Pavlovian conditioning. This means that unlike learned fear, which can be reduced through the use of extinction procedures that modify awareness of the CS-US contingency, learned dislike appears to be particularly resistant to extinction (Baeyens et al., 1988; Baeyens, Díaz, & Ruiz, 2005).

If disgust is acquired via a process of evaluative conditioning, this may help to explain why a significant proportion of individuals with OCD do not respond well to exposure-based treatment (Fisher & Wells, 2005; Schruers, Koning, Luermans, Haack, & Griez, 2005). Therefore, a model of OCD that incorporates disgust and acknowledges the potential methods by which disgust may be acquired and modified, could help improve treatment of OCD in much the same way as fear models have assisted in developing treatments for anxiety disorders more generally.

Adjuncts to exposure therapy for OCD

Given that disgust may not respond well to exposure alone, novel adjuncts to traditional exposure-based treatments may be needed to treat disgust-based symptoms. As previously mentioned, there is evidence to suggest that disgust responding may be accompanied by a cognitive bias toward threat. In addition, there are a number of maladaptive appraisals and beliefs that may work in tandem with cognitive threat biases to further enhance the magnitude of disgust responses. Therefore, it is possible that interventions aimed at reducing maladaptive cognitive biases may be effective in reducing disproportionate disgust responses and avoidance behaviours.

CHAPTER 1

A relatively new paradigm that has been used successfully to modify threat-based cognitive biases in individuals with anxiety is known as cognitive bias modification (CBM). This paradigm operates on the idea that negative information processing biases play a key role in the aetiology and maintenance of anxious psychopathology. CBM targets two of these biases. The first is an attentional bias, where an individual selectively attends to and processes threat-relevant cues in the environment over other cues. The second is an interpretive bias, where an individual shows a tendency to interpret ambiguity in a negative way. CBM paradigms have been shown to be effective in modifying both types of bias, and over the past decade there has been a surge of interest in various applications of the procedure. Given that most research on cognitive biases relevant to disgust has pointed to biases in interpretation, the present thesis focuses on CBM paradigms that modify interpretive biases (CBM-I).

CBM-I paradigms are typically script-based programs that present individuals with ambiguous scenarios and reward them for interpreting these scenarios in either a positive or negative manner. The paradigm was originally developed by Mathews and Mackintosh (2000), who used CBM-I to train non-clinical participants to interpret ambiguous homophones in either a positive or negative way. They found that participants who had a negative interpretation bias induced through negative CBM-I training experienced greater task-relevant anxiety compared to those who received positive CBM-I training, as well as a greater tendency to interpret novel information negatively. There have been a number of replications of this effect in individuals prone to excessive worry (Hirsch, Hayes, & Mathews, 2009), in individuals meeting full diagnostic criteria for generalised anxiety disorder (Hayes, Hirsch, Krebs, & Mathews, 2010), in individuals with social anxiety (Beard & Amir, 2008; Murphy, Hirsch, Mathews, Smith, & Clark, 2007) and in individuals with depression (Holmes, Lang, &

Shah, 2009; Watkins, Baeyens, & Read, 2009). More recently, the paradigm has been used in individuals high on OC symptoms (Clerkin & Teachman, 2011), where training a positive interpretation bias resulted in a significant reduction in the urge to perform neutralising behaviours following exposure to an OCD-relevant stressor (i.e., writing that you wished a friend would have a car accident).

In light of the evidence indicating the role of appraisals, beliefs and information processing biases in pathological disgust responses in OCD, CBM-I may represent a promising method by which disgust-based symptoms can be reduced in this clinical population. However, despite numerous applications of CBM-I to anxiety and some extensions of the paradigm to depression and substance abuse, no study to date has examined whether CBM-I training is effective in manipulating disgust responses. Therefore, the second aim of the current program of research was to examine whether a novel CBM-I paradigm targeting disgust-relevant interpretive biases and appraisals would be effective in reducing disgust responses in a non-clinical sample and in individuals with clinical OCD. CBM-I is easily delivered via computer, requires minimal therapist input, and can be delivered on almost any portable electronic device. Therefore, if CBM-I training was found to reduce disgust-based symptoms it would represent a highly cost-effective and user-friendly adjunct to the treatment of disgust-based psychological disorders.

Implications for the current program of research

Although the findings presented in this chapter offer preliminary evidence that disgust is implicated in morality, there is still a paucity of research investigating whether disgust contributes uniquely to moral judgment over and above other moral

emotions like anger. There are also clear differences in the literature regarding the origins and function of disgust expressed in the moral domain. Further research examining the specificity of the link between physical disgust and morality is therefore needed to resolve such discrepancies. Specifically, evidence that moral judgment draws on early affective precursors that originally governed responses to aversive tastes would challenge long held theories of moral reasoning that place heavy emphasis on recently evolved higher cognitive processes.

Prior work is limited in that it has typically examined the link between disgust and moral judgment in isolation, without comparison to other moral emotions such as anger. The majority of this previous work also lacks appropriate negative non-moral comparison stimuli, making it difficult to determine whether moral themes in particular elicit disgust or whether exposure to any negative stimulus can increase disgust responding more generally. Another important caveat to past research is that self-report of emotional experience alone is not sensitive enough to disentangle disgust from anger responses, given the high degree of semantic overlap between the emotion labels 'disgust' and 'anger'. In recent work, researchers have indicated that this problem is best overcome through the use of more sensitive physiological indicators of emotion, such as facial EMG. Therefore, the study outlined in Chapter 2 of this thesis seeks to provide a more rigorous examination of the role of physical disgust in responses to moral transgressions by comparing the effects of induced disgust to induced anger, by including negative non-moral control stimuli, and by using facial EMG to enhance the accuracy of assessment of emotional responding.

Furthermore, despite the growing number of studies showing that symptoms indicative of heightened disgust and hypermorality exist in OCD, no research to date has examined whether the two are related. Evidence of a link between abnormally

heightened physical disgust and moral rigidity in the context of a disorder with known biological underpinnings may provide an important test of an exaptation model of moral disgust. The research outlined in Chapter 3 makes an important first step in examining whether individuals with OCD display trait, state and psychophysiological disgust responses that are heightened above those of non-clinical individuals and, importantly, individuals with other non-OCD anxiety disorders. Following this, the experiment described in Chapter 4 examines whether individuals with OCD also showed use of more rigid moral reasoning strategies compared to non-clinical and anxious control participants, and if this is related to heightened physical disgust responses.

As has also been mentioned in this chapter, there is mounting evidence to indicate that disgust responses do not respond well to conventional exposure-based treatment. Novel adjuncts to treatment that specifically target disgust responses are needed to enhance treatment outcomes for individuals with disgust-based disorders. In light of the success of CBM-I in modifying anxious responses, it seems viable that CBM-I targeting disgust-based interpretive biases may represent a novel solution to this problem. The research described in Chapters 5 and 6 therefore provide the first empirical evaluation of the application of CBM-I to disgust responses in both clinical and non-clinical samples.

The findings presented in the following chapters make an important theoretical contribution by addressing discrepancies in existing models of moral disgust. The final chapters of this thesis also represent an important first step in applying novel CBM-I methodologies to disgust, helping to elucidate the impact of disgust-based interpretive biases on disgust responding and potentially highlighting a novel means by which pathological disgust can be treated.

Chapter 2

MORAL DISGUST: MORE THAN JUST A METAPHOR

The research outlined in this chapter examined whether physical disgust is aligned more closely with moral transgressions than it is with anger. It aims to help remedy a lack of prior research into comparisons between the effects of incidental disgust to the effects of incidental anger. As was outlined in Chapter 1, although prior studies have shown that inducing incidental disgust increases the severity of moral judgements, no studies to date have made a direct comparison to anger. Furthermore, much of the prior research has used self-report measures of emotional responding, which is limited by the likelihood that self-report is confounded by the high degree of semantic overlap between the labels 'disgust' and 'anger'. Self-report may therefore lack the precision to determine the specificity of the link between disgust and moral violations. This chapter addresses these gaps in our current understanding.

Using facial EMG to overcome semantic confounds

Measuring emotional responding via facial expressions has been proposed as an ideal way to overcome the semantic confounding inherent in using self-report measures of anger and disgust (Rozin et al., 2009; Russell & Giner-Sorolla, 2013), as facial expressions triggered by the two emotions can be differentiated on the basis of specific patterns of facial muscle activity (Ekman, 1999). Muscle activity over the *levator labii*

superioris (the muscle next to the nostril which retracts and causes the nose to wrinkle) is the central component of the characteristic facial expression of disgust (Rozin, Lowery, et al., 1994) and activity over this muscle site is selectively responsive to disgusting images (Vrana, 1993, 1994). Contrastingly, activity over the *corrugator supercilii* muscle (the muscle which draws the brow in when frowning) is a sensitive marker of negative affect, and is a robust indicator of anger when there is an absence of concurrent *levator labii* activity (Tassinary & Cacioppo, 2000). Muscle activity over these regions can be accurately indexed using facial EMG. This measurement technique has been shown to reliably distinguish between anger and disgust responses (Vrana, 1993) and therefore represents an ideal way to distinguish disgust from anger responses in the context of moral transgressions.

Only two studies to date have used facial EMG to examine affective facial responses to moral transgressions, and these studies have shown that increases in *levator labii* activity are observed during exposure to unfairness (Chapman et al., 2009), and are also associated with condemnation of purity violations (Cannon et al., 2011). However, Chapman and colleagues (2009) did not measure *corrugator* activity, meaning that their measurement of disgust may have been confounded with co-occurring anger. Furthermore, Cannon and colleagues (2011) did not compare EMG activity in response to moral violations to EMG activity in response to negative but non-moral stimuli, so it is not possible to determine whether *levator labii* activity was associated with moral violations or negative stimuli more generally.

Disentangling the effects of anger and disgust on moral judgment has important implications for our understanding of moral behaviour, as the two emotions are associated with opposing motivational tendencies. Disgust is primarily associated with an avoidance motivation (Rozin, Haidt, & McCauley, 1999), and so may drive

behavioural responses to moral violations consistent with avoidance or rejection. Conversely, anger is associated with an approach motivation (Carver & Harmon-Jones, 2009), which may drive the desire to punish or gain retribution. Therefore, our reactions to moral transgressions may be shaped by the emotional context in which the transgression is encountered. A transgression that elicits a high degree of disgust, or is presented in a way so as to evoke disgust, may elicit a desire to socially reject or ostracise the transgressor. A transgression presented in a way that elicits anger or outrage may elicit the desire to attack, punish or take revenge on the transgressor.

Aims & hypotheses

Although prior research demonstrates evidence of a link between physical disgust and responses to moral transgressions, the lack of comparison with other candidate moral emotions like anger, as well as limitations resulting from the sole use of self-report to index emotional responding, prevents inferences about whether disgust is *uniquely* linked to moral violations. Therefore, the current research aimed to determine whether physical disgust is more closely associated with moral transgressions than anger, using incidental and physiological measures to index emotional responding.

First, I examined whether incidental disgust had a greater impact on responses to moral violations, compared to incidental anger. Given that the effects of disgust are reported to be specific to moral themes, I predicted that inducing anger would not show the same specificity to moral themes as inducing disgust. I also predicted that inducing disgust would result in stronger responses to stimuli depicting moral themes, as opposed to negative themes in general. Second, I examined whether greater disgust (as indexed by greater *levator labii* activity) was expressed in response to moral as opposed to

negative non-moral stimuli. Given the evidence linking *levator labii* activity specifically to moral transgressions (Cannon et al., 2011; Chapman et al., 2009), I predicted that any heightened physiological responding to moral themes resulting from a disgust induction would enhance muscle activity at the *levator labii* more than the muscle sites which are not selective to disgust expressions (i.e., the *corrugator*). Lastly, since disgust and anger frequently correlate in moral judgment, I predicted that post-induction levels of disgust would predict responses to moral transgressions after controlling for post-induction levels of anger, but that post-induction levels of anger would not predict responses to moral transgressions after controlling for post-induction levels of disgust.

In light of the evidence linking state emotionality with moral judgment, another important consideration is whether trait emotionality produces similar effects. Disgust sensitivity refers to an individual's level of aversion toward specific disgust elicitors, and correlates positively with self-reported ratings of disgusting images (Schienle et al., 2001) and with levels of salivary cortisol while viewing a disgusting film (Rohrmann, Schienle, Hodapp, & Netter, 2004). Only one study to date has compared the relationship between trait disgust sensitivity and moral transgressions to trait anger and moral transgressions (Horberg et al., 2009), however, as with Cannon and colleagues' study (2011) this study did not include a set of negative, non-moral comparison stimuli. Furthermore, no study to date has determined whether trait disgust sensitivity is more closely associated with physiological responses to moral transgressions than trait anger. Therefore, I examined whether an individual's score on a measure of trait disgust sensitivity was associated with *levator labii* activity to moral transgressions. I predicted that trait disgust sensitivity would positively correlate with *levator labii* muscle activity

in response to images of moral transgressions, and that this effect would not be observed in response to negative non-moral images or with trait anger.

Method

Participants

Ninety students from the University of New South Wales in Sydney completed the study in exchange for course credit. There were 36 males and 54 females with an age range of 17-57 years (M = 21.8, SD = 6.22) and 11-20 years of education (M = 14.24, SD = 1.57). Exclusion criteria were visual or auditory difficulties that would have interfered with testing. All procedures were approved by the Human Research Ethics Committee of the University of New South Wales.

Mood manipulation

Disgust induction. Disgust was elicited by having the participant watch a four-minute video clip during which a character vomits repeatedly into a transparent bowl. The clip has been shown to successfully induce disgust (De Jong, van Overveld, & Peters, 2011), and was chosen as an alternative to a more commonly used amputation video (Gross & Levenson, 1993) as pilot testing revealed that many of the participants who were also taking medical studies did not find the amputation clip disgusting.

Neutral induction. A control 'no emotion' state was induced by having participants watch a short clip depicting fish, which has been used in prior research to elicit a neutral mood state (Lerner, Small, & Loewenstein, 2004).

Anger induction. Given that it is difficult to achieve high levels of anger via the use of video stimuli (Gross & Levenson, 1995; Rein, Atkinson, & McCraty, 1995), an alternative induction method was used. In everyday settings, anger is most commonly elicited through interpersonal interactions, and can be further enhanced or prolonged via angry rumination (Denson, 2009). Therefore, anger was elicited by having participants recall a time where they had felt especially angry, and to ruminate on the emotional aspects of this experience. To aid in recall, examples of situations that commonly provoke anger were provided (e.g., being treated unfairly, having an argument with a partner or family member). Participants were then asked to write down their memory in some detail, focusing on physiological sensations, thoughts and verbal expressions of anger, as well as thoughts about taking revenge. The instructions given for this induction were based on those developed by Wright and Mischel (1982), which have since been used in a number of other studies to elicit anger (Rusting & DeHart, 2000; Rusting & Nolen-Hoeksema, 1998; Salovey, 1992; Salovey & Birnbaum, 1989). Participants were then told that they would later be required to recall this memory in as much detail as they could as part of an emotional memory test. This was done to prolong the effects of the anger induction.

Moral judgment stimuli

Moral judgment stimuli were a set of 75 images compiled by Harenski and colleagues (Harenski, Antonenko, Shane, & Kiehl, 2008), 25 of which depicted moral violations, 25 were negative but did not contain a moral theme, and 25 neutral images (see Appendix for description of image content). All images in the moral category depicted social scenes indicating a specific moral violation (e.g., a man beating a child

with a baton). Each moral image had a negative non-moral (e.g., people crying), and neutral pair (e.g., people moving furniture), which were matched according to the number of individuals present in the image, as well as the setting. The moral and negative non-moral images were also matched on arousal. The majority of the images were taken from the International Affective Picture System (P. J. Lang, Bradley, & Cuthbert, 2005) with an additional few taken from the popular media.

Measures

All participants completed the following self-report measures of trait anger and disgust sensitivity.

The Aggression Questionnaire (AQ; Buss & Perry, 1992; Buss & Warren, 2000): The AQ measures a person's disposition towards trait anger. This is a 29-item self-report measure, comprising four factors: verbal aggression, physical aggression, hostility and anger, as well as a total aggression score. It has been shown to have good internal consistency ($\alpha = .89$; Buss & Perry, 1992) and construct validity (Becker, 2007). In the current study, the internal consistency was 0.89.

The Disgust Scale (DS; Haidt et al., 1994): The DS is a 32-item self-report questionnaire that assesses aversion to seven domains of disgust (food, animals, body products, body envelope violations, death, hygiene and sympathetic magic). It was used to gauge participants' level of trait disgust sensitivity. The scale has been shown to correlate positively ($r = .42$) with behavioural measures examining avoidance of disgust elicitors (Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999). The Disgust Scale has good internal consistency, with a Cronbach alpha coefficient reported of 0.81 (Olatunji, Williams, et al., 2007). In the current study, the Cronbach alpha coefficient was 0.85.

Facial EMG: Facial EMG was used to measure individual differences in facial responses to the three sets of image stimuli. Facial expressions of disgust are characterised by a retraction of the upper lip and wrinkling of the nose (Rozin, Lowery, et al., 1994), a movement that relies heavily on the *levator labii superioris* muscle. Disgust responses indexed via *levator labii* muscle activity have been found to correlate with scores on the Disgust Scale (r = .43), indicating good convergent validity (Olatunji, Haidt, McKay, & Bieke, 2008), therefore *levator labii* muscle activity was used specifically to index disgust-type responding to each image. For control purposes, *corrugator supercilii* activity was also measured. This muscle covers the medial portion of the brow and is activated during frowning. Activity over this muscle site was used to differentiate disgust from anger responses, as activity over this region without concurrent *levator labii* activity has been shown to be a sensitive marker of angry expressions (Tassinary & Cacioppo, 2000).

Electrode placement followed standard procedures described previously (Bailey, Henry, & Nangle, 2009; Fridlund & Cacioppo, 1986). Skin over the left *levator labii*, left *corrugator*, and centre of the forehead (single ground electrode) were cleansed with an alcohol wipe and abraded with NuPrep gel (Weaver and Co., Aurora, CO). Four gold-plated 9 mm bipolar surface electrodes were placed in pairs over each muscle region of interest, with an inter-electrode distance of approximately 1.25cm. The cap of each electrode was filled with Ten20 conductive paste (Weaver and Co.) and secured to the skin with medical tape. Muscle activity was continuously recorded with a PowerLab 8/30 Data Acquisition System (ADInstruments, Castle Hill, Australia) at a sampling rate of 2000Hz. A 10 to 500Hz bandpass filter and a 50Hz notch filter was applied, and an amplification factor of 20,000 was used. EMG recording was triggered

by DMDX (Version 3.2.3.0) software to ensure that the timing of the PowerLab and stimulus presentation was synchronised.

Each image was displayed on the computer screen for 5s, and was preceded by a blank screen for 5s. EMG signals were recorded for the duration of each image set, with the 500ms immediately prior to each image presentation serving as an index of baseline muscle activity. The order of image presentation within each set was randomised. The order of presentation of the three image sets was also randomised across participants.

Raw EMG signals were screened for electrical noise and movement artefacts, such as yawning. The average EMG signal was calculated using the root-mean-square (RMS) method, which represents the square root of the average power of the EMG signal over a specific time period (Tassinary & Cacioppo, 2000). Baseline muscle activity for each trial was calculated as the average RMS EMG activity 500ms prior to stimulus onset. Muscle activity in response to each image was calculated as the average RMS EMG activity of each 500ms interval period during which the image was displayed on the computer screen. Following the recommendations of van Boxtel (2010), the average RMS EMG percentage change from baseline (normalised EMG), averaged across individual trials within each image set, was calculated for the window 0-5000ms post-stimulus inset. Data from three participants from the no emotion condition had to be discarded due to excessive movement artefacts present in EMG recordings.

Procedure

The current study used an experimental design in which the acute experience of emotion was directly manipulated across three groups. Prior to the experimental manipulation, demographic information was collected and participants completed self-report measures of trait emotionality. Following this, participants were fitted with bipolar surface electrodes across their left *corrugator* and left *levator labii* muscles, according to the guidelines of Fridlund and Cacioppo (1986). The function of the EMG sensors was disguised by telling participants that the EMG electrodes measured changes in sweat gland activity (Bailey et al., 2009). Once fitted, participants were randomly assigned to one of three mood induction conditions. Both prior to the mood induction and immediately afterwards, participants were asked to rate their levels of six different emotions (disgust, anger, sadness, fear, happiness, surprise) on a 5-point Likert scale (0 = *Do not feel this emotion at all*, to 4 = *Feel this emotion extremely strongly*). Moral, negative non-moral and neutral image stimuli were presented in three separate sets. Each set consisted of 25 images belonging to only one image category, which were presented one-by-one on a computer screen for five seconds each. Participants were asked to view the images, and to try to minimise their blinking while the image was displayed on the screen. During this time EMG signals were recorded.

Results

Mood induction

Changes in disgust, anger, sadness, fear, happiness and surprise following the mood induction were calculated by subtracting post-mood induction ratings from pre-mood induction ratings. Mean mood change scores are presented in Table 1.1. The effects of each mood induction were then tested using a 3 x 6 mixed analysis of

variance (ANOVA) with the between subjects variable induction condition (no emotion, disgust, anger) and the within subjects variable mood change (disgust, anger, sadness, fear, happiness, surprise). For all analyses an alpha level of .05 was set.

There was a significant Induction condition x Mood change interaction $F(2, 87) = 41.39$, $MSE = 1.21$, $p < .001$, $\eta_p^2 = .49$. Follow-up tests of the simple effect of induction condition within mood change showed that participants in the disgust induction condition recorded higher levels of disgust post-induction compared to those in the no emotion ($p < .001$) and anger induction conditions ($p = .02$). Those in the anger induction condition reported greater levels of anger post-induction compared to those in the no emotion ($p < .001$) and disgust induction conditions ($p < .001$). Those in the anger induction condition also showed greater levels of disgust post-induction compared to those in the no emotion condition ($p < .001$). However, importantly, this was still lower than the level of disgust reported by those in the disgust induction condition ($p = .02$).

Levels of disgust and anger post-induction were of primary interest however, changes in the four other emotions are also reported here. Those in the disgust induction condition showed greater levels of surprise post-induction than those in the anger condition ($p = .003$), which was in turn greater than those in the no emotion condition ($p < .001$). Those in the disgust induction condition also showed greater levels of happiness post-induction than those in the anger condition ($p = .002$), but not greater than those in the no emotion condition ($p = .12$). Lastly, those in the anger induction condition showed greater levels of sadness ($p < .001$) and fear post-induction ($p = .003$) than those in the disgust condition, as well as those in the no emotion induction condition ($p < .001$ and $p = .02$, respectively).

Table 1.1

Change in emotion from pre- to post-mood induction

Induction condition	No emotion		Disgust		Anger	
	M	*SD*	*M*	*SD*	*M*	*SD*
Disgust	-0.07	0.45	2.90	1.18	2.30	1.15
Anger	-0.23	0.57	0.13	0.63	3.17	0.87
Sadness	-0.13	0.68	-0.30	0.84	1.80	1.54
Fear	0.30	0.75	0.13	1.04	1.07	1.62
Happiness	-1.33	1.32	-0.80	1.47	-1.87	1.07
Surprise	0.40	0.89	2.20	1.27	1.20	1.52

Note. *M* = Mean, *SD* = Standard deviation.

Effects of mood induction on psychophysiological responses to image stimuli

Separate univariate ANOVAs confirmed that there were no significant differences in raw baseline EMG activity in the *corrugator* ($p = .28$) or *levator labii* ($p = .24$) across the three induction conditions. To examine the effects of the mood inductions on EMG activity, *corrugator* and *levator labii* activity was analysed with separate 3 x 3 mixed ANOVA models with the between subjects variable of induction condition (no emotion, disgust, anger) and the within subjects variable of image type (moral, neutral, non-moral negative). The dependent variable was the average percentage change from baseline in EMG activity in response to images. Mean percentage change from baseline

in *corrugator* and *levator labii* activity across induction condition and image type are presented in Figure 1.1.

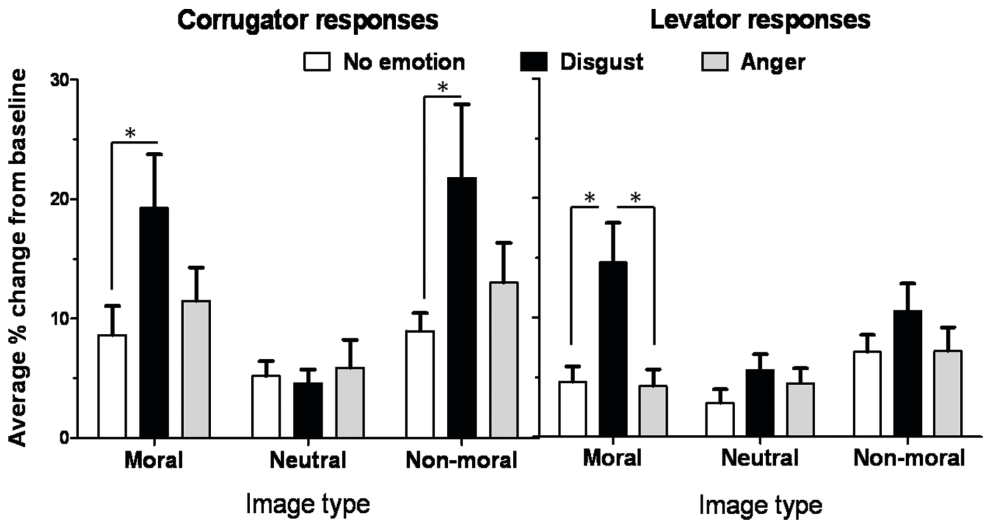

Figure 1.1. Mean (+ SEM) EMG change from baseline as a function of induction condition (no emotion, disgust, anger) and image type in the *corrugator* (left) and the *levator labii* (right). Asterisks indicate the significant simple main effects of induction condition within each image type.

Corrugator activity

There was a significant Induction condition x Image type interaction, $F(4, 168) = 2.81$, $MSE = 147.81$, $p = .04$, $\eta_p^2 = .06$. Follow-up tests of the simple effect of image type within induction condition showed that, for those in the disgust induction condition, *corrugator* activity was greater during presentation of moral ($M = 19.25$, $SD = 24.67$) compared to neutral images ($M = 4.54$, $SD = 6.54$; $p < .001$), but *corrugator* activity during moral and negative non-moral images did not differ ($M = 21.75$, $SD = 33.83$; $p = .34$). *Corrugator* activity to moral, neutral and negative non-moral images did not differ in either the anger or no emotion induction conditions (all ps > .05)

Further tests of the simple effect of induction condition within image type showed that, for moral images, those in the disgust induction condition showed greater *corrugator* activity than those in the no emotion (p = .03) but not those in the anger induction condition (p = .11). The same was also found for negative non-moral images, where those in the disgust induction condition showed greater *corrugator* activity than those in the no emotion induction condition (p = .04) but not in those who received the anger induction (p = .15).

Levator labii activity

There was a significant Induction condition x Image type interaction for *levator labii* activity $F(4, 168) = 4.12$, $MSE = 48.59$, $p = .003$, $\eta_p^2 = .09$. Follow-up tests of the simple effect of image type within induction condition revealed that participants in the disgust induction condition showed greater *levator labii* activity in response to moral images (M = 14.59, SD = 18.2) compared to negative non-moral images (M = 10.54, SD = 12.49; p = .04), which in turn was greater than the response to neutral images (M = 5.58, SD = 7.39; $p < .001$). Further tests of the simple effect of induction condition within image type revealed that for moral images, those in the disgust induction condition showed greater *levator labii* activity (M = 14.59, SD = 18.20) than those in the no emotion (M = 4.60, SD = 6.76, p = .003) and anger induction conditions (M = 4.25, SD = 7.62; p = .001), whereas the latter two conditions did not differ (p = .91).

Given that the anger induction produced stronger levels of anger than the disgust induction did levels of disgust, and given that the disgust and anger inductions also lead to mild elevations in anger and disgust respectively, I sought to further clarify the association between induced disgust and *levator labii* responses to moral transgressions by conducting separate regression analyses using post-induction levels of emotion

(instead of induction condition) as the independent variable. Using stepwise multiple regression I tested whether post-induction levels of disgust predicted *levator labii* responses to moral transgressions after controlling for post-induction levels of anger. Post-induction levels of anger were entered in Step 1 and post-induction levels of disgust entered in Step 2, with *levator labii* muscle activity to moral images as the dependent variable. The final model was statistically significant [R^2 = .07, $F(2, 84) = 3.03$, p = .02] and results showed that after controlling for post-induction anger, post-induction disgust predicted increased *levator labii* responses to moral images [β = .24, $t(84) = 2.20$, p = .01]. Conversely, post-induction anger was not a significant predictor of *levator labii* responses to moral images after controlling for post-induction disgust (p = .05). The same analysis was repeated for *corrugator* activity in response to moral images. After controlling for post-induction anger, post-induction disgust was not a significant predictor of *corrugator* activity to moral images (p = .66). Post-induction anger was also not a significant predictor of *corrugator* responses after controlling for post-induction disgust (p = .38).

Correlations between trait anger, disgust sensitivity and physiological responding

Correlations between trait anger, disgust sensitivity and EMG indices were also computed separately for each mood induction group (Table 1.2). Trait anger was not correlated with any of the EMG indices, however, disgust sensitivity showed a unique positive correlation with *levator labii* activity during presentation of moral images for those who had no emotion induced (r = .39, p = .04).

Table 1.2

Correlations between trait disgust sensitivity, trait anger and physiological responses

Image type	Moral		Neutral		Negative non-moral	
Muscle site	Cor	Lev	Cor	Lev	Cor	Lev
Correlations with trait disgust sensitivity						
No Emotion	.18	**.39***	.04	.13	.05	.26
Disgust	-.07	-.22	.07	-.07	.17	-.16
Anger	.19	-.09	.33	.01	.11	.02
Correlations with trait anger						
No Emotion	.22	.31	-.08	-.06	.23	.38
Disgust	.31	.35	.08	.34	.16	-.01
Anger	-.07	-.02	.17	-.04	.02	.02

Note. Physiological responses are presented across each of the three image types. Cor = Average % change from baseline of the *corrugator*; Lev = Average % change from baseline of the *levator*.

* Correlation significant at the .05 level (2-tailed).

Discussion

The aim of the current study was to evaluate the specificity of the link between disgust and morality by comparing links between disgust and moral transgressions to links involving anger using state, physiological and trait measures of emotionality. This is the first study that has compared the effects of induced and trait anger with induced and trait disgust sensitivity on physiological responses to moral transgressions using facial EMG. Results support the hypothesis that physiological responses would increase specifically to moral images among individuals who underwent a disgust

induction. As predicted, this was not observed when anger was induced. Furthermore, post-induction levels of disgust significantly predicted *levator labii* activity to moral images after controlling for post-induction levels of anger but not the other way around, indicating that even when disgust and anger co-occur in the context of moral transgressions, disgust is *uniquely* associated with moral transgressions whereas anger is not.

In regard to the specific muscle sites, those who had disgust induced had a significantly higher *levator labii* response when viewing images of moral transgressions compared to those who had anger or no emotion induced, with the latter two at equally low levels of responding. In contrast, there were no differences between the disgust and anger induction groups in *corrugator* activity, which increased in response to negative images more generally (i.e., to both the moral and negative non-moral images). It is important to note that inducing disgust or anger did not simply increase affective responding more generally, as there was no evidence of elevated muscle activity in response to neutral images. Taken together, these results indicate that incidental disgust and incidental anger both increase negative (i.e., *corrugator*) responding to negative stimuli, but that incidental disgust uniquely increases disgust (i.e., *levator labii*) responding to moral stimuli.

These results coincide with previous studies that have shown that inducing disgust increases the severity of individuals' self-reported moral judgments (Haidt, 2001; Schnall, Haidt, et al., 2008). Together with previous research, the current results provide further support for the unique ability of feelings of disgust to enhance reactions to moral transgressions. The results do, however, somewhat contradict certain findings from Gutierrez and Giner-Sorolla (2007) that found anger was more associated with increased perceptions of harm than disgust. One possible explanation as to why anger

was associated with greater perceptions of harm in Gutierrez and Giner-Sorolla's (2007) study comes from research showing that affective reactions are better predictors of the severity of an individual's moral judgments than are presumptions of harm. For example, affective reactions for actions that are identified as offensive yet harmless (e.g., eating one's dead pet dog) have been found to be better predictors of the severity of moral judgments than judgments about the level of potential harm involved in the action (Haidt, Koller, & Dias, 1993). The same result has been found when conservatives and liberals are interviewed about sexual morality issues such as incest (Haidt & Hersh, 2001). These findings suggest that judgments of harm may be influenced by separate affective processes which implicate anger more strongly than the severity of an individual's moral judgments, with the latter being influenced more specifically by disgust.

The current study also examined whether trait disgust sensitivity was more strongly correlated with responses to moral transgressions than trait anger. For individuals who underwent no emotion induction, trait disgust sensitivity was positively correlated with *levator labii* activity when viewing images depicting moral transgressions, whereas trait anger was not associated with any of the EMG indices of emotional responding. Furthermore, disgust sensitivity was not related to physiological responses to negative non-moral or neutral images, nor to *corrugator* activity. This suggests that trait disgust sensitivity may be uniquely associated with physiological responding to moral transgressions. This finding aligns with the results of Jones and Fitness (2008), which showed that individuals who scored highly on a measure of disgust sensitivity were also biased towards a conviction when tested in a mock juror scenario. If heightened disgust sensitivity impacts on moral judgment, this may have important implications for clinical groups who present with abnormal disgust

processing, such as OCD (Olatunji, Lohr, et al., 2007), Huntington's Disease (Hayes et al., 2009) and Parkinson's Disease (Sprengelmeyer et al., 2003; Suzuki, Hoshino, Shigemasu, & Kawamura, 2006). This is because the ability to make appropriate moral decisions and act within consensually derived moral norms is critical to functioning within society.

The finding that trait disgust sensitivity was not correlated with *levator labii* activity to moral images in the disgust induction group is surprising. One possible explanation for this null finding is that, in the absence of heightened state emotionality, individual differences in physiological responding to moral images may be more variable and thus determined by individual differences in trait disgust sensitivity. Van Dillen, van der Wal and van den Bos (2012) found a similar effect when examining the moderating role of individual differences in attention control on the effects of incidental disgust on moral judgments. Their data indicated that individual differences in attention control only impacted on the severity of moral judgments in a no emotion induction condition. This suggests that heightened levels of state disgust may override the effects of individual differences in trait emotionality, making participants generally more responsive to moral transgressions.

Some limitations must be kept in mind when interpreting the findings of the current research. Firstly, different mood induction techniques were used across the induction conditions so it is possible that this may have introduced variance that affected the data. The choice of using different mood induction methods reflected an attempt to achieve emotional states of anger and disgust in the most ecologically valid way. Prior evidence indicates that disgust is an object-bound emotion (Russell & Giner-Sorolla, 2013) and so can be reliably induced using visual stimuli (Gross & Levenson, 1995; Rein et al., 1995). Anger, however, is more bound to the influences of

context and situation (Russell & Giner-Sorolla, 2013), is enhanced and maintained by ruminative processes (Verona, 2005), and is more difficult to elicit using film stimuli (Gross & Levenson, 1995; Rein et al., 1995). Therefore, using a visual stimulus depicting a physically disgusting object to elicit disgust, and a personally generated memory that was closely tied to a specific context and situation relevant to the individual to elicit anger, is analogous to the way in which disgust and anger are evoked in everyday life, making these findings more generalisable beyond the lab context. Although it may be argued that the different induction methods had different effects on the quality of the emotion evoked, results remained unchanged when post-induction levels of emotion were used as predictors of physiological responding, as opposed to when the induction condition was used. This indicates that, regardless of how the emotion was elicited, state disgust significantly predicted physiological responses to moral transgressions, whereas state anger did not. Further replications of the current study using different methods of mood induction are however needed to confirm these findings.

Secondly, although the image stimuli used in the current study have been used in prior research on moral perception (Harenski et al., 2008; Harenski, Antonenko, Shane, & Kiehl, 2010), it is noteworthy that a minority of the images in the moral set and approximately a third of the images in the non-moral set also depicted other disgust elicitors (e.g., blood). Since research has shown that such disgust elicitors are associated with activation of the *levator labii* muscle, it might be argued that heightened *levator labii* activity observed in response to these image sets is in part be due to the presence of other disgust elicitors. However, if the pattern of *levator labii* activation in the current study were being driven solely by the images containing core disgust elicitors, it would be expected that *levator labii* activity in response to negative

non-moral images should be equal to or greater than that observed in response to moral images. Although this appears to be the case for those in the no emotion and anger induction conditions, there is still significantly greater *levator labii* activity in response to moral images compared to non-moral images in the disgust induction group, suggesting that state disgust has the effect of amplifying *levator labii* activity specifically to moral themes.

To conclude, the present study is the first to use a multi-method approach that evaluates the uniqueness of the link between disgust and morality through a comparison with anger using state, physiological and trait measures of emotional responding. Results indicate a unique relationship between disgust and moral themes, showing that both incidental disgust and trait disgust sensitivity are associated with greater physiological responses to moral transgressions, whereas incidental and trait anger are not. Furthermore, EMG data indicate that enhanced responding to moral themes was consistent with a disgusted facial expression rather than an angry expression. This research provides evidence that disgust expressed in a moral context is not merely used metaphorically to convey anger. Instead, it shares more similarities with physical disgust, providing support for the theory that moral disgust represents the biological expansion of physical disgust into the moral domain.

Chapter 3

DISGUST IN OCD

The next two experiments, outlined in this chapter and Chapter 4, examined whether heightened disgust responding is related to moral rigidity in individuals with OCD. These studies built on the findings of Chapter 2, which provided evidence that responses to moral transgressions are specifically affected by physical disgust and not anger, suggesting that physical disgust is closely tied with moral transgressions. The study in this current chapter provided an initial investigation into the levels of disgust responding in individuals with OCD relative to a group of non-clinical individuals as well as to a group of individuals with non-OCD anxiety disorders. It extends previous literature by using physiological indices of emotional responding in addition to self-report measures and also addresses the important question of whether elevations in disgust responding are associated specifically with OCD, rather than attributable to anxious psychopathology more generally.

Evidence of heightened disgust responding in OCD

As mentioned in Chapter 1, a growing body of research suggests that abnormal disgust responses may contribute to the maladaptive affective and behavioural symptoms that characterise OCD. OC symptomatology is associated with increased levels of self-reported disgust (e.g., Berle et al., 2012; Cisler et al., 2008; Olatunji,

2010) and greater behavioural avoidance of disgusting stimuli (Deacon & Olatunji, 2007; Olatunji, Lohr, et al., 2007; Tsao & McKay, 2004).

Disgust is a multifaceted construct comprised of disgust propensity (the tendency to respond with disgust) and disgust sensitivity (aversion to feelings of disgust). There is mixed evidence regarding the degree to which these separate constructs are implicated in OCD. Disgust propensity is comprised of disgust in three domains (Olatunji, Williams, Lohr, & Sawchuk, 2005): core disgust (e.g., rotting foods, body waste and small animals), animal reminder disgust (e.g., sexual acts, mutilation, injury and death), and contamination disgust (objects that pose the threat of contamination from other people, e.g., toilets, money, tissues). Core disgust has been most closely associated with self-reported OCD symptoms (Berle et al., 2012; Olatunji, Haidt, et al., 2008) and predicts changes in OCD symptoms longitudinally (Berle et al., 2012; Olatunji, 2010; Olatunji, Tart, Ciesielski, McGrath, & Smits, 2011).

Psychophysiological indices provide one method by which self-reported disgust responses can be supplemented with more objective data. Two of the most commonly used physiological indicators of disgust are electrodermal and facial muscle activity. Disgust provocation evokes increased electrodermal activity (Bradley, Codispoti, Cuthbert, & Lang, 2001; Lang, Greenwald, Bradley, & Hamm, 1993; Stark, Walter, Schienle, & Vaitl, 2005), and increases in skin conductance response (SCR) are observed when disgust is elicited using static images (Stark et al., 2005). As mentioned previously, disgust provocation also results in contraction of the *levator labii superioris* muscle (Schienle et al., 2001; Stark et al., 2005; Vrana, 1993, 1994; Yartz & Hawk, 2002), as well as the *corrugator supercilii*, which is considered a robust marker of negative affect and is particularly active when a person is exposed to negative stimuli (Tassinary & Cacioppo, 2000).

Physiological indices of emotion bypass semantic meaning and provide an insight into the true function and intensity of an emotional experience. This is unlike self-report, which has a semantic component that may be shaped by the emotional vocabulary of the participant's language and culture (Vrana, Cuthbert, & Lang, 1986). Physiological measures are therefore particularly useful for studying concepts like fear and disgust, which have a high degree of semantic overlap (i.e., being afraid of germs vs. being disgusted by germs) but also unique behavioural requirements that produce distinct physiological reactions (i.e., fight/flight vs. passive avoidance/repulsion).

Physiological markers of disgust provide an avenue to examine whether individuals with OCD show disgust responses that are elevated relative to individuals without the disorder. This approach aligns well with the recently proposed Research Domain Criteria (RDoC) for the study of psychopathology. The RDoC aims to characterise psychopathology in terms of normal and abnormal biological and behavioural processes rather than as categories of discrete symptoms (Sanislow et al., 2010). If individuals with OCD show more intense psychophysiological disgust responses than those without the disorder, it would suggest that OCD is characterised by biological and behavioural disgust responses that can be differentiated from normative disgust processes.

Cognitive processes that influence disgust responding

Given that the current study sits within a more general examination of the relationship between disgust and morality, it was important to examine whether cognitive factors pertinent to both OCD and moral rigidity, may also impact on disgust responding. A recent theory that has received relatively little empirical attention

proposes that disgust-based symptoms of OCD arise when normally occurring appraisals that accompany disgust responses (e.g., "I feel dirty") interact with maladaptive catastrophic beliefs (e.g. "I'll become completely contaminated") to produce pathological disgust (Cisler et al., 2010). These beliefs reflect the core maladaptive cognitions important in the development and maintenance of obsessional problems: an inflated sense of personal responsibility and perception of threat; beliefs about the importance of thoughts; and the need for perfectionism and/or certainty (OCCWG, 2005).

Cisler and colleagues (2010) assessed these belief domains alongside disgust propensity and contamination fear in a non-clinical sample and found that heightened disgust propensity interacted with the severity of obsessive beliefs, particularly the overestimation of threat, to potentiate contamination fear. Similarly, the severity of contamination concerns has been associated with the presence of maladaptive obsessive beliefs regarding overestimation of threat in clinical samples (Smith, Wetterneck, Hart, Short, & Björgvinsson, 2012). This evidence suggests that maladaptive obsessive beliefs may be an important factor contributing to elevated disgust responding in OCD. However, as with most previous research on disgust responding in OCD, all prior research examining the role of obsessive beliefs in disgust responses has relied solely on self-reported disgust.

Aims & hypotheses

The first aim of the current study was to provide an assessment of disgust responses in individuals with OCD across a range of disgust domains using psychophysiological indices of disgust responding alongside self-report measures. I

predicted that individuals with OCD would demonstrate heightened self-reported and physiological disgust compared to non-clinical control participants and individuals with other anxiety disorders. The inclusion of an anxious control group was critical because few studies examining disgust responding in OCD have used a clinical comparison group to control for anxious symptomatology.

The second aim of the current study was to determine whether obsessive beliefs are associated with psychophysiological disgust responses in addition to self-reported disgust. Previous research has specifically implicated the tendency to overestimate threat with disgust-based OC symptoms (Cisler et al., 2010). Consequently, I predicted that heightened beliefs in this domain would predict greater psychophysiological and self-reported disgust responses after controlling for trait disgust and diagnosis.

Method

Participants

Individuals with a primary diagnosis of OCD (n = 25) and those with other non-OCD anxiety disorders (n = 25) were recruited from advertisements placed in local newspapers and flyers sent out to local mental health practitioners. A further 25 non-clinical community control participants were recruited through advertisements placed in the local newspaper.

To be eligible for inclusion in the OCD group, participants had to have been diagnosed with OCD by a mental health professional or be experiencing obsessions and compulsions that interfered with their day-to-day functioning at the time of contact. To be eligible for the non-OCD anxiety group, participants had to have been diagnosed with or be experiencing symptoms of an anxiety disorder other than OCD.

The symptoms had to be current and impairing, and individuals were not eligible if they met criteria for a specific phobia alone. To be eligible for the non-clinical control group, participants could not have met criteria for a clinical psychological disorder in their lifetime. Participants were excluded from all three groups if they reported symptoms of a neurological or psychotic disorder, used illicit drugs, or if an immediate relative had experienced symptoms of psychosis. Written informed consent was obtained from all participants. The study was approved by the University of New South Wales Human Research Ethics Committee.

Stimuli

A set of 36 static images was chosen from the International Affective Picture System (P. J. Lang et al., 2005) and from popular media to assess psychophysiological disgust responses (see Appendix C). The images comprised six categories, three of which assessed responses to the separate domains of disgust elicitors identified previously: core disgust, contamination disgust and animal reminder disgust.

Core disgust was assessed using images depicting body waste (e.g., a dirty toilet) and was chosen because it is suggested to be the most universal disgust elicitor (Rozin, Haidt, & McCauley, 1999). If individuals with OCD show heightened disgust responses to these images, it suggests that individuals with OCD have stronger disgust reactions to unambiguous, universally disgusting stimuli than do those without the disorder. Contamination disgust was assessed using a second set of images depicting objects that were potential sources of contamination (e.g., a dustbin). These were chosen as they are more ambiguous than body waste and may be used to show that individuals with OCD are biased toward interpreting ambiguous stimuli as disgusting,

particularly due to threat of contamination. Animal reminder disgust was assessed using a third set of images depicting blood/injury. Blood/injury was chosen over other stimuli relevant to animal reminder disgust (such as death or sex) as it is relevant to other forms of anxiety, such as blood phobia, and is useful for assessing the degree to which individuals with OCD show heightened disgust responses to domains of disgust not directly linked with contamination.

The fourth set of images depicted moral transgressions in the absence of any core disgust content (e.g., a person pointing a gun at a child). This set was included to test the hypothesis that heightened disgust sensitivity in individuals with OCD may result in stronger sociomoral disgust reactions given that heightened trait disgust has been linked with heightened moral hypervigilance (Jones & Fitness, 2008). A fifth set of neutral images (e.g., people talking) and a sixth set of negative yet non-disgusting images (e.g., people crying) was used to test whether any heightened disgust responses in individuals with OCD may be due to heightened responses to visual stimuli or negative stimuli more generally.

There were six colour images in each category. Psychophysiological responses to each image were recorded and participants were also asked to provide a rating from 1 (*Not at all disgusting*) to 8 (*Extremely disgusting*) to indicate how disgusting they thought each image was. The order of image presentation within each category was randomised, as was the order of category presentation.

Measures

Diagnostic Interview

All individuals deemed eligible via telephone screening were assessed for the presence of current DSM-IV psychological disorders using the Anxiety Disorders Interview Schedule for DSM-IV (ADIS; Brown, DiNardo, & Barlow, 1994). As I am a provisionally registered psychologist, I was able to be trained in the administration of the ADIS and I was able to personally interview and diagnose all participants in the current study under the supervision of a senior clinical psychologist.

Clinical symptom measures

Obsessive-Compulsive Inventory – Revised (OCI-R; Foa et al., 2002): The OCI-R is an 18-item self-report questionnaire that was used to measure the severity of washing, checking, obsessing, hoarding, neutralising, and ordering symptoms. The OCI-R has good test-retest reliability and convergent and discriminant validity (Foa et al., 2002). The internal consistency in the current study was 0.92.

The Depression, Anxiety and Stress Scales (DASS-21; Lovibond & Lovibond, 1995)): The DASS-21 is a 21-item self-report scale that was used to measure depression, anxiety and stress. The internal consistencies for the depression, anxiety and stress subscales and the total score in the current study were 0.93, 0.89, 0.85, and 0.95 respectively.

The OBQ (OCCWG, 2005): This is a 44-item self-report questionnaire that was used to assesses the presence and severity of obsessive beliefs associated with OCD. Three subscales assess beliefs relating to the over importance of and need to control thoughts (ICT), beliefs relating to an inflated sense of responsibility for preventing harm or perceiving threat (RT), and beliefs relating to the need for perfectionism and

certainty (PC). In the present sample, the internal consistencies were 0.90, 0.90 and 0.93 for the ICT, RT and PC subscales respectively and 0.95 for the total score.

Trait disgust

Disgust Propensity Sensitivity Scale-Revised (DPSS-R; van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006): The DPSS-R consists of two 6-item subscales that were used to measure disgust propensity (the tendency to respond with disgust) and disgust sensitivity (aversion to the experience of disgust). The internal consistencies of the disgust propensity and sensitivity subscales in the current sample were 0.82 and 0.78, respectively.

Disgust Scale-Revised (DS-R; Haidt et al., 1994; modified by Olatunji, Williams, et al., 2007): The DS-R is a 27-item self-report questionnaire that, like the DPSS-R, was used to measure disgust sensitivity. It differs from the DPSS-R in its measurement of trait aversion to seven discrete domains of disgust elicitors (food, animals, body waste, body envelope violations, death, hygiene and sympathetic magic). The DS-R has superior psychometric properties compared to the original scale (Olatunji, Williams, et al., 2007), and its use represents an improvement on the study reported in Chapter 2. In the current study, the DS-R had an internal consistency of 0.89.

Psychophysiological variables

Facial EMG

Facial EMG was used to measure *levator labii superioris* muscle activity in response to each image. For control purposes, muscle activity over the *corrugator supercilii* was also measured (Tassinary & Cacioppo, 2000). Electrode placement was identical to that described in Chapter 2 and followed standard procedures used in

previous electromyographic research (Bailey et al., 2009; Tassinary & Cacioppo, 2000). The skin over the left *corrugator supercilii*, left *levator labii superioris* and the middle of the forehead was cleansed with an alcohol wipe and then gently abraded using NuPrep gel (Weaver and Co., Aurora, CO). To improve the clarity of the EMG signal, Ag-AgCL 4mm bipolar surface electrodes in a 7.5mm housing were used instead of gold-plated electrodes (which were used in Chapter 2). These electrodes were then filled with Ten20 conductive paste (Weaver and Co.) and then affixed to the *corrugator* and *levator* muscles using Microporous hypoallergenic surgical tape (3M Micropore). A fifth electrode was placed in the centre of the forehead to function as an earth. Muscle activity was recorded using a PowerLab 8/30 Data Acquisition System (ADInstruments, Castle Hill, Australia).

EMG responses were recorded using a passive viewing paradigm where each trial consisted of a blank screen for 5s with an orienting tone occurring at 4.5s, then one image presented on the screen for 5s. Images were presented using DMDX software (Version 3.2.3.0) to ensure that stimulus presentation and EMG recording was synchronised. EMG signals were recorded in 500ms intervals at a rate of 2000 samples per second, and the 500ms period prior to stimulus onset was used as a baseline measure of muscle activity. Raw EMG signals were filtered and processed offline. All recordings had a 10-500Hz band pass digital filter applied, and were cross-checked with video recordings of the participants' face. Movement artefacts (e.g., blinking) were removed manually. EMG data was also log-transformed to restore normality and outliers replaced with scores three standard deviations above or below the group mean. Overall, EMG data from 9 participants had to be discarded due to excessive movement artefacts (2 control, 4 non-OCD anxious and 3 OCD participants).

Electrodermal activity

Electrodermal responses were measured according to procedures outlined in previous research (Hein, Lamm, Brodbeck, & Singer, 2011) using a pair of ML116F finger electrodes attached to the left index and ring finger. Approximately 45 minutes prior to recording, participants were asked to wash their hands using non-abrasive soap and then dry them thoroughly. Care was taken to ensure that the signal had stabilised prior to data collection. The recording range was set to 40μS and baseline subject zeroing was used to subtract the participant's absolute level of electrodermal activity from all recordings. The mean amplitude of SCRs was obtained by first applying a 0.5Hz high pass filter to correct for changes in tonic skin conductance level, and then subtracting the maximum skin conductance level between stimulus onset to 3s post stimulus offset, from a baseline period of 2-0s prior to stimulus onset. This was expressed as a percentage change from baseline. The scores were then log-transformed to restore normality and outliers replaced with values three standard deviations above or below the group mean.

Procedure

Participants completed background and clinical assessments and then facial EMG and SCR electrodes were attached. Participants were told that the sensors were measuring sweat gland activity to direct attention away from the facial muscles. Once psychophysiological responses were recorded, the images were shown again and participants were asked to rate how disgusting they thought each was. EMG and SCR sensors were then removed and participants debriefed. The current study was conducted within the context of a broader study on the role of disgust in OCD, and

individuals in the OCD group were invited to attend a second testing session to complete components of the study outlined in Chapter 5. It should be noted that approximately half of the participants in the OCD group completed the current study in their first session, whereas the other half completed the current study in their second session (held at least one week after their first).

Results

Sample characteristics

Following the ADIS interview, two participants were excluded due to the presence of psychotic symptoms and a further two because although they had been diagnosed with an anxiety disorder in the past, they did not meet full criteria for an anxiety disorder at the time of testing. The final sample consisted of 25 non-clinical control participants, 21 individuals with non-OCD anxiety disorders and 25 with OCD. Demographic and clinical characteristics for the three groups are shown in Table 2.1, as are their trait disgust scores. A breakdown of the primary and secondary diagnoses in the clinical groups is shown in Table 2.2.

Table 2.1. *Demographic and clinical characteristics of sample*

Variable	Control group *M*	Control group *SD*	Anxiety group *M*	Anxiety group *SD*	OCD group *M*	OCD group *SD*	*df*	Inferential statistics *F*	η^2	*p*
Age	29.2	12.3	32.1	9.7	37.4	16.4	2	2.5	0.6	0.1
Education	16.6	2.4	16.5	2.7	15.9	3.4	2	0.4	0.1	0.7
OCI-R										
Washing	1.2	1.4	2.9	3.9	6.0	4.2	2	13.0	0.3	$< .001^{23}$
Ordering	2.6	2.6	5.1	4.2	8.6	3.5	2	19.3	0.4	$< .001^{123}$
Obsessing	2.5	2.4	6.6	3.1	8.7	2.8	2	33.0	0.5	$< .001^{123}$
Neutralising	1.3	1.9	2.3	3.1	6.0	3.7	2	17.1	0.3	$< .001^{23}$
Checking	2.5	2.8	4.0	2.8	6.6	3.9	2	10.2	0.2	$< .001^{23}$
Hoarding	3.6	2.9	4.3	3.6	4.3	3.5	2	0.4	0.0	0.7
OBQ										
RT	54.9	15.1	59.5	19.3	72.2	19.5	2	6.2	0.2	$.003^{23}$
ICT	24.7	7.9	30.6	12.0	42.6	15.8	2	13.6	0.3	$< .001^{23}$
PC	54.9	15.1	66.9	22.8	78.9	19.4	2	9.8	0.2	$< .001^{123}$
DASS										
Stress	13.5	8.5	26.3	7.3	26.9	11.3	2	16.2	0.3	$< .001^{12}$
Anxiety	6.2	6.3	15.4	8.2	18.5	10.4	2	14.3	0.3	$< .001^{12}$
Depression	8.6	8.0	23.8	10.3	25.5	13.0	2	18.7	0.4	$< .001^{12}$
DPSS-Propensity	11.6	4.3	11.2	3.3	14.6	4.3	2	5.0	0.1	$.009^{23}$
DPSS-Sensitivity	7.2	4.4	9.6	4.9	10.6	5.2	2	3.2	0.1	$.046^{2}$
DS-R	46.9	16.0	59.1	19.9	61.0	15.5	2	4.9	0.1	$.01^{12}$

Note: OCI-R = Obsessive-Compulsive Inventory – Revised; OBQ = Obsessive Belief Questionnaire; RT = Responsibility/Threat subscale of OBQ; ICT = Important/Control over thoughts subscale of OBQ; PC = Perfectionism/Control subscale of OBQ; DASS = Depression Anxiety & Stress Scale; DPSS = Disgust Propensity/Sensitivity Scale; DS-R = Disgust Scale-Revised. [1] Contrast between control group and anxiety group is significant; [2]contrast between control group and OCD group is significant; [3]contrast between anxiety and OCD group is significant.

Table 2.2

Primary and secondary diagnoses in the anxious control and OCD groups

	Anxious group	OCD group
Primary diagnoses		
Obsessive-compulsive disorder	0%	100.0%
Generalised anxiety disorder	48.6%	-
Social anxiety disorder	28.6%	-
Post-traumatic stress disorder	19.0%	-
Panic disorder	4.8%	-
Secondary diagnoses		
Major depression	42.9%	44.0%
Social anxiety disorder	28.6%	8.0%
Generalised anxiety disorder	23.8%	40.0%
Specific phobia	19.0%	0%
Post-traumatic stress disorder	4.8%	8.0%
Panic disorder	0%	8.0%
Bipolar disorder	0%	4.0%

Trait and self-reported disgust responses

Univariate ANOVAs were conducted to assess for group differences in trait disgust. Mixed repeated measures ANOVAs with the within subjects variable image (body products, contamination, mutilation, neutral, negative) and the between subjects variable of group (OCD, anxious, control) were used to examine group differences in self-reported and physiological disgust responding. As shown in Table 2.1, there was a significant main effect of group for each of the trait disgust measures (all *p*s < .05). For all measures, individuals with OCD scored higher than non-clinical control participants (all *p*s < .05). Only on the disgust propensity subscale of the DPSS-R did individuals with OCD also score higher than anxious control participants ($p = .009$).

Mean disgust ratings for static images are shown in Figure 2.1. There was a significant Group x Image interaction for self-reported disgust ratings $F(10, 340) = 4.02$, $p < .001$, $\eta_p^2 = .11$. Follow-up tests of the simple effect of group within image showed that individuals with OCD rated the images depicting body waste as significantly more disgusting than the non-clinical ($p < .001$), but not anxious ($p = .42$) control participants did. Individuals with OCD also rated images depicting contamination as more disgusting than non-clinical ($p < .001$) participants, but did not differ in their ratings compared to anxious control participants ($p = .42$). Within groups, non-clinical and anxious participants rated images depicting injury as the most disgusting, and significantly more disgusting than contamination, neutral or negative images (all *p*s < .001). In contrast, individuals with OCD rated images depicting body waste as the most disgusting, and significantly more disgusting than all other images (all *p*s < .01).

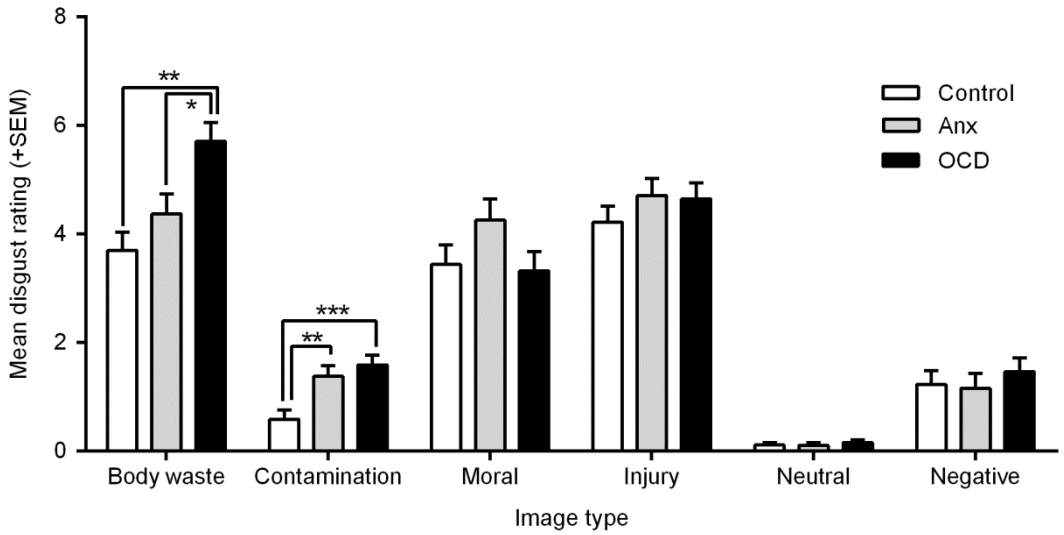

Figure 2.1. Mean (+ SEM) self-reported disgust ratings for the six image types across the three groups

* $p < .05$

** $p < .01$

*** $p < .001$

Psychophysiological responses

Due to excessive movement artefacts present in recordings, facial EMG data from 3 individuals in the non-clinical control group, 5 individuals in the anxious control group, and 2 individuals in the OCD group had to be discarded. Mean log-transformed facial EMG responses for the *corrugator* and *levator* muscles in response to each of the image sets are shown in Figures 2.2 and 2.3.

Corrugator supercilii

There was no significant Group x Image interaction for *corrugator* responses ($p = .84$) or main effect of group ($p = .46$), though there was a main effect of image $F(5, 290) = 9.36$, $p < .001$, $\eta_p^2 = .14$. Averaged across groups, images depicting injury

elicited the greatest increase in *corrugator* activity, and significantly more so than images depicting contamination (p = .001), neutral (p < .001) and negative content (p = .001).

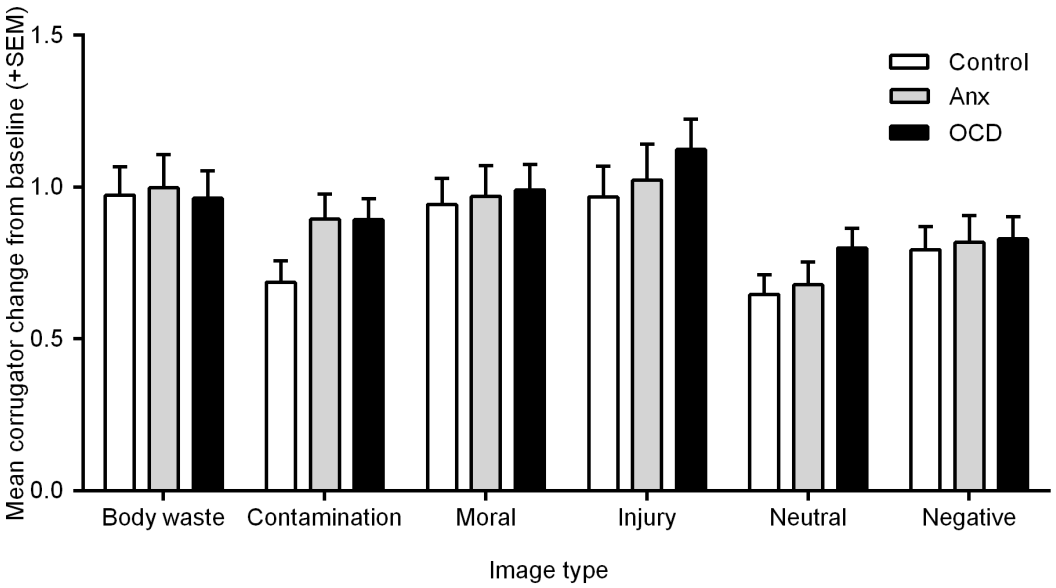

Figure 2.2. Mean (+ SEM) log-transformed percentage change from baseline in *corrugator* activity in response to the six image types across the three groups

Levator labii

There was no significant Group x Image interaction for *levator* responses (p = .38) or main effect of group (p = .75), though the main effect of image was significant $F(5, 290) = 11.47$, $p < .001$, $\eta_p^2 = .17$. Averaged across groups, images depicting injury, closely followed by body waste, elicited the greatest increase in *levator* activity, and significantly more so than contamination (both ps < .001), moral (both ps < .05), neutral (both ps < .001) and negative images (both ps < .001).

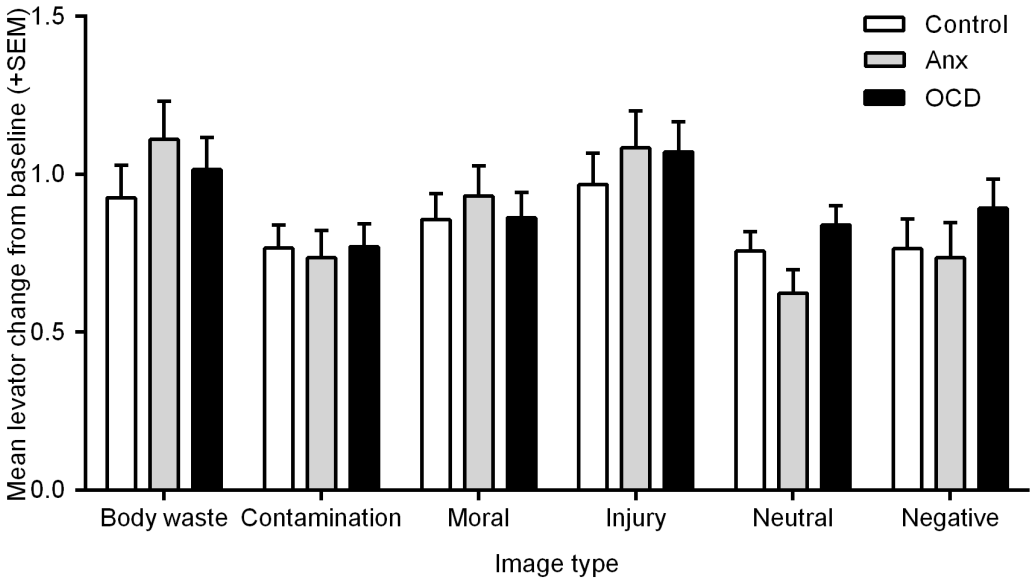

Figure 2.3. Mean (+ SEM) log-transformed percentage change from baseline in *levator* activity in response to the six image types across the three groups

Electrodermal activity

Electrodermal data from 2 non-clinical control participants, 5 anxious control participants and 1 OCD participant had to be discarded due to excessive movement artefacts present in recordings. Mean log-transformed electrodermal responses to images are also shown in Figure 2.4. There was no significant Group x Image interaction for SCRs (p = .93) or main effect of group (p = .72), though there was a main effect of image $F(5, 295) = 3.69$, p = .003, η_p^2 = .06. Averaged across groups, images depicting contamination elicited the greatest increase in electrodermal activity, and significantly more so than neutral ($p < .001$) and negative images (p = .04), but not the other image categories (all ps > .05).

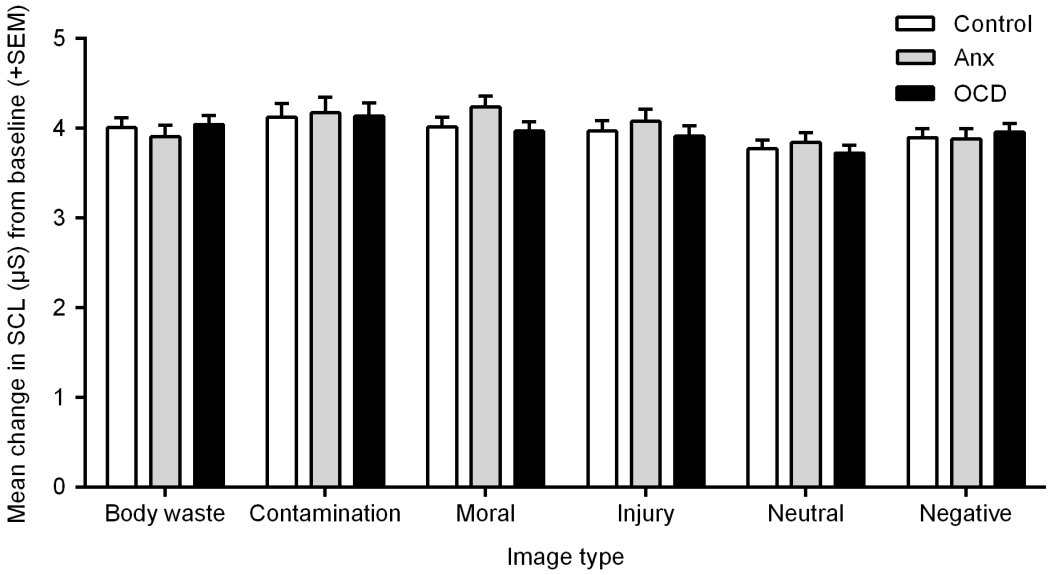

Figure 2.4. Mean (+ SEM) change from baseline in electrodermal activity (SCL) in response to the six image types across the three groups

Cognitive correlates of disgust responding

To examine whether obsessive beliefs were associated with self-reported and physiological disgust responses, partial correlations between the OBQ total score and self-reported and physiological disgust responses to the image types were carried out, controlling for diagnosis, disgust propensity (DPSS-R Disgust Propensity subscale score) and disgust sensitivity (DS-R score). To reduce the likelihood of Type I error, disgust responses to the four disgust-based categories (i.e., body waste, contamination, injury, sociomoral) were averaged into a single score. Table 2.3 shows the correlations between the OBQ total score and disgust responding to the three image types, controlling for group, disgust propensity and sensitivity. The OBQ remained significantly positively correlated with self-reported disgust responses to neutral images,

and *levator* responses to negative images, after controlling for group, disgust propensity and sensitivity (both *p*s < .05).

Table 2.3

Partial correlations between the OBQ total score and disgust responses after controlling for group, disgust propensity and disgust sensitivity

Control variables	Outcome measure	Image type	OBQ (r)
Group, Disgust sensitivity, Disgust propensity	Self-reported disgust responses	Disgust	0.09
		Neutral	0.31**
		Negative	0.24
	GSR	Disgust	0.25
		Neutral	0.07
		Negative	0.12
	Corrugator responses	Disgust	0.08
		Neutral	0.11
		Negative	0.07
	Levator responses	Disgust	0.17
		Neutral	0.10
		Negative	0.27*

Note. OBQ = Obsessive Belief Questionnaire
* $p < .05$
** $p < .01$

To determine whether a specific type of obsessive belief was more strongly correlated with disgust responses, the partial correlations showing significant associations between OBQ total scores and disgust responses (i.e., self-reported responses to neutral and *levator* responses to negative images) were repeated, substituting the OBQ subscale scores for the total score. These correlations are shown in Table 2.4. Results show that the association between the OBQ total score and self-reported disgust responses to neutral images was driven by the responsibility/threat and importance/control of thoughts subscales. In contrast, the association between OBQ total scores and *levator* responses to negative images was driven solely by the perfectionism/certainty subscale.

Table 2.4

Partial correlations between the OBQ and disgust indices

Control variables	Outcome	Image type	RT (r)	ICT (r)	PC (r)
Group, Disgust sensitivity, Disgust propensity	Self-reported disgust responses	Disgust	0.16	0.23	0.02
		Neutral	0.32*	0.34**	0.10
		Negative	0.25	0.28*	0.10
	Levator responses	Disgust	0.07	0.17	0.07
		Neutral	0.04	0.22	0.02
		Negative	0.17	0.15	0.28*

Note. RT = Responsibility/Threat subscale of OBQ; ICT = Importance/Control over thoughts subscale of OBQ; PC = Perfectionism/Control subscale of OBQ

* $p < .05$

** $p < .01$

CHAPTER 3

Discussion

Group differences in trait disgust

The first key finding to emerge was that, as predicted, individuals with OCD showed heightened disgust propensity (the tendency to respond with disgust) relative to anxious and non-clinical control participants, and higher disgust sensitivity (aversion to the experience of disgust) relative to non-clinical control participants. This suggests that heightened disgust propensity may be unique to individuals with OCD, whereas heightened disgust sensitivity may be associated with anxious pathology more generally.

These results coincide with the findings of previous studies in clinical samples that have shown correlations between self-reported disgust propensity and OCD symptoms (Berle et al., 2012). They also align with previous research in non-clinical samples which has demonstrated a stronger link between disgust propensity and OC symptoms than disgust sensitivity (e.g., Olatunji, 2010). The current results support the notion that disgust propensity and sensitivity reflect distinct processes that relate to psychopathology in different ways. For example, past research has shown that disgust propensity is associated with spider fear while both disgust propensity and sensitivity are associated with blood phobia, especially for those with a history of fainting (van Overveld, de Jong, Peters, et al., 2006). This suggests that variations in the two trait disgust measures may not only be associated with different forms of psychopathology, but also with different physiological responses.

Group differences in self-reported disgust

Group differences in state disgust were also examined in response to six categories of images, four containing images depicting specific categories of disgust. As predicted, individuals with OCD showed significantly higher self-reported disgust to images depicting body waste relative to non-clinical and anxious control participants. Furthermore, individuals with OCD rated images of body waste as being the most disgusting of all, while anxious and non-clinical control participants rated images of injury as the most disgusting.

The second of set images depicted objects that may be contaminated, and was chosen to assess whether individuals with OCD experience disgust in response to more ambiguous stimuli. Individuals with OCD rated these images as significantly more disgusting compared to non-clinical participants, but not compared to anxious participants. This finding suggests that a bias toward experiencing disgust in response to ambiguous, potentially contaminated stimuli is not specific to OCD and may be a characteristic of anxious pathology in general.

Two other domains of disgust were examined to assess whether enhanced disgust responses in individuals with OCD were restricted to a subset of disgust elicitors. The first of these was the domain of blood/injury, which is of interest as it has not been linked specifically to individuals with OCD, despite the stimuli often being rated as just as aversive as body waste (P. J. Lang et al., 2005). The second of these two images sets was the sociomoral disgust domain, which was chosen because of its relationship with disgust sensitivity (Jones & Fitness, 2008). Results showed no group differences in self-reported disgust to images depicting blood/injury or sociomoral transgressions.

Taken together, this pattern of results suggests that individuals with OCD show uniquely elevated subjective disgust responses to images of body waste – a strong core disgust elicitor. Although their subjective disgust responses to more ambiguous, possibly contaminated objects, was also elevated beyond non-clinical controls, it was not different from those with other anxiety disorders. These results coincide with previous research that has shown that OCD symptoms are most strongly associated with core disgust elicitors such as body waste (Olatunji, Lohr, et al., 2007) and, relatedly, smells (Berle et al., 2012). In terms of the RDoC for the study of psychopathology, the results suggest that OCD is associated with a subjective disgust response that is elevated beyond normative disgust responses as well as those observed in individuals with non-OCD anxiety disorders, specifically with regard to strong core disgust elicitors.

Group differences in psychophysiological disgust

While clear differences between the groups emerged on self-reported trait and state disgust, no differences were observed in psychophysiological responses. This finding ran counter to my prediction that heightened self-reported disgust in OCD would be accompanied by enhanced psychophysiological expressions of disgust, and it suggests that heightened disgust in OCD may be subjective and unrelated to physiology. However, these findings do coincide with the results of some studies that have found weak or no correlation between self-reported disgust and physiological markers of the emotion. For example, in a study examining the link between self-reported disgust and cardiac response during a disgust-eliciting film, de Jong and colleagues (2011) found no relationship between self-report and physiological measures, and suggested that self-reported disgust and physiological indices of the emotion may represent separate

phenomena. Furthermore, Stark and colleagues (2005) found that the amount and direction of covariation between self-reported disgust and EMG responses differed remarkably among participants. Their finding was consistent with the current study in which substantial variation was evident within all groups. Thus, it is possible that the high degree of individual variability in physiological measures obscured meaningful group differences, especially in a modestly sized sample.

Cognitive correlates of disgust in OCD

The second aim of the current study was to identify whether obsessive beliefs were associated with disgust responding after controlling for diagnosis and trait disgust. Recent evidence using non-clinical samples has indicated that pathological disgust responses associated with OC symptoms may not be due simply to heightened disgust propensity *per se*, but that heightened disgust propensity in conjunction with obsessive beliefs together may create pathological disgust (Cisler et al., 2010). The current study built on this research through the use of a clinical sample, and by examining how these maladaptive beliefs relate to physiological disgust responses in addition to self-report.

The results showed that, when controlling for trait disgust and diagnosis, the correlation between OBQ scores and self-reported disgust to neutral images, and *levator* responses to negative images, remained significant. When the subscales of the OBQ were examined separately, at least one significant correlation was found between disgust responses and the three OBQ subscales. These results align with previous research in non-clinical samples showing that obsessive beliefs contribute to disgust responses (Cisler et al., 2010). However, they also differ in that they do not indicate that

beliefs specifically about responsibility/threat are the primary belief driving disgust responses. Instead they implicate a range of belief domains.

The current research also extends Cisler and colleagues' (2010) findings in two important ways. Firstly, the results suggest that obsessive beliefs may not be associated with all forms of disgust responding, but instead may be more closely associated with disgust responses in reaction to stimuli that are non-disgusting (i.e., a 'pathological' disgust response). Secondly, these data indicate that obsessive beliefs are associated with both self-reported and physiological disgust responses. This is the first study to examine the relationship between obsessive beliefs and disgust responding that has used measures beyond self-report.

Some limitations must be kept in mind when interpreting the current findings. Firstly, although the sample size used in the current study is commensurate with prior studies using psychophysiological measures in clinical samples (e.g., Gehricke & Shapiro, 2000; Suvak et al., 2012; Wolf et al., 2004), a larger sample may be needed to detect subtler group differences in psychophysiological disgust responses. Secondly, recruitment of a heterogeneous OCD sample was predicated on the fact that trait disgust responses have been found to be elevated in individuals with a variety of OCD symptoms, and not simply those with contamination concerns (Berle et al., 2012) (Schienle, Schäfer, et al., 2003) and because my examination of disgust was not restricted to the domain of contamination. Nevertheless, future research is needed to clarify whether enhanced psychophysiological disgust responses may be observed in those whose primary symptom is contamination fear. Thirdly, a significant portion (60%) of the OCD group was taking psychotropic medication at the time of testing and it is possible that this affected psychophysiological responses. There were, however, no

significant differences in the number of participants in the OCD and the anxious group who were taking medication.

To conclude, the study reported in this chapter reveals novel findings regarding disgust responses in individuals with OCD, using psychophysiological measures of emotional responding as well self-report. The current study was also the first to compare these responses to a group of individuals with non-OCD anxiety disorders in addition to non-clinical control participants. These data show that individuals with OCD have higher trait disgust propensity (the tendency to respond with disgust) compared to both non-clinical and anxious control participants, as well as more intense self-reported disgust responses to strong core disgust elicitors. When controlling for trait disgust and diagnosis, levels of obsessive beliefs that are known to be common in individuals with OCD were positively correlated with both self-reported and psychophysiological disgust responses to non-disgusting stimuli. These results show that OCD is associated with a greater tendency to respond with disgust, while the intensity of obsessive beliefs is associated with a greater tendency to respond with disgust in contexts where disgust elicitors are absent. Building on these findings, the study reported in the next chapter presents the first examination of the relationship between heightened disgust responding and moral rigidity in OCD.

Chapter 4

MORAL RIGIDITY IN OCD

This chapter seeks to address an important gap in the literature, by examining whether heightened disgust responses are related to the moral rigidity often observed in individuals with OCD. This builds on the previous experiment, reported in Chapter 3, which provided novel evidence that individuals with OCD show elevated levels of trait disgust propensity and more intense self-reported disgust in response to core disgust elicitors when compared to non-clinical individuals as well as to individuals with other non-OCD anxiety disorders. These data made an important contribution to the existing literature by demonstrating that heightened disgust responses are specific to OCD rather than being simply the result of heightened anxious psychopathology more generally. Furthermore, after controlling for levels of trait disgust, obsessive beliefs were found to correlate positively with psychophysiological disgust responses to non-disgust stimuli. This suggests that obsessive beliefs may contribute to pathological disgust responses in this population.

In order to investigate this potential link, it was important to take into account other cognitive and neuropsychological characteristics pertinent to this population that could also contribute to moral rigidity. Therefore, this chapter draws on a prominent theory of moral reasoning known as dual process theory, which helps to explain how

emotion and cognition interact in moral judgment and how moral rigidity may arise in individuals with OCD.

Evidence of moral rigidity in OCD

Many individuals with OCD appear to live by a strict moral code and show a concern for preventing harm that goes beyond that observed in the normal population. The modest body of research examining moral reasoning in OCD lends empirical support to this clinical observation. Evidence shows that individuals with OCD are more likely to draw negative moral inferences about themselves from their intrusions compared to those with other psychiatric disorders (Ferrier & Brewin, 2005). It also indicates that OCD-related cognitions and symptoms are associated with sensitivity to self-domains of morality (Doron et al., 2007).

Research examining moral reasoning in OCD has typically pointed to cognitive distortions as the mechanism underpinning the hypermoral behaviour observed in those with the disorder. Cognitive distortions in OCD appear to bias the use of deontological moral reasoning processes (i.e., judging the morality of an action based on the degree to which it adheres to a set of rigid moral codes; Kant, 1981), over more utilitarian reasoning processes (i.e., the idea that what is morally right is what maximises happiness and minimises suffering for all affected; Mill, 2001). For example, when presented with a typical 'personal' moral dilemma designed to assess individual preferences for utilitarian and deontological moral reasoning strategies (e.g., a scenario in which it is necessary to personally cause harm to one person in order to save the lives of many), overinflated responsibility attitudes in individuals with OCD correlated with the tendency to favour the deontological option even if it would produce the worst

overall outcome (Franklin, McNally, & Riemann, 2009). This indicates that inflated perceptions of responsibility in individuals with OCD may increase their tendency to use more rigid deontological reasoning.

Although a cognitive distortions model of moral rigidity in OCD fits well with other cognitive models of the disorder (Rachman, 1997; Salkovskis, 1997), there is evidence that other factors may also play a role. Greene's dual process theory of moral reasoning suggests that two separate psychological processes affect our moral decisions: emotion and cognition (Greene, Nystrom, Engell, Darley, & Cohen, 2004). Greene proposes that deontological moral judgments reflect a reasoning process that is dominated by emotion, because intense affective reactions create a sense that an action is inherently wrong no matter what the consequences. Support for this hypothesis comes from evidence showing that reductions in negative emotional responding lead to reduced use of deontological moral reasoning. For example, compared to non-clinical individuals and individuals with Alzheimer's Disease, individuals with frontotemporal dementia (who commonly experience emotional blunting) are less likely to use deontological moral reasoning processes in moral contexts that elicit aversive emotional responses (Mendez, Anderson, & Shapira, 2005). Similar findings are also observed when negative affective responses are counteracted using a positive mood induction (Valdesolo & DeSteno, 2006), suggesting that sensitivity to prepotent, negative affective responses is closely associated with the use of deontological moral reasoning.

In contrast, Greene argues that utilitarian moral judgments are driven predominantly by cognitive processes, because initial negative emotional reactions must be overridden in order to choose the best overall outcome. Support for this prediction comes from research showing that reducing cognitive control via a cognitive load manipulation selectively interferes with utilitarian moral judgments (Greene, Morelli,

Lowenberg, Nystrom, & Cohen, 2008). Similarly, increased activity in the anterior cingulate cortex (an area responsive to cognitive conflict; Botvinick, Braver, Barch, Carter, & Cohen, 2001), as well as the anterior dorsolateral prefrontal cortex (an area implicated in abstract reasoning and cognitive control; Koechlin, Ody, & Kouneiher, 2003) is observed when individuals use utilitarian moral reasoning in response to personal moral dilemmas (Greene et al., 2004). This indicates that use of utilitarian moral reasoning, particularly in response to moral dilemmas that elicit strong emotional responses, draws on processes involving cognitive control. In light of these findings, it is likely that factors which impair cognitive control or heighten negative emotional responding will also impair use of utilitarian reasoning processes, particularly in contexts where emotion and cognition come into conflict.

A comparison of the literature on moral reasoning and research into affective and executive functioning abnormalities in OCD reveals a number of emotional and cognitive processes that affect moral judgment which also overlap with known deficits in OCD. As outlined in Chapter 1, and further demonstrated in Chapter 2, there is mounting evidence to suggest that heightened feelings of physical disgust enhance responses to moral transgressions. Chapter 3 also showed that individuals with OCD exhibit trait and state levels of disgust that surpass those observed in non-clinical individuals as well as those with other non-OCD anxiety disorders. If disgust is associated with more severe moral judgment and is elevated in those with OCD, then heightened disgust may contribute to moral rigidity in OCD.

In addition to disgust, evidence also suggests moral reasoning may be affected by impairments in cognitive control (Greene et al., 2008). In a moral dilemma the utilitarian outcome often involves committing a personal moral violation against one person in order to reduce the suffering of others, which requires the ability to inhibit a

strong prepotent affective response in order to engage in more logical, abstract reasoning while shifting attention away from the action to the outcome (Greene et al., 2004).

Deficits in specific aspects of cognitive control, particularly cognitive flexibility and inhibitory control, are well-documented in individuals with OCD (Andrés et al., 2008; Lawrence et al., 2006; Moritz et al., 2002; Van der Linden, Ceschi, Zermatten, Dunker, & Perroud, 2005). Indeed, some researchers have even suggested that inhibitory deficits may represent a candidate endophenotype of the disorder (Chamberlain, Blackwell, Fineberg, Robbins, & Sahakian, 2005). Therefore, it is likely that the impairments in inhibitory control and cognitive flexibility common to individuals with OCD may bias the use of deontological moral reasoning, thus providing an insight into the moral rigidity observed in those with the disorder.

Aims & hypotheses

The first aim of the current study was to determine whether individuals with OCD differ from those without the disorder in their use of utilitarian moral reasoning. Prior research into moral reasoning in individuals with OCD has been limited due to the lack of a clinical comparison group (Franklin et al., 2009; Harrison et al., 2012). Given that cognitive distortions (Beck, Emery, & Greenberg, 2005), impairments in cognitive control (Airaksinen, Larsson, & Forsell, 2005) and increased intolerance of disgust (Muris, Merckelbach, Schmidt, & Tierney, 1999) are also observed in individuals with high levels of anxiety more generally, it was critical to include a clinical comparison group to control for the effects of heightened anxiety. Therefore, the current study extends previous research by comparing the patterns of moral reasoning used by

individuals with OCD to those used by non-clinical individuals as well as a group of individuals with other non-OCD anxiety disorders. Given that differences in the use of deontological and utilitarian reasoning processes vary depending on the level of personal responsibility one has over the outcome (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001), the current study also sought to address a gap in existing research by examining reasoning strategies used in response to specific kinds of moral dilemmas (i.e., personal, impersonal and benign). I predicted that individuals with OCD should make fewer utilitarian judgments compared to both non-clinical and anxious control participants overall, but particularly in response to dilemmas that impose a high degree of personal agency over the outcome (i.e., personal moral dilemmas) and therefore elicit conflict between emotional and cognitive processes.

The second aim of the current research was to determine whether inhibitory control, cognitive flexibility and trait disgust were associated with moral reasoning in individuals with OCD. I predicted that poorer inhibitory control (as measured using the Hayling Sentence Completion Test), poorer cognitive flexibility (assessed using the Trail Making Test, Part B) and higher scores on measures of trait disgust would be associated with reduced utilitarian judgments. Given that disgust is a multifaceted construct, I measured three separate components of trait disgust: general disgust sensitivity (a general aversion toward the feeling of disgust), disgust propensity (the tendency to respond with disgust) and specific disgust sensitivity (aversion to specific types of disgust elicitors).

Method

Participants

Individuals with a primary diagnosis of OCD (n = 23), a non-OCD anxiety disorder (n = 21) and non-clinical community controls (n = 24) were recruited via advertisements placed in local newspapers and flyers sent around to local mental health practitioners. Inclusion criteria were a current diagnosis of OCD, a non-OCD anxiety disorder or no psychiatric diagnosis. Participants were required to be proficient in English and were excluded if they reported symptoms of a neurological disorder, used recreational substances on a regular basis, had a history of head injury, had been diagnosed with a learning disorder, or if they or an immediate relative experienced symptoms of psychosis. Additionally, participants were excluded from the non-OCD anxiety group if they only met criteria for a specific phobia or if they reported subclinical OCD symptoms.

All participants gave written informed consent to participate, and procedures were approved by the University of New South Wales Human Research Ethics Committee.

Measures

Diagnostic interview

The ADIS for DSM-IV (Brown et al., 1994): The ADIS was used to assess for the presence of current DSM-IV psychological disorders. It was administered by myself under the supervision of a senior clinical psychologist who specialises in OCD research.

Trait emotionality and clinical symptom measures

The DPSS-R (van Overveld, de Jong, Peters, et al., 2006): The DPSS-R was used to measure disgust propensity (the tendency to respond with disgust) and disgust sensitivity (aversion to the experience of disgust). The measure's structure and psychometric properties are described in Chapter 3. The Cronbach's alpha coefficients in the current study were 0.82 for the Disgust Propensity subscale and 0.78 for the Disgust Sensitivity subscale.

The DS-R (Haidt et al., 1994; modified by Olatunji, Williams, et al., 2007): The DS-R was used to measure the tendency to experience disgust in response to seven discrete domains of disgust elicitors (food, animals, body products, body envelope violations, death, hygiene and sympathetic magic). The scale's structure and psychometric properties are also described in Chapter 3. Cronbach's alpha coefficient in the current study was estimated to be 0.89.

The OCI-R (Foa et al., 2002): The OCI-R was used to assess the presence and severity of obsessions and compulsions. As mentioned in Chapter 3, it comprises six subscales that assess checking, hoarding, ordering, washing, obsessing and neutralising symptoms and has good psychometric properties in both clinical (Foa et al., 2002) and non-clinical samples (Hajcak, Huppert, Simons, & Foa, 2004). The Cronbach's alpha coefficient in the current study was 0.92.

Neuropsychological measures

The NART (Nelson, 1982): The NART was used as a measure of premorbid verbal intelligence to establish whether the three groups were equated on levels of general intellectual functioning.

The Hayling Sentence Completion Test (Haying Test; Burgess & Shallice, 1997): The Hayling Test was used to measure inhibitory control. The task is divided into two conditions that each contain 15 sentences with the final word missing. Part A is an initiation condition in which participants are asked to say a word which completes the sentence, requiring activation of a strongly stereotyped automatic response (e.g., 'He posted a letter without a…stamp'). Part B is an inhibition condition where participants are required to inhibit the stereotyped response and say a word which does not complete the sentence (e.g., 'The captain wanted to stay with the sinking…orange'). Participants' response latencies for both sections are recorded, as is the degree to which responses given in Part B relate to the probe sentence. Timing of response latency was by stop-watch and started as soon as the last word of the sentence had been read by myself, with timing ceasing as soon as the participant initiated their response. Scaled scores were obtained by adding response latencies in Part A and B, as were response errors in each section (i.e., inappropriate responses). A total scaled score was then computed from these results. The Hayling Test has been used as a measure of inhibitory control in many populations including OCD (Van der Linden et al., 2005), and it possesses good test-retest reliability (Burgess & Shallice, 1997) and high interrater reliability in OCD research (Van der Linden et al., 2005).

The Trail Making Test, Part B (TMT B; Reitan, 1985): The TMT B is a test of task switching that was used to measure cognitive flexibility. The test requires the participant to join circles containing the numbers 1 to 13 and the letters A to L in ascending order as quickly as possible, alternating between the number and letter sequences (i.e., 1, A, 2, B...). The total time taken to complete the test is recorded in seconds. Individuals with OCD perform more poorly on the TMT B compared to non-

clinical individuals (Moritz et al., 2002; Penadés, Catalán, Andrés, Salamero, & Gastó, 2005).

Moral dilemma stimuli

Fifteen scenarios requiring a yes/no answer were used to assess moral reasoning. All were taken from the set used by Greene and colleagues (2004) with five depicting benign non-moral dilemmas (e.g., deciding whether to catch a train or a bus to a meeting), five depicting impersonal moral dilemmas (e.g., deciding whether to flick a switch to kill one person to save five others) and five depicting personal moral dilemmas (e.g., deciding whether to smother your crying baby to prevent enemy soldiers from killing you and the people you are hiding with). Personal and impersonal moral dilemmas were differentiated on the basis of agency: in personal dilemmas the actions of the participants would directly result in the death of another person; in impersonal dilemmas their actions would still result in the death of another, but it would not be direct (i.e., flicking a switch vs. smothering a person). These dilemmas are or resemble dilemmas that have been discussed by contemporary moral philosophers, and they have been used in a number of experimental studies examining the neural basis of moral cognition (Greene et al., 2008; Greene et al., 2004; Greene et al., 2001). The dependent variable for the moral reasoning indices was computed by summing the number of times participants chose to permit the action required to achieve the utilitarian outcome for the three types of dilemmas, and the scores were then converted to a percentage. Response latencies were also measured in milliseconds.

Procedure

Participants were assessed using the ADIS for the presence of current psychiatric diagnoses. Those who met the eligibility criteria completed demographic, clinical, neuropsychological and trait emotionality measures. Participants then completed the moral dilemma task which was presented on a desktop computer. Each dilemma was presented on the screen in a random order for 45 seconds, followed by a question asking whether it was appropriate to perform the action needed to produce the best outcome for all (i.e., to produce the utilitarian outcome). Participants were required to give a 'yes' or 'no' answer on the keyboard, and the time taken for them to provide an answer was recorded.

Results

Sample

A breakdown of the primary and secondary diagnoses in the OCD and anxious control groups is shown in Table 3.1. Approximately three quarters of the OCD sample met criteria for a secondary diagnosis. The most common secondary diagnosis was generalised anxiety disorder (present in 56.5% of the sample), closely followed by major depression (present in 47.8% of the sample). The anxious control group was comprised mainly of individuals with a primary diagnosis of generalised anxiety disorder (47.6% of the sample) or social anxiety disorder (33.3% of the sample), and similarly to the OCD group, a high proportion of the group (42.9%) also met criteria for comorbid major depression. Demographic, neuropsychological, clinical and trait disgust characteristics of the sample are shown in Table 3.2. There was no difference in the number of males and females in each group, χ^2 (2, N = 68) = 2.21, p = .33, and the groups did not differ on verbal intelligence, $F(2, 65) = 1.29$, p = .28, η^2 = .04.

Table 3.1

A breakdown of the primary and secondary diagnoses in the anxious and OCD groups

	Anxious group	OCD group
Primary diagnoses		
Obsessive-compulsive disorder	0%	100.0%
Generalized anxiety disorder	47.6%	
Social anxiety disorder	33.3%	
Post-traumatic stress disorder	14.3%	
Panic disorder	4.8%	
Secondary diagnoses		
Major depression	42.9%	47.8%
Social anxiety disorder	23.8%	8.7%
Generalized anxiety disorder	23.8%	56.5%
Specific phobia	9.5%	0%
Post-traumatic stress disorder	9.5%	8.7%
Panic disorder	0%	8.7%

Table 3.2

Demographic and clinical characteristics of sample

Variable	Control group		Anxiety group		OCD group		Inferential statistics			
	M	*SD*	*M*	*SD*	*M*	*SD*	*df*	*F*	η^2	*p*
Age	29.50	12.48	32.14	9.73	36.22	15.73	65	1.60	.05	.21
Education	16.71	2.31	16.48	2.73	16.00	3.56	65	0.36	.01	.70
Cognitive Function										
NART IQ	110.94	7.01	113.31	5.69	110.21	7.05	65	1.29	.04	.28
Hayling	6.43	0.75	6.21	1.03	5.52	1.38	60	4.12	.12	.02[23]
Trails B time(s)	52.95	16.61	64.65	23.66	72.61	26.07	62	4.33	.12	.02[2]
OCI-R										
Washing	1.13	1.33	2.90	3.85	6.04	4.07	65	13.43	.29	.00[23]
Ordering	2.71	2.61	5.05	4.18	8.91	3.27	65	20.12	.38	.00[123]
Obsessing	2.50	2.41	6.57	3.12	9.00	2.63	65	34.29	.51	.00[123]
Neutralising	1.38	1.91	2.29	3.12	6.39	3.62	65	18.98	.37	.00[23]
Checking	2.63	2.76	4.00	2.76	6.65	3.69	65	10.14	.24	.00[23]
Hoarding	3.75	2.89	4.33	3.58	4.13	3.33	65	0.19	.01	.83
DPSS Propensity	11.54	4.37	11.19	3.34	14.52	4.51	65	4.44	.12	.02[23]
DPSS Sensitivity	7.25	4.46	9.62	4.93	10.43	5.34	65	2.66	.08	.08
DS-R	46.87	16.37	59.05	19.87	60.65	16.05	65	4.38	.12	.01[12]

Note. NART IQ = Total score on the National Adult Reading Test (Nelson & Willison, 1982; a test of verbal intelligence); OCI-R = Obsessive-Compulsive Inventory – Revised; DPSS = Disgust Propensity/Sensitivity Scale; DS-R = Disgust Scale-Revised. [1] Contrast between control group and anxiety group is significant; [2]contrast between control group and OCD group is significant; [3]contrast between anxiety and OCD group is significant.

Group differences in moral reasoning

Group differences on the indices of moral reasoning were examined using a 3 x 3 mixed repeated measures ANOVA with the between subjects variable of group (OCD, non-OCD anxiety, control) and the within subjects variable of dilemma (benign, impersonal, personal). There was a significant Group x Dilemma interaction $F(4, 130) = 3.41$, $p = .01$, $\eta_p^2 = .02$ for the number of times participants chose the utilitarian option (Figure 3.1). Follow-up tests of the simple effect of group within dilemma showed that those with OCD chose the utilitarian option for impersonal dilemmas significantly less often than non-clinical ($p = .03$) but not anxious ($p = .27$) participants. The effect size for this analysis ($d = 0.65$) was a moderate effect according to Cohen's convention for reporting effect sizes (Cohen, 1988). Further effect sizes for the differences between groups on indices of moral reasoning are shown in Table 3.3.

Table 3.3.

Between group effects (Cohen's d) on use of utilitarian moral reasoning

	Benign	Impersonal	Personal
Control vs. Anx	0.06	0.35	0.02
Control vs. OCD	0.11	0.65	-0.48
Anx vs. OCD	0.06	0.32	-0.48

Note. Cohen's *d* was calculated using group means and pooled standard deviation. Anx refers to anxiety disorders, OCD refers to obsessive-compulsive disorder.

Examining the effect of dilemma within group showed that for all groups the utilitarian option was chosen most for benign dilemmas, followed by impersonal dilemmas, and the least for personal dilemmas (all *p*s < .001). The Group x Dilemma interaction for overall reaction time was not significant ($p = .72$), nor was the main effect of group ($p = .55$). *Post hoc* analyses were then conducted, breaking reaction time data into 'appropriate' (i.e., utilitarian) and 'not appropriate' (i.e., deontological) responses. These results revealed a trend ($p = .07$) for those in the OCD group to be slower to respond 'not appropriate' to benign dilemmas (Figures 3.2 and 3.3).

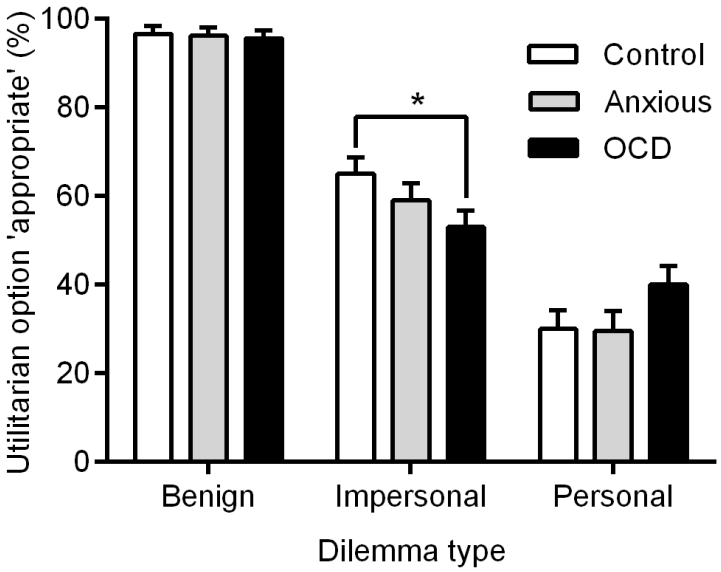

Figure 3.1. Percentage of dilemmas for which the utilitarian option was deemed 'appropriate'

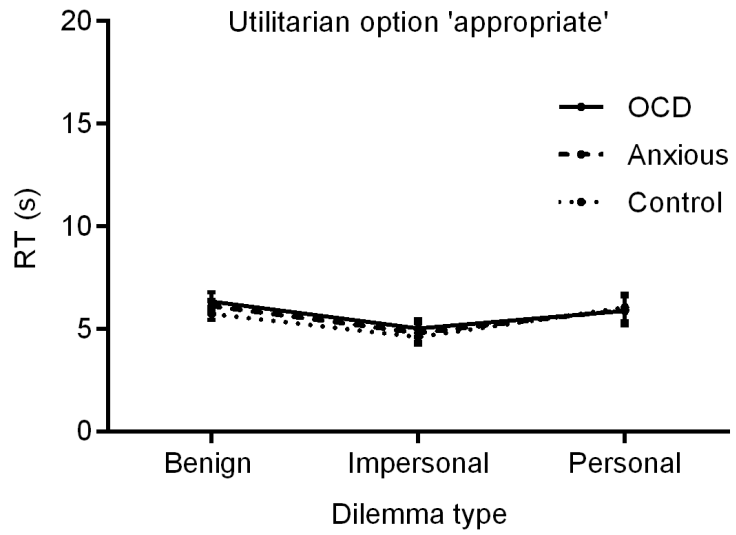

Figure 3.2. Mean (± SEM) reaction times (RT) (s) to classify personal, impersonal and benign dilemmas as 'appropriate'

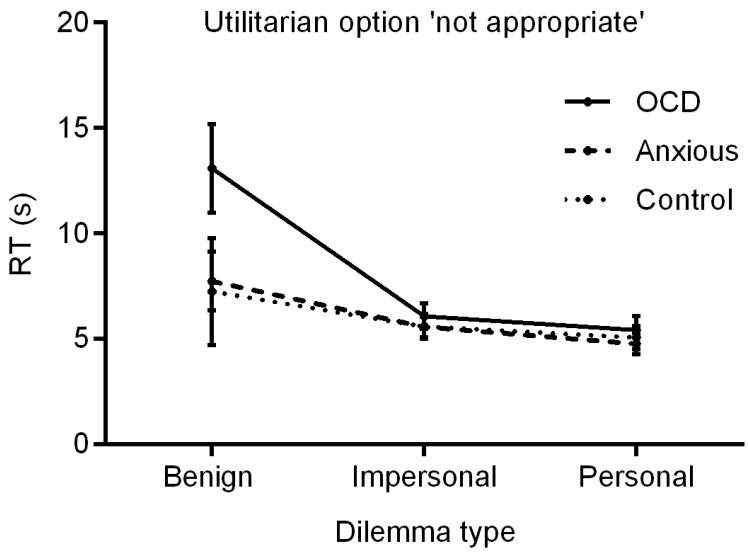

Figure 3.3. Mean (± SEM) reaction times (RT) (s) to classify personal, impersonal and benign dilemmas as 'inappropriate'

Group differences in trait disgust, inhibitory control and cognitive flexibility

Hayling Test data from three participants in the non-clinical control group and two participants in the anxious control group had to be discarded. These participants experienced substantial difficulty with Part A of the task: four because English was their second language and they did not show the stereotyped responses to the phrases in Part A, and one due to excessive performance anxiety that significantly interfered with task performance. Similarly, Trails B scores from one participant from the non-clinical control group and one participant from the anxious control group had to be discarded due to excessive difficulty with the task (control participant) and excessive performance anxiety (anxious participant). Significant group differences were observed on the Hayling Test, $F(2, 60) = 4.12$, $p = .02$, $\eta^2 = .12$ and TMT B, $F(2, 62) = 4.33$, $p = .02$, $\eta^2 = .12$. Those in the OCD group performed more poorly on the Hayling Test than the non-clinical ($p = .008$) and anxious ($p = .047$) participants, and also showed poorer performance on the TMT B compared to non-clinical participants ($p = .005$).

Significant group differences were also observed on the Disgust Propensity subscale of the DPSS-R, $F(2, 65) = 4.44$, $p = .02$, $\eta^2 = .12$ and there was a trend ($p = .08$) towards significant group differences on the Disgust Sensitivity subscale of the DPSS-R. For the Disgust Propensity subscale, those in the OCD group scored significantly higher than both non-clinical ($p = .02$) and anxious ($p = .01$) participants, and the latter two groups did not differ ($p = .78$). For the Disgust Sensitivity subscale, the OCD group scored significantly higher than the non-clinical group ($p = .03$) but not the anxious group ($p = .58$), and the non-clinical and anxious groups did not differ ($p = .11$). Finally, significant group differences were observed on the DS-R, $F(2, 65) = 4.38$, $p = .02$, $\eta^2 = .12$. The OCD ($p = .009$) and anxious group ($p = .02$) scored

significantly higher on the DS-R than non-clinical participants, however the two clinical groups did not differ ($p = .76$).

Correlations between OCD symptomatology, cognitive control, trait disgust and indices of moral reasoning

Correlations between OCD symptomatology, inhibitory control, cognitive flexibility, trait disgust and indices of moral reasoning are shown in Table 3.4. Scores on the OCI-R were not correlated with any of the indices of moral reasoning, nor were scores on the Hayling Test (all ps > .05). However, time taken to complete the TMT B was negatively correlated with utilitarian responses to impersonal moral dilemmas in the OCD group ($r = -.45$, $p = .03$).

Both the Disgust Propensity ($r = -.45$, $p = .04$) and the Disgust Sensitivity ($r = -.49$, $p = .03$) subscales of the DPSS-R correlated negatively with utilitarian responses to impersonal dilemmas in the anxious group. Unexpectedly, these same subscales correlated positively with utilitarian responses to personal moral dilemmas in the OCD group ($r = .51$, $p = .01$ and $r = .58$, $p = .004$, respectively). Scores on the DS-R did not correlate with moral reasoning indices in the OCD group (all ps > .05), but did correlate negatively with utilitarian responses to impersonal ($r = -.54$, $p = .01$) and personal dilemmas ($r = -.57$, $p = .007$) in the anxious group, and with benign dilemmas in the control group ($r = -.42$, $p = .04$).

Table 3.4

Correlations between measures of OCD symptomatology, cognitive control, trait disgust and indices of moral reasoning

	Group								
	Control			Anxious			OCD		
	Benign	Impersonal	Personal	Benign	Impersonal	Personal	Benign	Impersonal	Personal
OCI-R	-.01	-.10	.12	-.38	-.39	-.35	-.27	.27	.33
Neuropsychological									
Hayling	.43	.42	-.01	.24	-.08	.2	.29	.24	.00
Trails B	.16	.19	-.33	-.22	.14	.12	-.31	-.45*	-.39
Trait Disgust									
DPSS-R Propensity	-.28	-.09	-.07	-.01	-.45*	-.23	.13	.26	.51*
DPSS-R Sensitivity	-.26	.03	.24	-.14	-.49*	-.23	-.03	.13	.58**
DS-R	-.42*	-.17	.17	-.12	-.54*	-.57**	-.19	.01	.03

Note. OCI-R = Obsessive-Compulsive Inventory – Revised; Hayling = Hayling Sentence Completion Test total scaled score; TMT B = Trail Making Test Part B completion time in seconds); DPSS-R = Disgust Propensity/Sensitivity Scale; DS-R = Disgust Scale-Revised.

* $p < .05$
** $p < .01$

CHAPTER 4

Discussion

The degree to which individuals with OCD differ from individuals with other non-OCD anxiety disorders in terms of moral reasoning has not previously been investigated. Further, although evidence implicates cognitive distortions in the hypermoral behaviour observed in individuals with OCD, research involving other populations suggests that heightened disgust responses, as well as impaired inhibitory control and cognitive flexibility, might also be expected to impact on moral reasoning by enhancing adherence to rigid moral rules (i.e., deontological reasoning). Therefore, the aim of the current research was to examine the use of utilitarian moral reasoning in individuals with OCD relative to anxious and non-clinical control participants, and to determine whether trait disgust, inhibitory control and cognitive flexibility are related to moral rigidity. I predicted that the greater propensity to respond with disgust and greater aversion to feelings of disgust evident in individuals with OCD would interfere with utilitarian moral reasoning by heightening aversive emotional reactions to moral dilemmas. I also predicted that the impairments in inhibitory control and cognitive flexibility observed in this clinical group would further interfere with their ability to override prepotent emotional reactions and to use abstract reasoning to pursue utilitarian goals. In particular, I expected to observe the most pronounced group differences in utilitarian moral reasoning in response to personal moral dilemmas, as such dilemmas elicit the greatest degree of conflict between prepotent affective responses and cognitive control.

The results of the present study provided partial support for my predictions. Firstly, individuals with OCD showed reduced use of utilitarian moral reasoning compared to non-clinical individuals, however they did not differ from anxious individuals. Secondly, group differences between the non-clinical and OCD group were

observed specifically for impersonal moral dilemmas. Although this finding stands in contrast to prior research showing that individuals with OCD respond similarly to non-clinical controls on tests of moral reasoning (e.g., Franklin et al., 2009), prior research has not distinguished between impersonal and personal moral dilemmas. This is surprising given that personal and impersonal moral dilemmas have been shown to elicit opposing patterns of reasoning in non-clinical individuals (Greene et al., 2001), with impersonal dilemmas eliciting utilitarian responses and personal moral dilemmas eliciting deontological responses. The finding that individuals with OCD showed reduced utilitarian responses to impersonal but not personal moral dilemmas is intriguing. The fact that they demonstrate greater use of deontological moral reasoning in response to impersonal moral dilemmas (which typically elicit low emotion), suggests that more rigid, emotion-driven moral reasoning processes may be activated in individuals with OCD in contexts where more logical, outcome-driven reasoning should easily prevail.

As predicted, scores on a measure of cognitive flexibility (the TMT B) were negatively correlated with choosing the utilitarian option for impersonal moral dilemmas in the OCD group. Given that individuals with OCD showed poorer performance on the TMT B than non-clinical participants, one possibility is that reduced cognitive flexibility is a key factor that interferes with utilitarian responses to impersonal moral dilemmas in this group. This may be because poorer cognitive flexibility reduces the ability to shift attention away from the notion of causing harm to focus on the course of action needed to produce the best outcome overall. These findings align with Greene's dual process theory of moral reasoning by demonstrating that individuals with poorer cognitive control show more pronounced use of emotion-based, deontological moral reasoning (Greene et al., 2004; Greene et al., 2001). The

current results also coincide with recent findings showing that impersonal moral dilemmas recruit the executive control network more so that personal dilemmas (Chiong et al., 2013). Interestingly, scores on a measure of inhibitory control (the Hayling Test) did not correlate with any of the moral reasoning indices. However, inhibitory control is a multifaceted construct and the Hayling Test only measures a single component of inhibitory control known as response inhibition. It is possible that different components of inhibitory control may impact on responses to moral dilemmas.

Results concerning the relationship between measures of trait disgust and moral reasoning were more mixed. In line with predictions, heightened disgust propensity, general disgust sensitivity and specific disgust sensitivity were associated with decreased utilitarian responses to both impersonal and personal moral dilemmas in the anxious group. This supports the idea that heightened trait disgust would enhance the sense of aversion experienced at the thought of causing harm to another, and it coincides with previous research showing that increasing feelings of disgust enhances moral hypervigilance (Jones & Fitness, 2008). However, the relationship between measures of trait disgust and indices of moral reasoning was the opposite for the OCD group, where higher disgust propensity and general disgust sensitivity were associated with an increased likelihood of choosing the utilitarian option in response to personal dilemmas. This finding suggests that, in individuals with OCD, a greater propensity to respond with disgust as well as a general aversion to feelings of disgust is associated with reduced adherence to rigid moral rules in contexts where doing so would result in increased suffering.

Although no previous studies have specifically examined the relationship between trait disgust and moral reasoning in OCD, this finding is unexpected. Trait disgust is often associated with a general aversion toward experiencing distress

(Druschel & Sherman, 1999), which would make an individual less likely to endorse the utilitarian option in contexts where doing so would cause harm. The finding is also at odds with prior work demonstrating a negative correlation between stress and utilitarian moral decisions (Youssef et al., 2012). However, two previous studies have reported a positive correlation between increased feelings of disgust and utilitarian responses. Yan (2008) found that participants who underwent an auditory disgust induction showed more utilitarian moral judgments, particularly to personal moral dilemmas, compared to those who underwent a neutral mood induction. Similarly, Crockett and colleagues (2010) found that although increasing serotonin via citalopram reduced utilitarian responses to personal moral dilemmas, drug-related nausea (a physiological expression of disgust) increased utilitarian responses. Research has shown that self-disgust, which is closely related to guilt, is one of the most prominent emotions experienced in individuals with OCD suffering from religious or morality-focused obsessions (Berle & Phillips, 2006). It is therefore possible that in the current OCD sample, heightened trait disgust elicited greater self-disgust at the thought of opposing the utilitarian action. This explanation is however purely speculative, and further research is needed to reach firm conclusions about the relationship between trait disgust and moral reasoning in individuals with OCD.

Some limitations must be kept in mind when interpreting the current findings. Firstly, I only measured moral reasoning by asking whether the utilitarian option was appropriate. While this method of assessing moral reasoning aligns with the methodology adopted in previous studies that have used Greene's moral dilemma stimuli (e.g., Greene et al., 2008), it is possible that results may differ had I asked if deontological options were also appropriate. Future research should therefore alternate between the two modes of questioning so as to avoid any possibility of response bias.

Secondly, while I did not find an association between the Hayling Test and moral reasoning, this does not rule out the possibility that inhibitory control impacts on moral reasoning in those with OCD as the Hayling Test only measures one facet of inhibitory control. Therefore, future studies should incorporate additional assessments of inhibitory control. Thirdly, although the sample size used in the current study is similar to that used by Franklin and colleagues (2009), and extends previous research in important ways through the addition of a clinical control comparison group, the sample size used may not have provided sufficient statistical power to identify smaller group differences on moral reasoning indices or correlations between moral reasoning and inhibitory control. Further research using larger samples is therefore needed to cross-validate these findings.

To conclude, the current study was the first to examine the relationship between cognitive flexibility, inhibitory control, trait disgust and moral reasoning in individuals with OCD. Results showed that individuals with OCD demonstrated reduced utilitarian reasoning for impersonal moral dilemmas, with cognitive flexibility negatively correlated with utilitarian responses to impersonal but not personal moral dilemmas in this group. Furthermore, while heightened trait disgust was associated with reduced utilitarian responses to impersonal moral dilemmas in anxious individuals, trait disgust was associated with increased utilitarian judgments to personal moral dilemmas in those with OCD. Although further replications are needed to confirm these findings, these data provide novel evidence that disgust may have a unique relationship with moral reasoning in OCD compared to those with other non-OCD anxiety disorders.

Chapter 5

MODIFYING DISGUST: PART I

In this chapter I turn to focus more closely on questions of a clinical nature. Specifically, I draw on the secondary findings observed in Chapter 3, which indicated that pathological disgust responding in individuals with OCD was associated with the presence and severity of obsessive beliefs, to address the important question of whether pathological disgust responses can be modified by altering obsessive beliefs. This has important clinical implications as disgust has been shown to be slow to extinguish via standard exposure-based treatments (Adams, Willems, & Bridges, 2011; Mason & Richardson, 2010, 2012; McKay, 2006; Olatunji, Forsyth, et al., 2007; Olatunji, Smits, et al., 2007; Olatunji, Wolitzky-Taylor, et al., 2009; Smits et al., 2002) and is particularly resistant to direct cognitive challenge (McNally, 2002). This shows a pressing need for further research into methods that may enhance treatment outcomes for disgust-based symptoms, which this chapter seeks to address.

As will be discussed, the current study used the same OCD testing group as in Chapter 3. Participants came in for two sessions – one for each study – with the order of sessions counterbalanced to account for any order of testing effects.

How do maladaptive beliefs contribute to disgust responses?

Empirical evidence supports a link between the beliefs that contribute to disgust and those that contribute to anxiety (Davey, 1993; Woody & Teachman, 2000). It is therefore possible that maladaptive beliefs contribute to disgust responses in individuals with OCD in a similar way to which they contribute to obsessions.

Rachman's cognitive theory of obsessions proposes that everyday intrusions become obsessions when they are interpreted as personally meaningful or threatening, effectively "transforming a commonplace nuisance into a torment" (Rachman, 1997, p. 794). Early belief and appraisal models (Salkovskis, 1985) and more recent extensions of these models (Frost & Steketee, 2002), propose that a key factor in determining how intrusions will be interpreted is the presence of maladaptive obsessive beliefs.

Feelings of disgust may also be influenced by obsessive beliefs in much the way as interpretations of intrusive phenomena are. Cognitive theories of disgust (Teachman & Saporito, 2009) propose that the cognitive response to a disgust elicitor involves a primary appraisal (e.g., "That cockroach is disgusting"), which is then interpreted in either a benign (e.g., "That cockroach is disgusting but is unlikely to harm me."), or threatening manner (e.g., "That cockroach is disgusting and if it touches me I won't cope/I'll get sick/I'll be completely contaminated."). Holding maladaptive beliefs that overestimate the likelihood for harm or threat, or that overemphasise the importance and personal significance of thoughts, may increase negative interpretations of primary disgust appraisals and thus amplify disgust responses (Cisler et al., 2010; Teachman, 2006). Cisler et al. (2010) have provided preliminary evidence that elevated disgust propensity interacts with obsessive beliefs to heighten contamination concerns in non-

clinical samples. These findings suggest that reducing or counteracting the effects of obsessive beliefs may reduce disgust responses.

Cognitive bias modification of interpretation (CBM-I)

Recent evidence (e.g., T. J. Lang, Moulds, & Holmes, 2009) suggests that it is possible to counteract maladaptive appraisals of intrusive phenomena through the use of CBM-I, a paradigm that aims to directly modify interpretations by repeatedly training and rewarding either positive or negative interpretations of ambiguous but potentially threatening stimuli. This paradigm was originally developed by Mathews and Mackintosh (2000), who used CBM-I to train non-clinical participants to interpret ambiguous homophones in either a positive or a negative way. They found that those who had received the negative CBM-I training experienced greater task-relevant anxiety, as well as a greater tendency to interpret novel information negatively, compared to those who received the positive CBM-I training. There have been a number of replications of this effect in individuals prone to excessive worry (Hirsch et al., 2009), as well as in individuals whose symptoms meet full diagnostic criteria for generalised anxiety disorder (Hayes et al., 2010), in individuals with social anxiety (Beard & Amir, 2008; Murphy et al., 2007) and in individuals with depression (Holmes et al., 2009; Watkins et al., 2009). The paradigm has been used more recently in individuals high on OC symptoms (Clerkin & Teachman, 2011), where training a positive interpretation biases resulted in a significant reduction in urges to perform neutralising behaviours following exposure to an OCD-relevant stressor (i.e., writing that you wished a friend would have a car accident).

Aims & hypotheses

The aim of the current study was therefore to examine whether elevated levels of disgust responding in individuals with OCD could be reduced by using positive CBM-I training to induce a more positive interpretation bias. Given that obsessive beliefs were found to be specifically associated with elevated levels of physiological disgust responding to non-disgusting stimuli (as described in Chapter 3), I predicted that positive CBM-I training would reduce levels of disgust in response to non-disgusting or ambiguous stimuli, relative to a no training control condition.

Method

Design

The present study used a single group randomised crossover design where participants' self-report and psychophysiological disgust responses to a range of static image stimuli were assessed with and without positive CBM-I training.

Participants

Twenty-five individuals (6 male and 19 female) with a primary diagnosis of OCD were recruited as part of a broader study on the role of disgust in OCD using advertisements placed in local newspapers and flyers distributed in the waiting areas of local mental health clinics. This sample used in the current study were the same participants used in the OCD group from the study described in Chapter 3. The current study was conducted in a separate testing session from that of Chapter 3, with a minimum of one week between the two sessions. As will be discussed, the order of

sessions was counterbalanced to account for any order of testing effects. Eligibility criteria for the current study was identical to that described in Chapter 3, where participants had to meet criteria for a current diagnosis of OCD, and were excluded if they reported symptoms of a neurological or psychotic disorder, used illicit drugs, or if an immediate relative had experienced symptoms of psychosis. Written informed consent was obtained from all participants. The study was approved by the University of New South Wales Human Research Ethics Committee.

Diagnostic interview and clinical symptom measures

The *ADIS for DSM-IV* (Brown et al., 1994): As described in Chapter 3, the ADIS was used to assess for the presence of current DSM-IV psychological disorders. I administered all ADIS interviews under the supervision of a senior clinical psychologist who specialises in OCD. Only those with a primary diagnosis of OCD were invited to take part in the study. Given that testing sessions for the current study and the study described in Chapter 3 occurred within two weeks of each other, only one diagnostic interview was performed to confirm eligibility for both studies.

The OCI-R (Foa et al., 2002): The OCI-R was used to assess the presence and severity checking, hoarding, ordering, washing, obsessing and neutralising symptoms (see Chapter 3 for a full description of the scale's structure). It has excellent psychometric properties in both clinical (Foa et al., 2002) and non-clinical samples (Hajcak et al., 2004).

The OBQ (OCCWG, 2005): The OBQ was used to assess the presence and severity of obsessive beliefs associated with OCD. These include: the over-importance of, and need to control, thoughts; an inflated sense of responsibility for preventing harm

or overestimation of threat; and the need for perfectionism and certainty. The OBQ has good internal consistency (OCCWG, 2005) as well as convergent and discriminant validity (Wu & Carter, 2008).

The NART (Nelson, 1982): The NART is a test of premorbid intellectual functioning and was used as a measure of general intelligence in the current study.

CBM-I procedure

The CBM-I task used in the present study was based on the modifications of the original Mathews and Mackintosh (2000) paradigm made by T. J. Lang and colleagues (2009), which aimed to modify beliefs about intrusions. The paradigm was designed to target appraisals and beliefs stemming from the three target domains assessed by the OBQ. As with prior CBM-I research, the task was divided into a training phase and a recognition phase.

CBM-I training phase

The CBM-I training phase consisted of 72 positively valanced sentences with an additional 8 neutral filler items. The CBM-I items were derived from the set of maladaptive beliefs outlined by the OCCWG (2005). A further set of items that specifically targeted appraisals of intrusive thoughts were derived from the Cognitive Intrusions Questionnaire (Freeston, Ladouceur, Thibodeau, & Gagnon, 1992). Each item comprised a sentence that remained ambiguous until the final few words, which rendered the sentence positively valanced. The final few words of each sentence were presented as word fragments for the participant to solve (e.g., 'Having no control over my thoughts means that I am… n_rmal').

Prior to the training phase, participants were told that they were about to read a series of sentences about thoughts and feelings, and that they should either imagine themselves in the situation outlined in the sentence, or else think of the sentence as if it was a thought that came across their mind in everyday life. The first part of each sentence appeared on the screen for two seconds, after which the word fragment appeared for them to solve. To ensure that participants had read and understood all of the training items, a total of 32 comprehension questions followed randomly selected training items. These questions referred to the item that had appeared immediately prior, and participants were required to give a 'yes/no' response for each (e.g., 'Do you think that not having control over your thoughts is unusual?').

Participants were given feedback as to whether they had answered the question correctly, and the number of correct answers was totalled to give an overall training accuracy score out of 32.

CBM-I recognition phase

A standard component of CBM-I training paradigms is the use of a recognition phase that is used to determine whether training has influenced the interpretation of novel, ambiguous material (i.e., to test whether an interpretation bias has been induced). The recognition items used in the current paradigm were ten emotionally ambiguous statements that each had a title. Participants were asked to read each of these statements one by one, along with their titles, and give a rating from 1 (*did not understand at all*) to 9 (*understood completely*) to indicate how well they understood each statement. Following a two-minute rest period they were presented with each of the titles a second time, accompanied by two negative and two positively valanced statements. Two of these statements were target statements: one negative and one positive statement,

worded similarly to the original sentence. The other two were foil statements: one negative and one positive statement that did not have similar wording to the original statement. In CBM-I paradigms, target statements are used to test whether training results in training-congruent changes in the interpretation of novel material that is similar to the original material, while foil statements are used to test whether training produces training-congruent changes in the processing of novel material more generally.

The targets and foils were presented beneath the title one by one, and participants were asked to read each and to give a rating from 1 (*very different in meaning*) to 4 (*very similar in meaning*) to indicate how similar in meaning they thought the statement was to the original. Similarity ratings for the targets and foils were summed, resulting in a total score for each of the four recognition categories (i.e., positive targets, negative targets, positive foils, negative foils). A sample set of CBM-I recognition items is shown in Table 4.1.

Table 4.1.

Sample CBM-I recognition items

Title	Looking at myself
Ambiguous statement	Having intrusive thoughts makes me feel different about myself
Positive target	Now when I reflect on myself, I feel completely normal
Negative target	Now when I reflect on myself, I feel that I am going crazy
Positive foil	Now when I reflect on myself, I feel I know myself better than before
Negative foil	Now when I reflect on myself, I feel I know myself less than before

Picture stimuli

The data presented in Chapter 3 was used as an indication of the magnitude of disgust responses in the absence of positive CBM-I training. To compare these to disgust responses *following* positive CBM-I training, a second set of images were chosen from the International Affective Picture System (P. J. Lang et al., 2005) and from popular media, which were matched for content to the images described in Chapter 3. In accordance with the stimuli used in Chapter 3, this second set of images was divided into six categories, four depicting different domains of disgust elicitors (body waste; contamination; sociomoral disgust; blood/injury), a fifth depicting neutral items (e.g., people talking) and a sixth depicting negative, yet non-disgusting themes (e.g., people crying). Full details of the rationale behind the choice of specific disgust stimuli are described in Chapter 3. Self-reported disgust responses to each of the

images were obtained by asking the participant to provide a rating from 1 (*not at all disgusting*) to 8 (*extremely disgusting*) on the keyboard.

Psychophysiological disgust responses

Physiological responses to the image stimuli were also measured using facial EMG and electrodermal activity. The procedure used to record facial EMG and electrodermal data was identical to that described in Chapter 3. Overall, facial EMG and electrodermal data from 2 participants had to be discarded due to excessive movement artefacts present in recordings.

Procedure

All data showing disgust responses in the absence of CBM-I training was obtained in a single testing session, the results of which are described in Chapter 3. Data showing disgust responses following CBM-I training was obtained in a separate session. To control for practice effects from one session to the next, participants were randomly assigned to receive either the CBM-I training or no CBM-I training in the first session.

When participants arrived for their first session, they were asked to wash their hands with soap and were administered the ADIS and clinical self-report measures. Those assigned to receive no CBM-I training in the first session then had facial EMG and electrodermal sensors applied and their physiological and self-reported disgust responses to the static images were recorded. Those assigned to receive positive CBM-I training in the first session completed the positive CBM-I training and recognition tasks prior to having their physiological and self-reported disgust responses measured. On completion of the first testing session, participants were scheduled for their second

testing session, which had to be a minimum of one week after their first. When they arrived for their second testing session they were asked to wash their hands with soap, and were given the alternate CBM-I condition (i.e., training or no training) and then had their physiological and self-reported disgust assessed in response to the second set of images. On completion, participants were reimbursed for their time and were debriefed on all components of the study.

Results

Sample

Participants were only included in the analysis if valid data was obtained for the current study and the study described in Chapter 3. As such, three participants were excluded (1 who withdrew and 2 whose psychophysiological data was excluded due to excessive movement) resulting in a final sample of 22 individuals. The flow of participants into the study is shown in Figure 4.1 and demographic characteristics of the final sample presented in Table 4.2. Details of secondary diagnoses and medication status of the sample used in the current study are presented in Table 4.3.

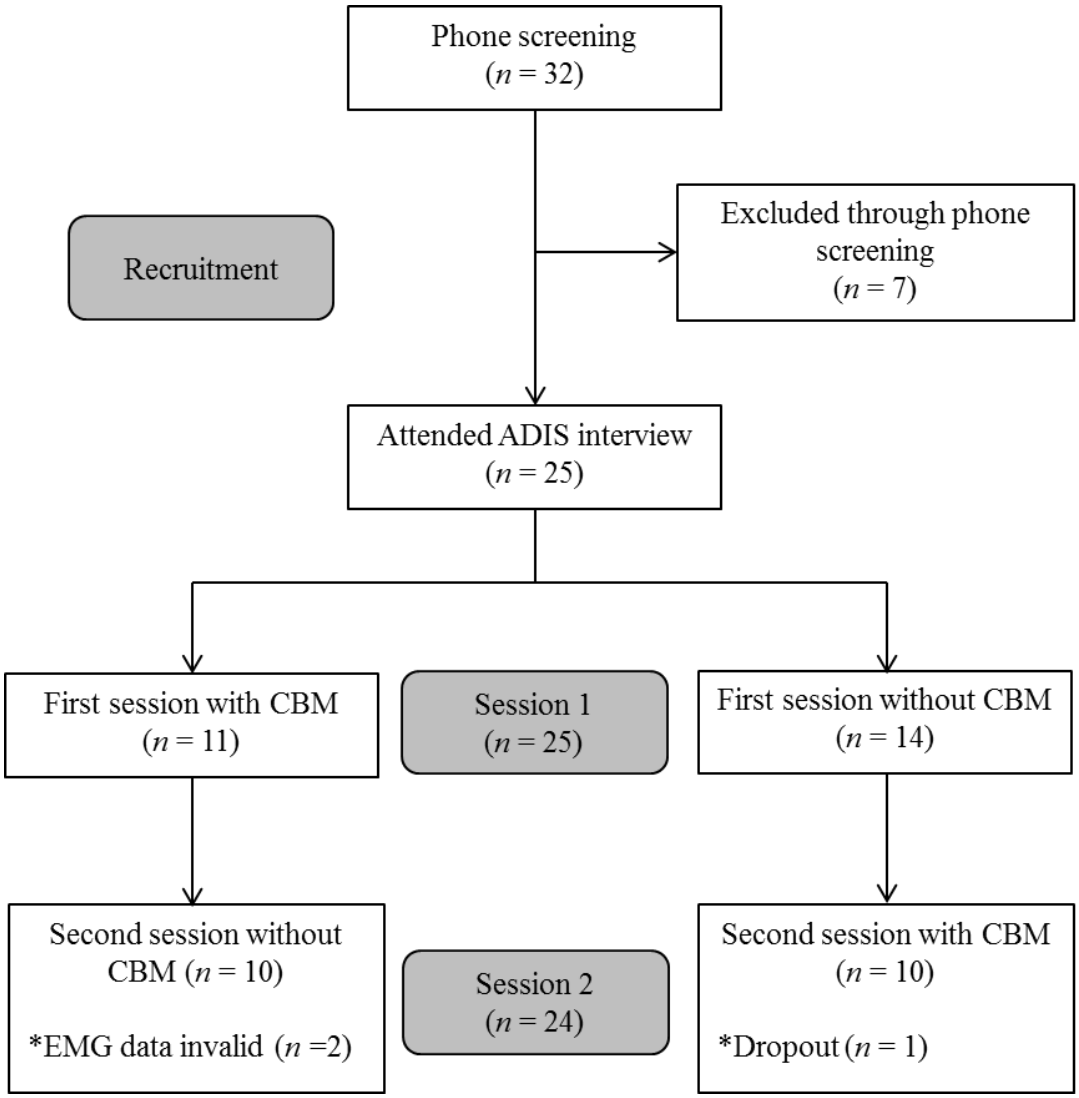

Figure 4.1. Participant flow diagram

Table 4.2

Demographic and clinical characteristics of sample

Variable	*M*	*SD*
Demographics		
Age	38.09	16.70
Years of education	16.09	3.56
NART IQ	28.73	7.86
OCI-R		
Washing	5.91	4.12
Ordering	8.82	3.29
Obsessing	8.50	2.84
Neutralising	6.23	3.52
Hoarding	3.95	3.33
Checking	6.82	3.91
OBQ		
RT	78.73	18.14
ICT	40.91	15.81
PC	72.32	19.82

Note. Total score on the National Adult Reading Test ; OCI-R = Obsessive-Compulsive Inventory – Revised; OBQ = Obsessive Belief Questionnaire; RT = Responsibility/Threat subscale of OBQ; ICT = Important/Control over thoughts subscale of OBQ; PC = Perfectionism/Control subscale of OBQ.

Table 4.3

Secondary diagnoses and medication status

Variable	N	%
Secondary diagnoses		
Generalised anxiety disorder	11	50.0
Major depression	9	40.9
Social anxiety disorder	2	9.1
Post-traumatic stress disorder	2	9.1
Panic Disorder	1	4.5
Current medication		
None	10	45.5
SSRI only	10	45.5
Mood stabiliser only	1	4.5
Combination	1	4.5

Note. SSRI = Selective Serotonin Reuptake Inhibitor

Effects of CBM-I on interpretation bias

As mentioned previously, the recognition phase of the CBM-I training assesses the degree to which the training results in training-congruent changes in the recall of novel ambiguous material. Training is successful if participants rate the statement of the training-congruent valence as being more similar to the original ambiguous statement than the statement of the training-incongruent valance.

In the current analysis, similarity ratings for positive and negative targets and foils were totalled and compared using a 2 (Valance: positive vs. negative) x 2 (Relevance: target vs. foil) repeated measures ANOVA. The Valence x Relevance interaction was not significant $F(1, 21) = 2.99$, $p = .10$, $\eta_p^2 = .13$, and while positive targets received the highest mean similarity ratings (indicating that a positive interpretive bias was induced to some extent), the main effect of valence did not reach significance $F(1, 21) = 2.80$, $p = .11$, $\eta_p^2 = .12$. There was a significant main effect of relevance $F(1, 21) = 16.23$, $p = .001$, $\eta_p^2 = 0.44$, where targets were rated significantly higher than foils. Based on prior CBM-I research these results show that positive CBM-I training induced a weak positive bias in the interpretation of novel ambiguous material.

Effects of CBM-I on disgust responses

Although not significant, the pattern of responses observed in the CBM-I recognition phase suggested that a weak positive interpretation bias may have been activated following the positive CBM-I training. Disgust responses with and without CBM-I training were therefore compared. Separate repeated measures ANOVAs with the within subjects variable of CBM-I (training vs. no training) were used to compare

self-reported and psychophysiological disgust responses to each of the image categories, with and without CBM-I training. The mean self-reported disgust ratings for each of the image categories with and without CBM-I training, as well as the mean log-transformed percentage change from baseline in *corrugator* and *levator* muscle activity, are shown in Table 4.4.

Table 4.4

Mean self-reported disgust ratings and EMG responses for each image type with and without CBM-I training

	Self-report		*Corrugator*		*Levator*	
Image type	No CBM	CBM	No CBM	CBM	No CBM	CBM
Body waste	5.75	5.54	0.98	1.08	1.03	1.04
Contamination	1.56	1.66	0.90	0.84	0.77	0.82
Injury	4.64	5.06	1.14	1.08	1.08	0.95
Moral	3.27	3.58	0.99	0.96	0.84	0.92
Neutral	0.16	0.14	0.80	0.71	0.84	0.73
Negative	1.44	1.17	0.84	0.73	0.88	0.67

There was no significant main effect of CBM-I training for self-reported disgust or *corrugator* activity in response to any of the image types (all *p*s > .05). However, there was a significant main effect of CBM-I training for electrodermal responses to images depicting contamination $F(1, 21) = 4.84$, $p = .04$, $\eta_p^2 = 0.19$, where electrodermal activity was lower with CBM-I training than without (Figure 4.2).

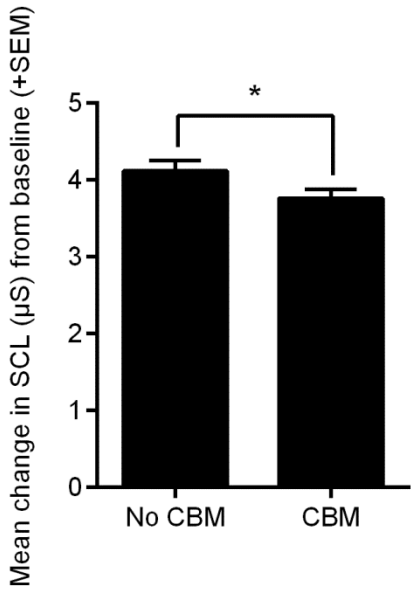

Figure 4.2. Effects of CBM-I training on electrodermal responses to images depicting sources of contamination

Impact of baseline obsessive belief severity on CBM-I effects

Given that individuals who initially had high levels of obsessive beliefs may have been particularly resistant to the effects of CBM-I training, partial correlations were carried out to examine whether the strength of baseline obsessive beliefs (as indexed by the OBQ subscales) were associated with disgust responses following

CBM-I training, after controlling for levels of disgust responding in the absence of CBM-I training. Results showed that the responsibility/threat subscale of the OBQ was positively correlated with *levator labii* responses to images of body waste after CBM-I training, even after controlling for *levator* responses to a matched set of images in the absence of CBM-I training (r = .48, p = .03), confirming my hypothesis that stronger obsessive beliefs would be associated with a weaker response to CBM-I training.

Discussion

Cognitive models of OCD propose that maladaptive obsessive beliefs increase the likelihood that intrusive phenomena will be interpreted as personally meaningful, aversive or harmful. More recently it has been suggested that maladaptive obsessive beliefs may amplify reactions to sources of disgust in a similar manner (Teachman, 2006), increasing the likelihood that feelings of disgust will be interpreted as threatening or catastrophic. Indeed, the findings of the study presented in Chapter 3 indicated that increased levels of obsessive beliefs were associated with increased disgust responding to non-disgusting stimuli, suggesting that obsessive beliefs are an important mechanism underpinning pathological disgust in this clinical group. Therefore, the aim of the current study was to examine whether modifying obsessive beliefs through the use of a novel positive CBM-I training paradigm impacts disgust responses in individuals with OCD. I predicted that counteracting the effects of maladaptive obsessive beliefs by training a positive interpretive bias would result in a reduction in disgust responses generally and, specifically, disgust responses to non-disgusting stimuli.

The results showed that CBM-I training induced a weak positive bias in the interpretation of novel ambiguous material, which did not impact self-reported or facial electromyographic disgust responses. However, electrodermal activity in response to contamination images was significantly lower following positive CBM-I training than it was without CBM-I training, providing some support for my predictions. The results also showed that beliefs surrounding inflated perceptions of personal responsibility and overestimation of threat correlated positively with *levator labii* responses to images of body waste following CBM-I training, even after controlling for *levator* responses to this image set in the absence of CBM-I training.

The results of the current study further emphasise the impact of obsessive beliefs on disgust responses in individuals with OCD, particularly with regard to sources of contamination. They also corroborate the findings of Cisler and colleagues (2010), who showed that levels of obsessive beliefs significantly predicted contamination concerns in non-clinical individuals. However, the changes in disgust responses observed in the current study occurred even though positive CBM-I training produced only a weak positive interpretation bias, making it difficult to determine whether changes in disgust responses occurred directly as a result of CBM-I training.

There are a number of ways that the current findings may be interpreted. Firstly, it may be argued that reductions in disgust responses following CBM-I training are attributable to demand characteristics. The risk of demand characteristics is something that has been raised in a recent review of the CBM literature (MacLeod & Mathews, 2011), which suggests ruling out demand characteristics by assessing the effects of CBM training via measures other than self-report, such as psychophysiology. In the current study, the primary effects of CBM-I training were on physiological indices of disgust responding, making it unlikely that these findings are purely attributable to

demand characteristics. Secondly, it is possible that rather than inducing a positive interpretive bias, the positive CBM-I training may have caused a training-congruent reduction in state anxiety that reduces electrodermal activity in response to contamination stimuli. It is difficult to rule out the effects of CBM-I on mood in the current study, as changes in state anxiety were not assessed. However, studies have indicated that the effects of CBM training occur independently of mood (Standage, Ashwin, & Fox, 2010), and researchers have failed to show interference in CBM effects via mood manipulation (Salemink & van den Hout, 2010). Additionally, if CBM-I training produced its effects solely via reductions in task-relevant anxiety then I would expect to see reductions in responses to all image stimuli, rather than only those depicting sources of contamination. This suggests that the CBM-I effects observed in the current study were not simply driven by training-congruent changes in mood.

A third possibility is that inducing even a weak positive interpretation bias is sufficient to produce changes in electrodermal disgust responses in individuals with OCD, particularly with regard to stimuli that depict sources of contamination. Although the absence of CBM-I effects on self-reported emotion may be considered an indication against this theory, evidence suggests that emotionally-driven changes in electrodermal activity can occur even outside of conscious awareness (Soares & Öhman, 1993). This indicates that it is possible to observe emotion-related changes in electrodermal activity in the absence of concurrent changes in self-reported emotion. If my CBM-I training only produced very subtle changes in disgust responses, it may have produced changes in emotional responses that were capable of being expressed in terms of autonomic arousal despite being too subtle to be expressed via self-report.

The lack of a clear change in interpretive bias makes it difficult to interpret the current results in terms of existing cognitive models of OCD, and research that

successfully induces a positive interpretation bias is needed to confirm these findings. However, the results of the current study provide preliminary evidence that activating more helpful beliefs by training a positive interpretation bias may be effective in reducing emotional arousal in response to contamination stimuli in a heterogeneous sample of individuals with OCD.

Some limitations must be kept in mind when interpreting the current findings. Firstly, although the current study used a single sample crossover design in which the order of CBM-I conditions was randomised (a common experimental design used to examine the effects of an intervention; Jones & Kenward, 2003), it is possible that an aspect of the positive CBM-I training other than the induction of positive interpretation biases impacted on disgust responding. Although I have discussed findings that arguably rule out a number of these factors, future research using a neutral CBM-I training condition is needed to control for the non-specific effects of the CBM-I task.

Secondly, it is possible that I may have observed greater CBM-I effects on disgust responding, had I directly targeted disgust-based interpretations. The decision to target obsessive beliefs was predicated on prior work by Cisler and colleagues (Cisler et al., 2010), as well as Clerkin and Teachman's (2011) recent application of CBM-I to an analogue OCD sample. However, cognitive models of OCD propose that obsessive beliefs exert their effects on emotional responses primarily by increasing negative interpretations (Rachman, 2002, 2004). Therefore, manipulating interpretations may more directly impact on disgust-relevant cognitions, and so produce greater changes in disgust responding. Although the current study made an important first step in the application of CBM-I to disgust, future research examining the effects of CBM-I training that targets disgust-based interpretations is clearly warranted in order to fully

evaluate the usefulness of this novel tool as an adjunct to treatment in disgust-based disorders.

Thirdly, as this was the first study to apply CBM-I training to individuals meeting full diagnostic criteria for OCD, it is possible that the cognitive rigidity characteristic of this sample may render those with the disorder more resistant to bias modification. It is possible that more lengthy and numerous training sessions may be needed for CBM-I training to be effective in individuals with OCD.

To conclude, the current study was the first to examine whether counteracting the effects of maladaptive obsessive beliefs through positive interpretation bias training impacted on disgust responding in individuals with OCD. Although interpretation bias training produced only a weak positive bias, training significantly reduced electrodermal responses to images depicting sources of contamination. Given that only a single, brief CBM-I training session was used in the current study, these findings are promising, and future research is clearly warranted to more fully evaluate the application of this novel paradigm to the treatment of pathological disgust. In light of this, the following chapter will present the findings of a second study that examines the effects of using CBM-I training to directly modify disgust-relevant interpretations, on disgust responding.

Chapter 6

MODIFYING DISGUST: PART II

The following chapter reports on a study that used a novel CBM-I training procedure to modify disgust-based interpretations. Given that a core characteristic of OCD is cognitive rigidity, it was difficult to determine whether the weak CBM-I effect observed in the previous study was the result of an ineffective paradigm or simply a cognitively rigid sample. Before further research into the applicability of CBM-I for disgust on clinical samples is conducted, I determined that it would first be important to show that a) disgust-based interpretations have a causal influence on disgust responses, and that b) CBM-I can successfully modify disgust-based interpretations in a non-clinical sample.

Evidence for interpretive biases in disgust

Previous research on interpretive biases in disgust has found that inducing disgust results in a negative interpretive bias that is similar to that observed when anxiety is induced. Using a set of verbally presented homophones that were either threat/neutral (e.g., die/dye) or positive/neutral (e.g., peace/piece) to test interpretive biases, Davey and colleagues (2006) found that inducing disgust led participants to make significantly more threat-relevant interpretations of the homophones than they did neutral in the threat/neutral condition. Furthermore, positive homophones were not

favoured in the positive/neutral condition, indicating that inducing disgust produced a specific bias towards threat-relevant interpretations, as opposed to emotional interpretations more generally. This effect mimicked that observed when anxiety was induced, suggesting that state disgust may induce threat-relevant interpretive biases in a similar way to anxiety. In Davey and colleagues' (2006) experiment, the effects of disgust on interpretive biases occurred in the absence of an increase in self-reported anxiety, indicating that the effect of disgust on interpretation bias was non simply mediated by the effect of disgust on anxiety levels. Mayer, Busser and Bergamin (2009) have replicated these findings and raise the notion that the link between disgust and anxiety may arise because disgust evokes a negative interpretation bias towards threat.

Past research has also shown that a tendency to interpret stimuli as disgusting is associated with an array of psychopathological symptoms. For example, in an experiment assessing the expected consequences of contact with various types of animals in a group of individuals high and low in spider fear, it was found that the best predictor of spider fear was the expectation of a disgusting consequence arising from contact with a spider (Van Overveld, De Jong, & Peters, 2006). In this experiment, participants were presented with images of spiders, maggots, pit bull terriers and rabbits and were asked to rate the likelihood with which each of the animals would be associated with a) an electric shock (harmful consequence), b) a sip of a foul tasting liquid (a disgusting consequence), or c) nothing (a neutral consequence). The expectation of a disgusting consequence following presentation of a spider image was significantly stronger in the high spider fearful group compared to the low spider fear group. This shows that a disgust-based expectancy bias (i.e., expecting a disgusting consequence) may contribute the development of spider fear.

A similar result has been found when participants high and low in spider fear are asked to rate how likely an image of a spider would be paired with a disgusted or a fearful facial expression, where those high in spider fear reported significantly higher expectancies that spiders would be paired with disgusted facial expressions compared to those with low spider fear. Higher expectancies for the disgust expression to be paired with images of spiders was also significantly associated with behavioural avoidance on a task that required participants to approach a black box containing a spider (Olatunji, Cisler, Meunier, Connolly, & Lohr, 2008).

Disgust-based interpretive biases have also been implicated in eating disorder pathology. In two separate studies where participants were asked to rate the emotions elicited by images of fat body shapes and high energy foods, the results showed that participants with higher levels of abnormal eating attitudes rated high energy food and fat body shapes as more disgusting than participants with lower levels of abnormal eating attitudes (Griffiths & Troop, 2006; Harvey, Troop, Treasure, & Murphy, 2002). This indicates that some aspects eating pathology may be driven by a tendency to interpret things related to food and body shape in a more disgusting way.

These studies demonstrate that inducing disgust can lead to a negative interpretive bias similar to that found when inducing anxiety, and that a bias to interpret something as disgusting may underpin some forms of psychopathology. In light of this evidence, as well as the evidence linking disgust with a number of anxiety disorders, it seems important to determine whether interpretive biases associated with disgust can be modified using CBM-I paradigms.

Aims & hypotheses

There has only been one study to date that has attempted to manipulate disgust-relevant biases. Using an attentional probe task to train attention towards or away from words relating to contamination in individuals high on obsessive-compulsive traits, Najmi and Amir (2010) found that training attention away from the contamination-related words resulted in reduced attentional bias for contamination themes and a greater ability to approach feared objects on a test of behavioural avoidance. However, this study only targeted attentional, and not interpretive, biases. Therefore, the first aim of the current study was to examine whether a CBM-I paradigm could be used to modify disgust-based interpretive biases.

In the current study, a disgust-based CBM-I training paradigm was compared to a control CBM-I paradigm that trained benign interpretive biases. This approach differs slightly from that used in Chapter 5, which had more of a therapeutic focus, by providing a direct test of the causal influence of disgust-based interpretive biases on disgust responses. This was important to clarify, because if disgust-based interpretive biases do not impact on disgust responses, it follows that altering such biases through positive CBM-I training will not impact on disgust responding.

In line with previous research examining the effects of CBM-I training on anxiety, I predicted that individuals who were trained to make disgust-based interpretations would show a) a greater tendency to interpret novel ambiguous information in a disgust-relevant way, b) higher trait disgust, and c) greater self-reported disgust in response to disgust elicitors, compared to individuals who were trained to make benign interpretations. An important issue in examining the effects of interpretation modification is disentangling the true effects of training from demand

effects. It has been suggested that self-reported outcomes of the effects of interpretation training should be supplemented with more objective outcomes such as behavioural and psychophysiological measures (MacLeod & Mathews, 2011). Therefore, the second aim was to examine the effects of CBM-I training on behavioural avoidance of disgust elicitors, and physiological disgust responses as indexed via facial EMG. Given that CBM-I training is thought to produce true changes that are not simply reflective of demand characteristics, I predicted that inducing disgust-based interpretive biases should also affect indices of disgust responding beyond self-report: namely, greater behavioural avoidance of, and heightened physiological responses to, disgust-elicitors.

The current study made a number of improvements on the study in Chapter 5, including the use of a control CBM-I training condition, rigorous pilot testing of CBM-I training items, a between-groups design with random assignment to the two CBM-I conditions, the addition of clinical symptom and mood measures administered before and after CBM-I training, as well as the inclusion of a behavioural task designed to assess behavioural avoidance of disgust elicitors.

Method

Participants

Non-clinical community control participants were recruited through the use of advertisements placed in the local newspaper. Once participants had expressed their interest via phone or email, they were sent a screening questionnaire to complete online. The screening questionnaire comprised demographic questions, questions about past psychiatric history and English literacy skills. Individuals were eligible to participate if they indicated on the screening questionnaire that they could read and write in English,

were at least 18 years of age, and did not have a history of psychosis or neurological disorder. After completing the screening questionnaire, eligible participants were contacted by phone.

Sixty individuals took part in the study (63.3% female, mean age = 33.4, *SD* = 17.27, range = 18-77, mean education = 16.08, *SD* = 2.70) and were randomised to receive either the benign (*n* = 30) or the disgust CBM-I training (*n* = 30). Independent samples t-tests confirmed that there were no differences in age or years of education between the two CBM-I training groups (all *p*s > .05), and chi square tests also revealed no differences in gender χ^2 (1, *N* = 60) = .29, *p* >.05.

CBM-I task

The CBM-I task used in the present study was based on the paradigm devised by Mathews and Mackintosh (2000) and the modifications made by T. J. Lang and colleagues (2009). This script-based paradigm was designed to target interpretations of potentially disgusting situations and objects. It contained 32 sentences, each presented twice, that were either benign (used for the benign CBM-I training) or disgust-based (used for the disgust CBM-I training). A further 10 ambiguous sentences were used in the recognition phase, each of which had accompanying benign and disgust-based targets and foils. Targets were benign and disgust-based sentences with similar wording to the original ambiguous sentence. Foils were benign and negative yet non-disgust-based sentences, with less similar wording to the original sentence. A negative rather than a disgust-based foil was used to test for the generalisation of disgust-based bias training to negative material more generally.

The items for the CBM-I training and recognition tasks were generated by myself and a research assistant, in accordance with the seven domains of disgust elicitors outlined by Haidt, McCauley and Rozin (1994). A total of 100 benign and 100 disgust-based training items were generated initially, as well as 30 ambiguous recognition statements with accompanying benign and disgust-based targets and foils. These items were pilot-tested as an online questionnaire using a sample of 101 people who were asked to rate from 0-5 how much disgust each of the sentences evoked. Only those sentences where the disgust version elicited significantly more disgust than the benign version were included in the final CBM-I paradigm. The CBM-I task was programmed using E-prime software (Versions 1.1.4.1, Pittsburgh: Psychology Software Tools Inc.) and was presented to participants on a desktop computer.

CBM-I training phase

In the training component of the paradigm, participants were presented with a sentence for two seconds, which had the final few words missing. These missing words meant that the initial sentence presented was ambiguous (e.g. "Squelching mud between my toes reminds me of…"). Following this, the final few words of the sentence were presented separately as word fragments for the participants to solve (e.g. "Pl_ying in the ba_kyard" for benign training, or "St_pping in do_ poo" for disgust training). Participants were asked to complete the word fragments by filling in the first missing letter. A total of 32 comprehension questions followed the randomly selected sentences to ensure that participants had read and understood all statements. This meant that, for the 32 pairs of training items, one sentence from each pair was followed by a comprehension question. Participants were required to give a 'yes/no' response for each of these comprehension questions. For example, the correct response to the question

"Does squelching mud between your toes make you happy?" would be "yes" for the benign training and "no" for the disgust training. Participants were given feedback to indicate whether they had answered the question correctly or not. Correct responses for each of the comprehension questions were totalled to give a single training accuracy score. Mean response latencies were also calculated to give a mean training reaction time score.

CBM-I recognition phase

Participants were presented with 10 emotionally ambiguous statements immediately following training to check whether training influenced the subsequent interpretation of novel ambiguous material, along with item titles that conveyed the general theme of the statement. They were asked to read each statement along with its title, and to ensure that they had read all the parts of the statement before moving on to the next item. They were then asked to rate from 1 (*Not at all*) to 9 (*Extremely well*) how well they understood the words that appeared on the screen in front of them. Once they had rated all 10 ambiguous statements they were presented with each of the themed titles again, this time accompanied by four emotionally valanced statements (targets and foils). A sample recognition item with accompanying targets and foils is shown in Table 5.1.

Table 5.1

Sample CBM-I recognition item with accompanying target and foil statements

Title	Eating out
Ambiguous statement	When I go to a restaurant where I can watch the chef prepare my meal, I always think the same thing.
Disgust target	When I go to a restaurant where I can watch the chef prepare my meal, I always think about how dirty the chef's hands might be.
Benign target	When I go to a restaurant where I can watch the chef prepare my meal, I always think about how delicious it looks.
Negative foil	When I go to a restaurant where I can watch the chef prepare my meal, I always get impatient.
Benign foil	When I go to a restaurant where I can watch the chef prepare my meal, I always enjoy myself.

Participants were shown each of the four statements one by one in a randomised order, and asked to think back to the original statement and rate from 1 (*very different in meaning*) to 4 (*very similar in meaning*), how similar each was to the original statement. Once a rating was given for a statement the next immediately appeared and participants were not able to return to change a previous rating. Similarity ratings were totalled, resulting in a score for each of the four recognition categories (benign target, benign foil, disgust target, negative foil). Cronbach's alpha coefficients were 0.84, 0.80, 0.85 and 0.80 for each of the category totals respectively.

Measures

Trait disgust, clinical symptoms and mood change

DPSS-R (van Overveld, de Jong, Peters, et al., 2006): The DPSS-R was used to gauge the impact of CBM-I training on trait levels of disgust. As mentioned in previous chapters, the DPSS-R is a 12-item scale that is split into two subscales comprising the Disgust Propensity subscale (the tendency to respond with disgust) and the Disgust Sensitivity subscale (aversion to the experience of disgust). The scales have been shown to have adequate internal consistency (Cronbach's alpha: Disgust Propensity subscale = 0.78; Disgust Sensitivity subscale = 0.77) and account for unique variance in predicting phobia symptoms; the Disgust Sensitivity subscale in predicting blood-injection fears and the Disgust Propensity subscale is predicting spider fears (van Overveld, de Jong, Peters, et al., 2006). The test-retest reliability coefficients of the Disgust Propensity and Disgust Sensitivity subscales in the current sample were 0.77 and 0.83 respectively.

The DS-R (Haidt et al., 1994): The DS-R was used to measure the tendency to experience disgust in response to seven discrete domains of disgust elicitors (food, animals, body products, body envelope violations, death, hygiene and sympathetic magic). As mentioned in previous chapters, the DS-R has been shown to correlate positively (r = .42) with behavioural measures of disgust-related avoidance (Rozin, Haidt, McCauley, et al., 1999). It had a test-retest reliability coefficient of 0.66 in the current study.

The OCI-R (Foa et al., 2002): Given disgusts' implication in other anxiety disorders, and OCD in particular, the effects of CBM-I training on OC symptomatology was also assessed using the OCI-R. The OCI-R has good test-retest reliability and

convergent and discriminant validity (Foa et al., 2002). The test-retest reliability of the OCI-R in the current sample was 0.80.

The DASS-21 (Lovibond & Lovibond, 1995): The DASS-21 was also used to determine whether any effects of CBM-I training on behavioural and physiological measures could be attributed to more general changes in negative affect. The DASS-21 is a 21-item self-report scale comprising subscales that assess for symptoms of depression, anxiety and stress, all of which have been found to have excellent reliability and good convergent and discriminant validity (Crawford & Henry, 2003). The test-retest reliability coefficients for the Depression, Anxiety and Stress subscales in the current study were 0.93, 0.85 and 0.90 respectively.

To examine the immediate effects of CBM-I training on current mood, participants completed a mood ratings form (Gross & Levenson, 1995) on which they were required to rate from 0 (*None at all*) to 8 (*Extremely*) how strongly they were feeling 4 different emotions (Anxiety, Disgust, Sadness, Tension) immediately prior to- and post- training.

Behavioural avoidance

Three behavioural approach tasks based on those used by Deacon and Olatunji (2007) were used to assess behavioural avoidance of disgust-eliciting objects. Each behavioural approach task had four steps. The first involved the use of a small cookie that had been placed on the floor. Participants were asked to i) hold the cookie, ii) touch the cookie to their lips, iii) take a bite of the cookie, and then iv) eat the whole cookie. The second involved the use of an old comb that had visible specs of dust between the bristles. Participants were told that it was a comb that had been used by another researcher at the university. They were asked to i) hold the comb by the bristles,

ii) run the comb through their hair, iii) run the bristles across their forehead, and then iv) touch the bristles to their lips. The final behavioural approach task was a green bedpan partially filled with water that had a small piece of toilet paper floating in it. Participants were told that the bedpan had been filled with water from a flushed toilet down the hall. They were asked to i) touch the seat of the bedpan while wearing a latex glove, ii) put their hand in the water while wearing the glove, iii) touch the seat with their un-gloved hand, and then iv) touch the water with their un-gloved hand. If the participant chose to complete the step, they were asked to rate their anxiety and disgust from 0 (*None at all*) to 10 (*Extreme*). If they chose not to complete the step, they were asked to give their anticipated ratings.

Physiological disgust responses

Facial EMG was used to measure differences in *levator labii* and *corrugator supercilii* muscle activity in response to images depicting a range of disgust elicitors. Electrode placement followed standard procedures described in previous electromyographic research (Bailey et al., 2009; Fridlund & Cacioppo, 1986) and was identical to the procedure described in Chapters 3 and 5. Specifically, two sets of Ag-AgCl 4mm bipolar surface electrodes in a 7.5mm housing were applied to the left *corrugator supercilii* and *levator labii superioris* to measure spontaneous facial affect in response to five sets of images. A fifth electrode was placed in the middle of the forehead to function as an earth. Prior to affixing the electrodes, the skin was cleaned with an alcohol wipe and then abraded with NuPrep gel (Weaver and Co., Aurora, CO). Ten20 conductive paste (Weaver and Co.) was used between the electrodes and surface of the skin, and electrodes were held in place with Microporous hypoallergenic surgical tape (3M Micropore). EMG muscle activity was recorded using a PowerLab 8/30 Data Acquisition System (ADInstruments, Castle Hill, Australia) at a sampling rate of

2000Hz. Raw data was filtered for artefacts using a 20-400Hz bandpass filter with an amplification factor of 20,000. Non-affective movements caused by yawning and blinking were also removed.

Images were presented using DMDX software (Version 3.2.3.0) to ensure accurate timing of EMG recording and stimuli presentation. Facial muscle activity occurring during the presentation of image stimuli was recorded using a passive viewing paradigm. The presentation of images was timed such that participants saw a blank screen for 5s with an orienting tone occurring at 4.5s. After 5s an image appeared and remained on the screen for 5s. Images within each set were presented randomly, as was the order of each set.

A total of 30 images were compiled from various sources and were used to assess disgust responses across five domains. Six images were used to measure disgust responding to: body products, contamination, mutilation; negative but non-disgusting situations, and neutral themes (see Appendix C for descriptions of image content).

The average increase in muscle activity was calculated using the RMS method outlined by Tassinary and Cacioppo (2000). Muscle activity occurring within the 500ms prior to image presentation was used as baseline muscle activity. The average of each 500ms interval period while the image was on the screen was calculated separately for each image set in order to detect variability of responding across trials. Following this, the RMS EMG percentage change from baseline, averaged across individual trials within each image set, was calculated for the 5s during stimulus presentation.

Participants also gave self-reported ratings of disgust for each image on an eight-point Likert scale from 1 (*Not at all disgusting*) to 8 (*Extremely disgusting*). Rating scores for each of the five image categories were then totalled. Cronbach's

alpha coefficients for the total scores were: body products = 0.84; contamination = 0.74; mutilation = 0.79; neutral = 0.76; negative non-disgust = 0.71.

Procedure

Participants who were deemed eligible, based on their answers to the online screening survey, were contacted by phone and invited to take part in the study. After arranging a time to attend the experiment session, they were emailed internet addresses to complete the DASS-21, OCI-R, DPPS-R and DS-R online prior to attending the session. On average, participants completed these questionnaires five days prior to attending the session.

All participants gave their informed written consent prior to participating in the study. Before beginning the CBM-I training, participants were required to have completed the DASS-21, OCI-R, DPPS-R and DS-R. Immediately prior to training participants were given the emotion ratings form to complete, after which I affixed the facial EMG sensors. Immediately after training, participants completed the emotion rating form a second time and facial muscle activity was recorded throughout the presentation of all five image sets. Self-reported disgust ratings were obtained for each image then EMG sensors were removed and participants completed the behavioural approach tasks. Finally, I re-administered the DASS-21, DS-R, DPSS-R and OCI-R, debriefed participants regarding the aims of the study, and ensured that no participant left the experiment session with elevated levels of distress. The duration of the entire experiment session was approximately two hours.

CHAPTER 6

Results

CBM-I training & recognition

Before any effects of CBM-I training on disgust responding were explored, analyses of training accuracy scores and recognition scores were conducted to determine whether a) participants achieved a high enough training score to show that they understood the task, and b) whether training had any immediate effects on the interpretation of novel ambiguous material. An independent samples t-test revealed that there was no difference in training accuracy score between the two training conditions $t(58) = .45$, $p = .66$, indicating that both groups performed equally on the training component of the CBM-I task.

To determine whether the CBM-I training resulted in biases in the interpretation of new ambiguous material, similarity ratings for the benign and disgust targets and foils were totalled and compared across CBM-I conditions. Results were analysed using a repeated measures ANOVA with the between subjects factor of CBM-I training (benign vs. disgust training conditions), and the two within subjects factors of valence (benign vs. disgust) and training-relevance (target vs. foil). Results showed a significant main effect for training-relevance $F(1,58) = 13.4$, $p = .001$, $\eta_p^2 = .19$, where targets were rated as being more similar than the foils. There were no main effects of CBM-I training or valence, nor were there any significant interactions between CBM-I training, valence or training-relevance (all ps $> .05$).

CBM-I effects on mood

To examine the effects of CBM-I training on mood, repeated measures ANOVAs with the between subjects factor of CBM-I training (benign vs. disgust) and

the within subjects factor of time (pre- vs. post-training rating) were conducted for the four emotions that participants rated immediately before and immediately after completing the CBM-I task. There were no significant Time x CBM-I training interactions. Results showed a main effect of time for all emotions: Anxiety, $F(1, 58) = 20.99$, $\eta_\rho^2 = .27$, $p < .001$), Disgust $F(1, 58) = 7.09$, $p = .01$, $\eta_\rho^2 = .11$, Sadness $F(1, 58) = 4.89$, $p = .03$, $\eta_\rho^2 = .08$, Tension $F(1,58) = 12.07$, $p = .001$, $\eta_\rho^2 = .17$. Across both CBM-I training conditions, Anxiety ($p < .001$), Sadness ($p = .03$) and Tension ($p = .001$) decreased from pre- to post- training. Across both CBM-I training conditions, Disgust increased from pre- to post-training ($p = .01$). Importantly, disgust increased from pre- to post- training equally across both CBM-I conditions, meaning that any effects of the disgust-based CBM-I would not simply be the results of a training-congruent change in mood.

CBM-I effects on clinical symptoms and trait disgust

To determine the effects of CBM-I training on trait disgust, OC symptoms and negative affect, a 2 x 2 repeated measures ANOVA was used with the between subjects factor of CBM-I training (benign vs. disgust) and the within subjects factor of time (pre-training score vs. post-training score). There was significant Time x CBM-I training interaction for the Disgust Propensity $F(1, 58) = 4.44$, $p = .04$, $\eta_\rho^2 = .07$, but not the Disgust Sensitivity $F(1, 58) = 3.57$, $p = .06$, $\eta_\rho^2 = .06$ subscale of the DPSS-R, and no interaction for the DS-R $F(1, 58) = .36$, $p = .55$, $\eta_\rho^2 = .01$. There were significant Time x CBM-I training interactions for the Stress $F(1, 58) = 6.88$, $p = .01$, $\eta_\rho^2 = .11$, and Anxiety $F(1, 58) = 13.55$, $p = .001$, $\eta_\rho^2 = .19$, but not the Depression $F(1, 58) = .00$, $p = .95$, $\eta_\rho^2 = .00$ subscales of the DASS-21. There was also a Time x CBM-I interaction

for the OCI-R $F(1, 58) = 7.68$, $p = .007$, $\eta_\rho^2 = .117$. Follow-up tests of simple effects showed the same pattern of results for all measures which had significant interactions, where no significant differences were found between pre- and post- training scores for those who received the benign training but significant increases in scores for those who received the disgust training (all *p*s < .05).

I also examined whether disgust CBM-I training produced stronger effects on specific OC symptoms, therefore the above analysis was conducted on the separate subscales of the OCI-R. Significant Time x CBM-I interactions were found for the Checking $F(1,58) = 7.46$, $p = .008$, $\eta_\rho^2 = .11$, and Hoarding $F(1,58) = 7.70$, $p = .007$, $\eta_\rho^2 = .12$ subscales. Follow-up tests of simple effect of time within CBM-I training revealed that Checking scores increased from pre- ($M = 2.77$, $SD = 2.45$) to post-training ($M = 3.97$, $SD = 3.32$) for those who received the disgust CBM-I training ($p = .01$), and remained unchanged for those in the benign training condition ($p = .20$). A similar pattern of results was observed for scores on the Hoarding subscale of the OCI-R, where scores increased from pre- ($M = 4.77$, $SD = 2.96$) to post- training ($M = 6.43$, $SD = 3.26$) for those who received the disgust CBM-I training ($p < .001$) but remained the same for those in the benign training condition ($p = .80$). There were no significant Time x CBM-I interactions for the Washing, Ordering, Obsessing or Neutralising subscales of the OCI-R (all *p*s > .05).

To determine whether post-training changes in the DPSS-R and OCI-R could be attributed to changes in negative affect, change scores for the Anxiety and Stress subscales of the DASS-21 were first computed by subtracting pre-training scores from post-training scores. These change scores were then entered as covariates into a 2 x 2 repeated measures ANOVA with the same between and within subjects factors as used in the previous analysis. When the Stress change score was entered as a covariate, the

Time x CBM-I interaction for the DP subscale of the DPSS-R fell below significance $F(1, 58) = 1.69$, $p = .20$, $\eta_\rho^2 = .03$, and fell lower when the Anxiety change score was entered as a covariate, $F(1, 58) = 0.72$, $p = .40$, $\eta_\rho^2 = .01$. This also occurred for the Time x CBM-I interaction for the Disgust Sensitivity subscale of the DPSS-R, which fell below significance when the Stress change score was entered as a covariate $F(1, 58) = 2.23$, $p = .14$, $\eta_\rho^2 = .04$, and when the Anxiety change score was entered as a covariate $F(1,58) = 2.22$, $p = .14$, $\eta_\rho^2 = .04$. The Time x CBM-I interaction for the OCI-R fell just below significance, albeit to a lesser degree than the DPSS-R scales, when Anxiety change score was entered as a covariate $F(1,58) = 3.56$, $p = .06$, $\eta_\rho^2 = .06$, as well as when Stress change score was entered as a covariate $F(1,58) = 3.91$, $p = .05$, $\eta_\rho^2 = .07$.

As there were significant Time x CBM-I interactions for the Checking and Hoarding subscales of the OCI-R, the above analysis was also conducted separately for these subscales. The Time x CBM-I interaction for the Checking subscale remained significant when the Anxiety change score was entered as a covariate $F(1,58) = 5.37$, $p = .02$, $\eta_\rho^2 = .09$ and also when the Stress change score was entered as a covariate $F(1,58) = 5.09$, $p = .03$, $\eta_\rho^2 = .08$. Similarly, the Time x CBM-I interaction for the Hoarding subscale remained significant when the Anxiety change score $F(1,58) = 5.66$, $p = .02$, $\eta_\rho^2 = .09$ and Stress change score was entered as a covariate $F(1,58) = 5.82$, $p = .02$, $\eta_\rho^2 = .09$.

CBM-I effects on behavioural avoidance

The number of steps completed, as well as the levels of anxiety and disgust reported while completing each step, were strongly correlated across all three behavioural approach tasks (*r*s range from .51-.81). Therefore, the number of steps

completed across all behavioural approach tasks was totalled to form a composite score, and the anxiety and disgust ratings for each step averaged.

An independent samples t-test was used to determine the effects of CBM-I training on the total number of steps completed, and levels of anxiety and disgust across the three behavioural approach tasks. Results are shown in Table 5.2. There were no differences between the CBM-I training conditions on number of steps completed, anxiety or disgust (all *p*s > .05).

Table 5.2

Total steps completed, anxiety and disgust ratings, averaged across all three behavioural approach tasks for the benign and disgust CBM-I training conditions.

	Benign CBM-I		Disgust CBM-I	
	M	*SD*	*M*	*SD*
Steps Completed	8.00	3.54	7.33	2.89
Mean Anxiety	3.32	2.75	4.27	2.63
Mean Disgust	3.68	2.94	4.74	2.70

Note. M = Mean; SD = Standard Deviation

CBM-I effects on physiological disgust responses

To assess the effects of CBM-I training on physiological responses during presentation of each image set, a 2 x 5 repeated measures ANOVA with the between subjects factor CBM-I training (benign vs. disgust) and the within subjects factor of

image type (body products, contamination, mutilation, negative non-disgust, neutral) was used to analyse muscle activity separately for both the *corrugator* and *levator*.

The average percentage change from baseline in muscle activity in the *corrugator* and *levator* during each of the image sets are presented in Figures 5.1 and 5.2. There were no main effects of CBM-I training evident in either the *corrugator* or *levator* (all *p*s > .05).

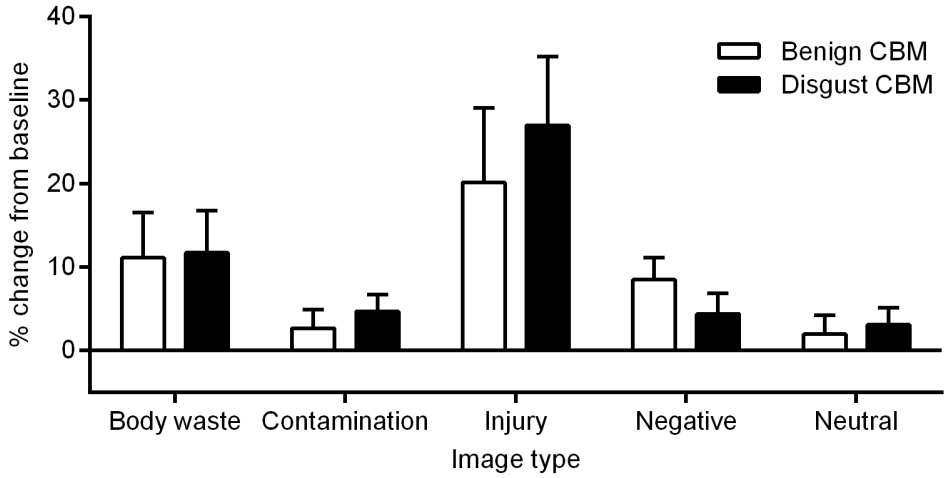

Figure 5.1. Percentage change from baseline in *corrugator* activity during the presentation of image sets for those who received the benign compared to the disgust CBM-I training. There was no significant main effect or interaction involving CBM-I training conditions, indicating that training did not impact on *corrugator* responses.

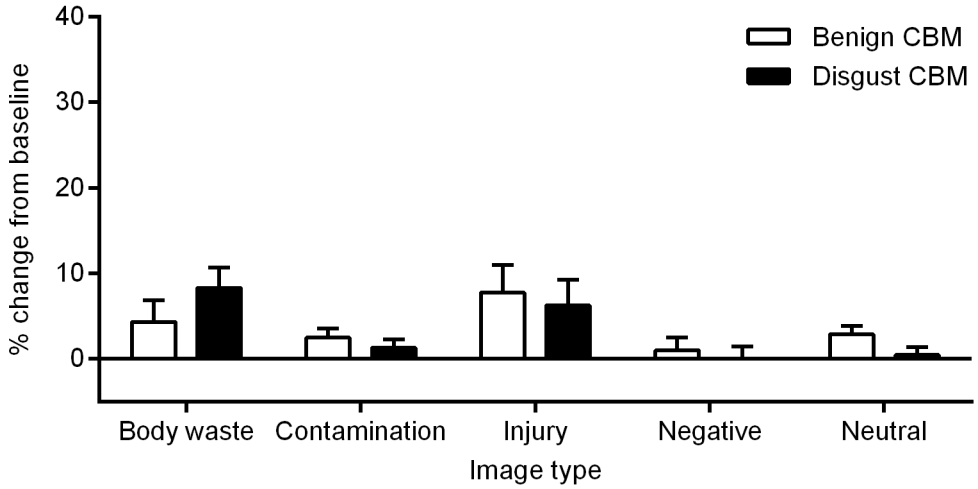

Figure 5.2. Percentage change from baseline in *levator* activity during the presentation of image sets for those who received the benign compared to the disgust CBM-I training. There was no significant main effect or interaction involving CBM-I training conditions, indicating that training also did not impact on *levator* responses.

CBM-I effects on self-reported disgust responses

A 2 x 5 repeated measures ANOVA was also used to examine the effects of CBM-I training on self-reported disgust ratings for each of the image sets. Mean self-reported disgust ratings for each image set are shown in Figure 5.3. Results revealed a significant CBM-I training x Image interaction $F(4, 232) = 3.36$, $p = .01$, $\eta_\rho^2 = .06$. Follow-up tests of simple effects revealed that, for the images depicting body products, those who received the disgust CBM-I training rated the images as being more disgusting ($M = 4.32$, $SD = 1.89$) than those who received the benign CBM-I training ($M = 3.28$, $SD = 1.79$, $p = .03$). Interestingly, self-reported disgust ratings of neutral images were higher for those in the benign CBM-I condition ($M = 1.54$, $SD = 1.60$) than those who received the disgust CBM-I ($M = .70$, $SD = 1.01$, $p = .02$).

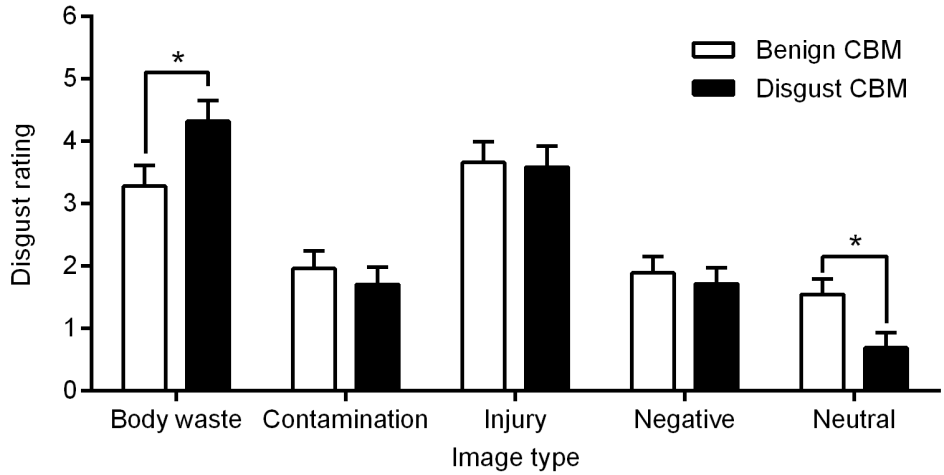

Figure 5.3. Self-reported disgust ratings. The disgust CBM-I group showed significantly stronger self-reported disgust in response to images depicting body waste. In contrast, the benign CBM-I group showed significantly stronger disgust responses to neutral images than those in the disgust CBM-I group.

Discussion

CBM-I offers a way of testing the causal link between interpretive biases and symptomatology. While a number of studies have applied this paradigm to anxiety, no research to date has applied the paradigm to disgust. The potential use of CBM-I training in modifying disgust responses has significant clinical utility given that this emotion has been implicated in a number of anxiety disorders. Therefore, the present study was the first to examine whether disgust-based interpretative biases could be manipulated using a computerised CBM-I procedure.

I predicted that training a bias towards disgust-based interpretations versus more benign interpretations would lead to a) training-congruent biases in the interpretation of new ambiguous material, b) higher levels of trait disgust, c) greater self-reported disgust and behavioural avoidance of disgust-eliciting objects, and d) more intense physiological responses – specifically at the site of the *levator labii* muscle – in response to disgust elicitors.

Unexpectedly, CBM-I training did not produced training-congruent effects on the interpretation of novel ambiguous material. This finding differs substantially from previous research as CBM-I training has commonly been shown to produce clear, training-congruent interpretative biases (Holmes & Mathews, 2005; Mathews & Mackintosh, 2000; Muris, Huijding, Mayer, & Hameetman, 2008; Muris, Huijding, Mayer, Remmerswaal, & Vreden, 2009; Salemink, van den Hout, & Kindt, 2007; Steinman & Teachman, 2010; Vassilopoulos, Banerjee, & Prantzalou, 2009; Yiend, Mackintosh, & Mathews, 2005). Similarly, while scores on the behavioural approach tasks were in the predicted direction, the effects of CBM-I training also did not significantly alter patterns of behavioural avoidance or physiological responses (e.g., facial muscle activity) toward static images of disgust elicitors.

Training-congruent effects were however observed for the DASS-21 and the DPSS-R, specifically for the Anxiety and Stress subscales of the DASS-21 and the Disgust Propensity subscale of the DPSS-R, coinciding with previous studies showing that CBM-I training effectively alters scores on measures of trait psychopathology (Beard & Amir, 2008; Mathews, Ridgeway, Cook, & Yiend, 2007; Salemink, van den Hout, & Kindt, 2009; Steinman & Teachman, 2010; Vassilopoulos et al., 2009). Interestingly, the significant Time x CBM-I interaction that was found on the Disgust Propensity subscale fell below significance after DASS-21 Anxiety and Stress change

scores were entered as covariates, suggesting that the effects of the CBM-I training on disgust propensity could be attributed to changes in stress and anxiety. That this change was accounted for specifically by anxiety and stress, but not depression, coincides with previous literature linking disgust closely with anxious symptomatology (Olatunji, Moretz, et al., 2010).

Training-congruent effects were also observed for the OCI-R and, specifically, the Checking and Hoarding subscales. While the significant Time x CBM-I interaction for the OCI-R total score fell below significance once Anxiety and Stress change scores were entered as covariates, the Time x CBM-I interaction for the two subscale scores did not. This is an interesting finding that runs counter to my prediction that disgust-based CBM-I training would affect symptoms most closely tied to disgust, such as those on the Washing subscale of the OCI-R. The absence of any training-congruent changes in interpretive biases – the typical manipulation check used in CBM-I research - makes it difficult to interpret these findings.

As is evident, most of the original predictions for the current study were not supported by the results, with the only supported predictions being on self-report outcome measures. There are several ways this pattern of results can be interpreted. Firstly, it is possible that multiple, more extensive CBM-I training sessions may be needed to produce training-congruent effects on behavioural indices of disgust. Only a few studies have investigated the effects of interpretation training on avoidance behaviour, and these have provided inconsistent results (Lange et al., 2010; Teachman & Addison, 2008). Using a CBM-I procedure to train interpretive biases in socially anxious people, Lange and colleagues (2010) found that interpretation training did not consistently influence performance on an approach-avoidance task where participants were required to pull or push a joystick in response to images of crowds. Using CBM-I

to train threatening and non-threatening interpretations related to spiders also did not influence subsequent avoidance behaviour towards a live spider in an analogue spider-phobic sample (Teachman & Addison, 2008). However, as in the present study, Lange and colleagues (2010) and Teachman and Addison (2008) used only a single session of CBM-I training, therefore it is unclear whether the absence of training-congruent effects on behavioural avoidance reflects true null effects of CBM-I training, or whether more intensive training is needed to produce clear behavioural changes.

Similarly, relatively few CBM studies have used psychophysiological indices of emotion as outcome measures, and those that have also produced mixed findings. Using CBM-A to train attentional biases towards negative, as opposed to positive social information has been found to increase cortisol levels in response to threat (Dandeneau, Baldwin, Baccus, Sakellaropoulo, & Pruessner, 2007). Conversely, attentional bias training for spider-relevant material had no effect on heart rate or galvanic skin responses in response to images of spiders (Van Bockstaele, Verschuere, De Houwer, & Crombez, 2010). While activity at the *levator labii superioris* has been found to correlate with self-reported measures of disgust, it may take more training sessions and images containing a greater degree of ambiguity to allow biases to come into play.

An alternative explanation is that CBM-I training may not be effective at manipulating disgust responses. In support of this notion, it has been suggested that disgust, as distinct from anxiety, may be particularly resistant to cognitive challenge (McNally, 2002). This is for two reasons. Firstly, cognitions may be difficult to change simply because one of the strongest facilitators of cognitive change – exposure – is less effective for disgust responses than it is for anxiety, as discussed in Chapter 1. Secondly, the cognitive component of disgust appears to linger even after a disgust response has been extinguished. For example, in a study where a neutral CS (a neutral

face) was paired with a disgusting US to produce a disgust-based CR, it was found that even after the response was extinguished to a level where participants no longer expected the neutral CS to elicit the disgusting US, they still rated the neutral CS as disgusting (Mason & Richardson, 2012). Similarly, Rozin and colleagues have shown that the appraisal of a cockroach as disgusting does not change even after all contaminants have been removed through sterilisation (Rozin et al., 1986). These findings indicate that disgust responses may be especially hard to change with traditional behavioural and cognitive therapy techniques, and therefore such responses may be difficult to change via training targeting interpretive biases.

It is important to note that the CBM-I training used in the current study did not result in any training-specific effects on mood state. This coincides with previous research showing that the effects of interpretation manipulation remain largely independent of the effects of mood. For example, Standage and colleagues (2010) found that inducing a training-incongruent mood state after training did not change the effects of CBM-I on resolution of ambiguous word strings. Other researchers have also shown that independently varying the valence of CBM-I training and a subsequent mood induction produces interpretive biases that remain congruent with the CBM-I training, and not the valence of the subsequent mood induction (Salemink & van den Hout, 2010). Importantly, the current study found training-congruent changes in disgust propensity in the absence of any training-specific changes in task-related disgust. This suggests that heightened post-training disgust propensity observed in the disgust-based CBM-I training group did not simply result from a disgusted mood state producing mood-congruent effects on cognition.

Some limitations must be kept in mind when interpreting the current data. Firstly, the paradigm used consisted of only 64 training trials completed in a single session.

While other studies have also observed CBM-I effects using a single training session (T. J. Lang et al., 2009; Salemink et al., 2007; Wilson, MacLeod, Mathews, & Rutherford, 2006), other studies which have demonstrated stronger downstream effects on anxiety have typically used lengthier and more numerous training sessions; e.g., three sessions over a week for socially anxious children (Vassilopoulos et al., 2009), seven daily sessions for depression (Blackwell & Holmes, 2010), four weekly sessions for generalised anxiety disorder (Brosan, Hoppitt, Shelfer, Sillence, & Mackintosh, 2011), 16 sessions over 8 weeks for social anxiety (Beard, Weisberg, & Amir, 2011), 8 daily sessions for high trait anxiety (Salemink et al., 2009) or even a single session of 288 (Najmi & Amir, 2010) or 160 trials (Wilson et al., 2006).

Secondly, the absence of any training-congruent effects on the interpretation of novel ambiguous material makes it difficult to determine whether the training-congruent effects observed for the DASS-21, OCI-R and DPSS-R were due to the effects of the CBM-I training or whether they simply reflect demand characteristics pertinent to the task. Indeed, the significant change in the Checking and Hoarding subscales of the OCI-R are unusual and run counter to what would be predicted if disgust-based CBM-I training affected the symptoms most closely related to disgust (i.e., the Washing subscale). Although CBM-I researchers propose a number of reasons why CBM-I for anxiety is relatively impervious to demand characteristics (MacLeod & Mathews, 2011), relatively few CBM-I studies have used physiological measures to corroborate self-report findings, and it remains unknown whether CBM-I for disgust holds the same proposed resistance to demand effects.

It is also possible that changes from pre- to post- training on the DASS-21 and OCI-R over such a short period of time (five days on average) may simply reflect changes in the perception or recollection of clinical symptoms, rather than the clinical

symptoms themselves. Alternatively, it is possible that the training-congruent changes in self-reported responses may reflect a training-induced change in processing style influencing decision-making processes that underpin responses to questionnaire items. As MacLeod, Koster and Elaine (2009) note, these possibilities are not restricted to CBM training, and many studies of more conventional cognitive behaviour therapy-based interventions have relied exclusively on self-report measures of symptom and emotional change. However, these findings do demonstrate an important point for the status of CBM research, and one that coincides with an issue raised by MacLeod and Mathews (2011) highlighting the need for CBM effects to be more fully evaluated using objective measures beyond self-report. In light of evidence suggesting that disgust responses may be especially difficult to alter, further research using lengthier and multiple CBM-I training sessions is needed to clarify the utility of CBM-I training for modifying disgust.

To conclude, in the current study, the use of a single session of CBM-I training was found to produce relatively few training-congruent effects on disgust responding, with the only significant effects being observed in the self-report of disgust propensity, negative affect and OC symptoms, with changes in disgust propensity being driven largely by changes in negative affect. These findings suggest that CBM-I may not be effective in modifying disgust responses. However, while there are theoretical grounds to support this (such as the resistance of disgust to extinction and cognitive challenge), future research using more extensive and numerous CBM-I training sessions are needed to reach firm conclusions. These findings also have implications for CBM-I research more broadly. That is, had I adopted an approach that solely used self-report, I may have concluded that disgust-based CBM-I training was effective in producing training-congruent effects in negative affect. However, the absence of training-congruent

changes in behavioural and psychophysiological data in conjunction with an absence of training-congruent effects on the interpretation of novel ambiguous material, suggests that changes in negative affect may be at least partially attributable to demand characteristics. This highlights the need for future CBM-I studies to supplement self-report measures with other objective measures of emotional change.

Chapter 7

GENERAL DISCUSSION

Despite growing enquiry into the potential role of disgust in moral judgment, relatively little attention has been directed towards evaluating the specificity of this link. Prior to commencing this thesis, the studies that had been completed in this literature failed to include other candidate moral emotions such as anger, failed to compare necessary negative non-moral control stimuli, and used measurement techniques that were limited in their capacity to disentangle expressions of disgust from anger. Evidence of a unique link between physical disgust and morality in non-clinical individuals would support the claim that moral disgust is a biologically expanded form of physical disgust. This has important implications for our understanding of moral behaviour, as it implies that our moral judgments may be predominantly based on early affective processes as opposed to more recently evolved higher order cognitive functions. Therefore, the current program of research provided a more rigorous evaluation of the role of disgust in morality.

There has also been a paucity of research in the clinical literature that examines the association between disgust and the moral rigidity observed in OCD. Evidence that heightened physical disgust is related to moral rigidity in the context of OCD - a disorder with established biological underpinnings - would provide further support for the theory that moral disgust represents an expansion of physical disgust into the moral

domain. Therefore, the current program of research also provided an initial investigation into the link between heightened physical disgust and moral rigidity in OCD.

Finally, despite the growing popularity of CBM-I techniques for modifying fear responses, no studies had examined whether CBM-I training is also effective in modifying disgust. With evidence indicating that heightened disgust responses are present in a number of psychiatric disorders (Olatunji, Cisler, McKay, & Phillips, 2010; Olatunji & McKay, 2009; Olatunji, Unoka, Beran, David, & Armstrong, 2009; Teachman, 2006), are more resistant to exposure-based treatments (Mason & Richardson, 2012), and are difficult to change via direct cognitive challenge (McNally, 2002), there is a clear need to highlight novel adjuncts to treatment that specifically target disgust. Accordingly, this thesis also provided an initial investigation into the application of CBM-I to disgust.

Outline of discussion

The first section of this chapter will provide a summary of the key findings presented in Chapters 2, 3 and 4, which address the first aim of evaluating the specificity of the link between physical disgust and morality. A conceptual consideration of how these findings contribute to the existing literature will then be provided, along with the implications of these findings for theoretical models of moral disgust. The second section will provide a brief overview of the findings presented in Chapters 5 and 6, which address the second aim of evaluating the effectiveness of a novel CBM-I paradigm for modifying disgust responses. These findings will also be discussed in the context of the broader CBM literature.

The third section of this chapter will provide an acknowledgement of the limitations associated with each of the studies and a discussion of how future research may overcome these limitations. This chapter will conclude with some discussion of the particular strengths in this program of research, and will propose ways in which future research may build on and extend the issues raised in this thesis.

Summary of Chapters 2, 3 and 4

The study outlined in Chapter 2 was the first to compare the effects of disgust and anger on physiological responses to moral transgressions using facial EMG. It was also the first to examine the effects of individual variations in trait disgust and trait anger on responses to moral transgressions. The results revealed several important findings that are indicative of a stronger relationship between physical disgust and moral transgressions than between anger and moral transgressions. Firstly, inducing disgust, but not inducing anger, increased physiological responses to moral transgressions. Secondly, elevated responses to moral transgressions in those who underwent a disgust induction involved activation of the *levator labii* muscle, which is the central muscle implicated in facial expressions of disgust. Thirdly, trait disgust but not trait anger was associated with increased *levator labii* muscle activity in response to moral transgressions in those who underwent a neutral mood induction. These findings suggest that state, trait and physiological indices of disgust are more closely associated with morality than state, trait or physiological indices of anger.

Several studies have since expanded upon these findings. Many of these align with the findings presented in Chapter 2 in showing that disgust enhances responses to moral transgressions. However, they also extend these findings by showing that disgust

and anger may both impact on and be elicited by discrete classes of moral transgressions. The burgeoning literature on moral disgust has led to an additional 48 studies published on the topic since beginning this program of research. Two of these studies have also compared the effects of induced anger to induced disgust on responses to moral transgressions. The first compared the effects of anger and disgust on judgments of permissibility in response to the same moral dilemma stimuli used in Chapter 4 (Ugazio et al., 2012). The authors predicted that anger would result in a greater number of permissibility judgments relative to disgust, given that anger is associated with an approach motivational tendency which primes a propensity to engage in action (Carver & Harmon-Jones, 2009), whereas disgust is a withdrawal-based emotion associated with a suspension of action (Rozin et al., 2008). Using two different methods to induce disgust (an odour and a disgust-eliciting film) and a separate method to induce anger (receiving critical feedback from a peer about an essay), Ugazio and colleagues (2012) showed that, as predicted, inducing anger resulted in more judgments of permissibility than inducing disgust. This was the case for both impersonal and personal moral dilemmas. These findings were interpreted as evidence that motivational tendencies predict the manner in which moral judgments will be influenced by emotions.

In the second study, Seidel and Prinz (2013) used a novel mood induction paradigm in which irritating and emetic sounds were used to induce anger and disgust. Although both emotions increased the severity of moral judgments, responses to different types of moral violations were affected to different degrees. Specifically, they found that harsh, irritating sounds enhanced the severity of judgments regarding violations of autonomy (e.g., threats of harm, injustice or violations of personal rights), whereas recorded sounds of a person vomiting amplified judgments of purity violations (i.e., violations of sanctity or natural order). The authors interpret these findings as

evidence of a causal relationship between disgust and purity violations, and anger and autonomy violations.

A number of other recent studies that use alternate methodologies lend further credence to this claim. Specifically, there are six new studies that have found greater self-reported anger towards violations of autonomy and greater self-reported disgust towards violations of purity (Giner-Sorolla, Bosson, Caswell, & Hettinger, 2012; Horberg et al., 2009; Russell & Giner-Sorolla, 2011a, 2011b, 2011c, 2013). One study has even further refined the classification of moral transgressions by showing that, compared to anger, disgust was a stronger mediator of responses to a specific class of autonomy violations known as interpersonal justice violations (i.e., being treated without dignity or respect by others; Skarlicki, Hoegg, Aquino, & Nadisic, 2013).

In addition to showing that anger and disgust map onto specific types of moral transgressions, two recent studies have also shown that disgust and anger impact on secondary cognitive and affective responses to moral transgressions in different ways. For example, Laurent, Clark, Walker and Wiseman (2013) found that although exposure to hypocrisy elicited a mix of anger and disgust, anger mediated the desire to punish whereas disgust mediated feelings of guilt. Similarly, Piazza, Russell and Sousa (2013) found that the amount of anger elicited by a moral transgression was positively correlated with the ability to generate mitigating circumstances in which the transgression would be considered allowable. Levels of disgust, in contrast, were not correlated with the ability to generate mitigating circumstances and remained consistent even when contextual information relevant to the moral transgression varied.

Taken together, the results of these studies suggest that disgust most prominently affects and is elicited by transgressions that involve violations of natural

order, sanctity or bodily purity. Anger in contrast, affects and is elicited by moral transgressions that violate individual rights or autonomy. Furthermore, there is preliminary evidence that feelings of disgust and anger that arise in the context of moral transgressions may be associated with distinct cognitions and appraisals that may impact on moral reasoning and behaviour. Anger may be associated with a greater tendency to generate mitigating circumstances, but also with a desire to gain retribution. Disgust, on the other hand, may be more impervious to circumstance or reasoning and may enhance feelings of guilt.

The studies presented in Chapters 3 and 4 built on those presented in Chapter 2 by examining the link between disgust and moral reasoning in the context of OCD. The research outlined in Chapter 3 first sought to confirm that individuals with OCD show evidence of heightened disgust responses compared to individuals without the disorder. It extended prior work in two important ways: firstly, by examining disgust responses to specific categories of disgust elicitors; and secondly, by including sensitive physiological indices of disgust in addition to self-report. The results showed that a heterogeneous sample of individuals with OCD displayed evidence of subjective disgust responses (at the trait level and in response to core disgust elicitors in particular) that were heightened beyond those of non-clinical individuals and those with other non-OCD anxiety disorders. Furthermore, the presence of maladaptive obsessive beliefs predicted heightened physiological disgust responding to non-disgusting stimuli, which indicates that obsessive beliefs may be implicated in pathological disgust responding.

These findings coincide with prior work showing that heightened levels of trait disgust are associated with increased OC symptomatology (Berle et al., 2012; Cisler et al., 2010; Cisler et al., 2008; Mancini et al., 2001; Muris et al., 2000; Olatunji, 2010; Olatunji, Cisler, et al., 2007; Olatunji et al., 2004; Schienle, Stark, et al., 2003; Thorpe

et al., 2003; Tolin et al., 2006) as well as greater behavioural avoidance (Deacon & Olatunji, 2007; Olatunji, Lohr, et al., 2007; Tsao & McKay, 2004). The difference in disgust responding observed between the OCD and clinical control group also aligns with prior research showing that the relationship between OC symptomatology and disgust sensitivity remains after controlling for negative affect (Mancini et al., 2001; Olatunji, Ebesutani, et al., 2011). Furthermore, the finding that maladaptive obsessive beliefs were associated with increased physiological responding to non-disgusting stimuli in the OCD group provides further support for the notion that maladaptive beliefs may be implicated in pathological disgust symptoms (Myers et al., 2008; Tolin et al., 2008; Tolin et al., 2006). Taken together, these findings provide further evidence that individuals with OCD experience stronger disgust compared to individuals without the disorder and, importantly, individuals with other non-OCD anxiety disorders.

The study presented in Chapter 4 also showed that individuals with OCD demonstrated use of more rigid moral reasoning strategies in response to moral dilemmas that elicit the use of more flexible, outcome-driven moral reasoning strategies in non-clinical individuals. This greater use of rigid moral reasoning strategies in the OCD group was associated with reduced cognitive flexibility. That individuals with OCD should show heightened physical disgust responses as well as more rigid moral reasoning strategies, indicates a possible association between the two. Indeed, the rationale underpinning the research outlined in Chapter 4 has been reiterated in a recent commentary (Vicario, 2013) of Harrison and colleagues' study (2012). Vicario (2013) notes that the heightened moral sensitivity observed in the OCD group in Harrison et al.'s (2012) study might reflect enhanced disgust for immoral outcomes. Further, Vicario goes on to state that heightened moral sensitivity in individuals with OCD may

be grounded in the same neural mechanisms underpinning their altered sensitivity to physical disgust.

However, an unusual finding was observed in Chapter 4 when examining the correlation between trait disgust and moral reasoning. Here, higher scores on measures of trait disgust sensitivity and propensity were associated with increased moral rigidity in response to low-conflict (i.e., impersonal) moral dilemmas in the anxious control group. However, in contrast, these scores were associated with decreased moral rigidity in response to high-conflict (i.e., personal) moral dilemmas in the OCD group. The relationship between trait disgust and moral rigidity in the anxious control group was as predicted, as higher trait disgust should enhance avoidance behaviour and thus make it less likely that the participant will choose the utilitarian action when the action required is aversive. However, the relationship between trait disgust and moral reasoning in the OCD group runs counter to what would be expected, where those with higher trait disgust showed a greater tendency to perform an aversive act to achieve the greatest outcome.

The findings presented in Chapter 4 are difficult to interpret within the broader litertature, as there is a paucity of research in this area. The positive correlation between trait disgust and moral rigidity observed in the anxious control group aligns with the findings of Ugazio and colleagues (2012), who, as mentioned earlier in this chapter, showed that disgust resulted in decreased permissibility judgments in response to personal moral dilemmas. However, the relationship observed in the OCD group is at odds with this work. It should be noted that Ugazio and colleagues (2012) only measured the effects of induced disgust, which as observed in Chapter 2, tends to obscure the effects of trait disgust (the measure used in Chapter 4). As such, the findings may not be directly comparable. Only one study to date reports findings that

coincide with the findings observed for the OCD group in Chapter 4, where nausea (which could be taken as a proxy measurement of disgust) was also associated with increased permissibility judgments for personal moral dilemmas.

One explanation for the unusual relationship found between trait disgust and moral rigidity in the OCD group is that heightened trait disgust may interact with other features of the disorder to produce this relationship. For example, with the exception of safety behaviours, individuals with non-OCD anxiety disorders demonstrate behaviour indicative of avoidance (American Psychiatric Association, 2000). Although individuals with OCD also demonstrate avoidance behaviour, the disorder is characterised a compulsive urge to act in order to rectify the situation or prevent an adverse outcome (American Psychiatric Association, 2000). Therefore, if heightened disgust increases negative emotional responses to high-conflict moral dilemmas, this may elicit a compulsion in individuals with OCD to act in order to produce the best outcome. In individuals with non-OCD anxiety disorders, heightened trait disgust may have the reverse effect of enhancing a prepotent tendency to respond with passive avoidance. This explanation is, however, purely speculative. These findings must be replicated in order to reach firm conclusions about the relationship between trait disgust and moral reasoning in individuals with OCD.

Implications for theoretical models of moral disgust

Together with the findings of the recent studies mentioned above, the results outlined in Chapters 2, 3 and 4 have numerous implications for theoretical models of moral disgust. To recap, some theorists argue that moral disgust may represent a compelling example of exaptation (Chapman & Anderson, 2013; Rozin et al., 2008),

where a trait expands to adopt another function but its root form remains unchanged (Bock, 1959; Mayr & Tax, 1960). In contrast, other theorists propose that disgust expressed in a moral context is merely metaphorical and is used either to draw similarities with things that are prototypically offensive, or simply to convey a response more akin to anger (Bloom, 2004; Nabi, 2002). The stronger relationship between physical disgust and moral transgressions (at the state, trait and physiological level) observed in Chapter 2, along with the co-occurring abnormalities in disgust responding and moral reasoning in the OCD participants found in Chapters 3 and 4, align more closely with the exaptation theory of moral disgust. Thus, these data suggest that disgust expressed in the context of moral transgressions is more closely related to physical disgust, and is not simply a metaphor for anger. Furthermore, in light of recent studies showing that anger and disgust are associated with discrete classes of moral transgressions, it seems likely that disgust expressed in response to specific types of moral transgressions represents an example of exaptation. Specifically, transgressions that involve violations of purity/divinity may elicit a response akin to physical disgust that has evolved to serve the function of policing social norms related to natural order and sanctity. Transgressions that involve violations of justice or autonomy may thus elicit responses more akin to anger, which may serve the alternate function of counteracting direct threats to one's individual rights.

That these two emotions are related to specific classes of moral transgression fits with a biological theory of moral emotions. For example, an examination of the purity/divinity violations used in prior research reveals that such violations have the tendency to be abstract (e.g., taboos) and commonly involve a third party that is separate from the self (e.g., an animal or vulnerable other). In such cases it may be more biologically adaptive to withdraw from the transgressor to prevent oneself from

becoming affected. Feelings of disgust experienced in response to such violations may also activate cognitive components of the disgust response, such as the perceived threat of contagion. This may explain why the mere concept of being associated with someone who commits sanctity violations causes disgust (Rozin, Markwith, et al., 1994), as there is the perception that their depravity may in some way be transmitted via close contact or association. On the other hand, autonomy violations are often directed against a specific person, commonly the self, and frequently involve obstruction of an individual's goals (e.g., theft or harm). It may therefore be more biologically adaptive to respond with anger in such situations, as anger is associated with an approach motivational tendency and so may produce behaviour more effective in counteracting the actions of the transgressor.

Implications for the study of moral disgust

Beyond theoretical models, the studies in Chapters 2 and 4 also raise important issues regarding the design of future experimental investigations into moral disgust. Firstly, the inclusion of negative non-moral control stimuli outlined in Chapter 2 demonstrated that, although responses to moral transgressions increased after disgust was induced, responses to negative stimuli also increased more generally. This indicates that part of the effect of disgust on moral transgressions may be a result of its ability to amplify responses to negative stimuli. Without appropriate negative control stimuli, future research examining the impact of disgust on responses to moral transgressions may be limited in its ability to infer that disgust has a unique impact on moral transgressions, as induced disgust may increase sensitivity to negative stimuli more generally.

Secondly, the finding that trait levels of disgust had an opposing impact on moral reasoning in individuals with OCD relative to individuals with other non-OCD anxiety disorders raises the possibility that disgust interacts in distinct and possibly opposing ways with characteristics of certain disorders, even when such disorders share the characteristic of heightened anxiety. This specificity points to the need to include other clinical control samples when examining the impact of disgust on facets of certain psychological disorders. That is, had I only examined the relationship between trait disgust and moral reasoning in the non-clinical and OCD sample, I might have concluded that disgust has the opposite effect on moral reasoning in clinical disorders, relative to non-clinical individuals. However, this deduction would have been incorrect; disgust, in fact, had the same effect in non-clinical and anxious individuals but the opposite effect in the OCD sample.

Summary of Chapters 5 and 6

In addition to showing that individuals with OCD show disgust responses that are elevated beyond those of non-clinical and anxious control groups, Chapter 3 revealed that the presence of maladaptive obsessive beliefs predicted increased disgust responses in individuals with OCD, particularly towards ambiguous or non-disgusting stimuli. This gave rise to the possibility that modifying such beliefs would, in turn, reduce disgust responses in those with the disorder. In light of evidence demonstrating the effectiveness of CBM-I for reducing symptoms of anxiety, and the success of a recent application of this procedure to the modification of intrusive thoughts in individuals high in OC symptoms (Clerkin & Teachman, 2011), Chapter 5 examined the effectiveness of a CBM-I program targeting maladaptive obsessive beliefs for

modifying disgust-based symptoms in an OCD sample. Using CBM-I training to activate more positive beliefs resulted in significant reductions in autonomic arousal in response to contamination stimuli. However, there were no effects of CBM-I training on the interpretation of novel ambiguous material or on self-report measures of disgust.

The finding that positive training reduced negative affect in response to OC-relevant stressor stimuli, as outlined in Chapter 5, is comparable to that of Clerkin and Teachman (2011). However, the results overall reveal more discrepancies with Clerkin and Teachman, as well as other CBM-I studies. CBM-I training did not produce changes in the interpretation of novel ambiguous material or self-reported indices of emotional responding.

The precise impact of CBM-I training on disgust responses in the OCD sample is difficult to discern, as CBM-I training accuracy scores in this group were highly variable with some individuals scoring well below typical scores in the training phase for other CBM-I studies. This difficulty with the positive CBM-I training may be indicative of the degree to which positive training items ran counter to participants' original maladaptive beliefs. Poor performance on positive CBM-I training may also be partly attributable to the poor cognitive flexibility known to be associated with the disorder. Therefore, it is possible that multiple sessions of CBM-I training may be needed to achieve the same training effects observed in samples that are not typically characterised by cognitive rigidity. Nevertheless, the difficulty of demonstrating CBM-I effects in individuals with OCD made it difficult to determine whether the absence of CBM-I effects on disgust responses was because CBM-I training is ineffective in modifying disgust, or whether individuals with OCD simply have greater difficulty engaging in CBM-I training. Therefore, to more fully test the ability of CBM-I to

modify disgust responses, the study presented in Chapter 6 examined the effects of CBM-I training on disgust responses in a non-clinical sample.

The methodology outlined in Chapter 6 built on the methodology used in Chapter 5's study in a number of important ways. Firstly, participants were randomised to either a disgust-based or a benign CBM-I training condition so that the effects of engaging in the CBM-I task could be controlled for. Secondly, the CBM-I training aimed to directly manipulate disgust-relevant appraisals, which may be more closely tied to disgust responses than obsessive beliefs. Thirdly, mood was measured immediately prior to and following the CBM-I training to rule out the possibility that any effects of CBM-I training were simply the result of CBM-I training inducing a training-congruent change in mood. Fourthly, the effects of CBM-I training on specific forms of psychopathology and trait emotionality were assessed. Finally, a series of disgust-eliciting behavioural avoidance tasks were included to examine the effects of CBM-I training on pathogen avoidance behaviour. These methodological refinements rendered the study a rigorous empirical test not only of the effectiveness of CBM-I in modifying disgust responses and associated symptomatology, but also of the degree to which disgust-based interpretation biases impact on the intensity of disgust responding.

Compared to participants in the control CBM-I training condition, those who received the disgust-based CBM-I training showed significant increases in self-reported depression, anxiety, stress, disgust propensity and obsessive-compulsive symptoms. However, group differences in post-training disgust propensity and OC symptoms did not remain significant after controlling for changes in stress or anxiety, suggesting that CBM-I training exerted its effects on disgust propensity and OC symptoms primarily via its effects on general negative affect. Furthermore, unlike previous CBM-I studies, CBM-I training did not significantly alter interpretations of novel ambiguous material,

behavioural avoidance of disgust-elicitors, or physiological disgust responses. This finding indicates that the effects of CBM-I training on negative affect are partly attributable to demand characteristics.

Theoretical implications

CBM-I training paradigms are useful for two purposes. Firstly, they serve a therapeutic purpose by offering a relatively low-cost, user-friendly method through which elevated emotional responses can be reduced. Secondly, they constitute an elegant way of determining the causal relationship between interpretive biases and emotional responding. Although numerous studies have now applied CBM-I to anxiety in non-clinical, analogue and clinical samples, the studies outlined in Chapters 5 and 6 represent an important first step in investigating the application of CBM-I training to disgust responses.

In the context of prior CBM-I research, the current findings may be interpreted in one of two ways. The first option is that they indicate that CBM-I training is not effective for modifying disgust symptoms in the same way as it has been shown to be in modifying anxious symptoms. If this were the case, it would offer further support to the theory that disgust responses are acquired and maintained in a different manner from anxious and fear-based responses, and are less influenced by cognitive biases than are fear responses. Indeed, this explanation aligns with the findings of recent studies that have shown that disgust responses are not particularly influenced by mitigating circumstances (Piazza et al., 2013; Russell & Giner-Sorolla, 2011a) or cognitive elaboration (Russell & Giner-Sorolla, 2011c), indicating that they may operate more independently from cognitive processes than fear responses do. However, research

showing that disgust is associated with negative interpretive biases (Davey et al., 2006) indicates that cognitive biases do have some role in disgust responding. A more likely explanation for the current findings is that training may have been too brief, or that the cognitive mechanisms targeted in the CBM-I training paradigms were not amenable to modification using CBM-I training.

In addition to being the first to investigate the applicability of CBM-I training to disgust, the studies of Chapter 5 and 6 also highlight an important point that may shape the way that CBM-I programs are evaluated in the future. These studies demonstrate the importance of including measures beyond self-reported symptoms in evaluating the effectiveness of CBM-I training. In particular, had the study in Chapter 6 adopted the conventional CBM-I design of evaluating training effects by measuring interpretation bias and self-reported symptoms only, it might be concluded that CBM-I training was reasonably effective in reducing disgust-based symptoms. However, the lack of CBM-I effects observed on tests of behavioural avoidance and physiology, *in conjunction* with an absence of CBM-I effects on the interpretation of novel material, indicates either that the training effects observed on self-report measures may be partially attributable to demand characteristics, or that CBM-I training was not effective in modifying behavioural responding.

Limitations

Some limitations must be kept in mind when interpreting the findings outlined in the current thesis. However, it should be noted that many of the limitations described here apply to many studies that have been published in the past few years and represent a significant challenge for disgust research generally.

Defining moral transgressions

As is evident from the discussion of recent research into the effects of anger and disgust on moral transgressions, there is considerable variation in how researchers operationalise moral judgment and what they constitute to be a moral transgression. This also applies to the current research. In this thesis, two forms of moral stimuli were used. The study in Chapter 2 used a set of static image stimuli depicting a blend of moral transgressions. These stimuli are used to assess emotional responses to visual stimuli containing a scene that unambiguously depicts an immoral act. In contrast, the study in Chapter 4 used a set of moral dilemmas to assess moral reasoning. These stimuli require the participant to formulate permissibility judgments about a written scenario in which one of two negative outcomes will occur depending on their decision. In light of the rapidly expanding literature on moral disgust, it seems prudent that a set of standardised stimuli tapping different facets of moral judgment be developed so that the findings of this growing pool of studies, and those of the current program of research, can be directly compared.

Sample size

Due to difficulty recruiting clinical participants, particularly an anxious control group with a non-OCD anxiety disorder but no subclinical OCD symptoms, the sample sizes in the clinical studies outlined in Chapters 3 to 5 led to lower than optimal statistical power. These samples were occasionally reduced further in analyses of physiological data after some participants' data was discarded due to excessive movement artefacts. This issue may have obscured meaningful group differences in physiological disgust responding between the three groups in the study in Chapter 3, as well as the changes from pre- to post-CBM training in the study in Chapter 5. Using

facial electrodes on clinical samples, particularly those who suffer from concerns relating to contamination, is an inherently difficult task. Participants may have difficulty maintaining a posture that is still and relaxed enough to capture natural spontaneous facial affect. Indeed, these studies represent the first application of facial EMG to individuals with OCD. Future studies using physiological measures of emotional responding in clinical samples should therefore seek to recruit a larger pool of participants in order to allow for the reductions in sample size necessary when recordings of participants have high numbers of movement artefacts.

The use of cross-sectional designs

Due to the use of cross-sectional designs in the current program of research, particularly in Chapter 3's examination of heightened disgust responses in individuals with OCD, conclusions regarding directionality require additional evaluation using longitudinal investigations. Specifically, Chapter 3 revealed that individuals with OCD show disgust responses that are heightened beyond those of individuals with anxiety as well as non-clinical individuals. In this thesis, as well as in the many other recent studies of disgust in psychopathology, it is assumed that heightened disgust responding is what causes disgust-based symptoms like contamination fear, washing symptoms (in OCD), and fear of spiders, snakes or blood (in specific phobias). However, it is possible that individuals with such disorders may originally have had normal disgust responses that were then amplified by co-occurring anxiety and avoidance behaviour. That is, just as neutralising and avoidance behaviour increases the frequency of intrusive thoughts in OCD, avoidance behaviour may exacerbate normative disgust responses to the point where they become pathological. Another possibility is that underlying negative beliefs, such as an overestimation of threat, may result in increased disgust responses and subsequent disgust-based symptoms. Longitudinal studies are

needed, therefore, to determine whether abnormally heightened disgust responding precedes avoidance behaviour or whether pre-existing beliefs about threat increase an individual's vulnerability to respond with the emotion of disgust, thus prompting disgust-based symptoms.

Strengths

Each of the studies included in this thesis also has a number of strengths that should be acknowledged.

The use of control samples and stimuli

Despite the large body of work examining the relationship between disgust and moral judgment, few studies have included negative non-moral comparison stimuli to rule out the possibility that disgust may increase negative responding more generally. The inclusion of a set of such stimuli in the study in Chapter 2 revealed that inducing disgust did indeed increase responding to negative non-moral stimuli, but increased responding to moral stimuli to a greater degree. The inclusion of negative non-moral control stimuli in this study therefore strengthens conclusions regarding the degree to which induced disgust influences responding to moral themes specifically.

Although a few studies have shown that individuals with OCD show elevated disgust responses relative to non-clinical samples, an anxious clinical control group is rarely included to control for the effects of an anxiety disorder on disgust responding. The inclusion of a non-OCD anxiety disorder group in the studies outlined in Chapters 3 and 4 allow us to infer that the fact that individuals with OCD evidenced use of more rigid moral reasoning strategies compared to non-clinical individuals may be partially

attributable to heightened anxiety, as they did not differ significantly from anxious control participants.

Use of facial EMG to measure emotion

The inclusion of facial EMG as a measure of emotional responding is a particular strength of several of the studies in this thesis. Although some researchers include heart rate as a measure of emotional responding in disgust research (P. J. Lang et al., 1993; Rohrmann & Hopp, 2008; Stark et al., 2005), electrocardiographic correlates of disgust are often inconsistent (Prkachin, Williams-Avery, Zwaal, & Mills, 1999; Vrana, 1993) and vary depending on the type of stimulus used (e.g., static images vs. guided imagery). Facial muscle activity associated with the disgust expression is therefore conceptualised as a more robust measure of disgust responses (Chapman et al., 2009; Vrana, 1993), and facial EMG represents one of the most sensitive measures by which to measure facial muscle activity (Tassinary & Cacioppo, 2000; van Boxtel, 2010). Therefore, the use of this highly sensitive physiological measure allowed for a much more fine-grained examination of disgust responses than is possible via the measurement of either self-report or heart rate.

Future extensions of this program of research

An important extension to this research would be to examine the *way* in which disgust impacts on moral behaviour, now that it is established than such an impact exists. The studies outlined in this thesis, as well as much of the prior research (with a few notable exceptions e.g., Chapman et al., 2009), have investigated the role of disgust in morality by having participants either passively respond to moral transgressions or indicate their preferred course of action in response to a hypothetical moral dilemma

from a limited number of pre-set options, However, it may be that the responses to these hypothetical moral dilemmas are substantively different to responses to real-world situations.

Naturalistic studies that measure disgust and anger responses in samples of individuals who have been exposed to real-world moral transgressions may provide further insights into how disgust impacts on behavioural responses to moral transgressions. Such research would also have clinical implications for our understanding of psychological disorders that are precipitated by trauma, such as post-traumatic stress disorder, grief and depression. Based on the findings outlined in Chapter 2 and the recent extensions of this research (Piazza et al., 2013; Russell & Giner-Sorolla, 2013; Ugazio et al., 2012), I would predict that individuals who have been exposed to moral transgressions that were committed against themselves and which violated their autonomy (e.g., physical abuse) would respond predominantly with anger and may possess a desire to gain retribution. However, as anger expressed in response to moral transgressions has been shown to be influenced by variations in contextual and intentionality information, and is a relatively reasoned and flexible emotion (Russell & Giner-Sorolla, 2011a, 2011c), these individuals may be amenable to cognitive restructuring. Conversely, I would predict that individuals who have experienced transgressions of bodily purity (e.g., sexual abuse) would respond primarily with disgust and may show the tendency to withdraw from the transgressor. Given that disgust in response to moral transgressions has been shown to be a relatively unreasoned emotion, is often justified tautologically, and is impervious to variations in contextual or intentionality information (Russell & Giner-Sorolla, 2011a, 2011c), such individuals may not respond optimally to cognitive restructuring, and as such, may require an alternate or more intensive approach to treatment.

Another possible extension of the research outlined in this thesis would be to design a CBM-I training paradigm that specifically targets secondary disgust appraisals. Unlike primary disgust appraisals, which involve making an evaluation of a stimulus as being disgust or not, secondary disgust appraisals involve concern about the ability to cope with one's own physiological disgust reactions (Teachman, 2006). Secondary disgust appraisals may be more easily modified as they revolve around a subjective evaluation of coping ability, rather than the more objective evaluation of a stimulus. Therefore, it may be more effective to target interpretations of the physiological experiences associated with disgust.

Such a paradigm could draw on aspects of Clark's (1986) cognitive model of panic, which posits that panic attacks arise from a catastrophic misinterpretation of normal physiological sensations. These sensations are often those that accompany anxiety, including an increased heart rate, sweating and breathlessness. In individuals with panic disorder, these normally occurring sensations are misinterpreted as signs that something is seriously wrong (e.g., that a fast-beating heart signals an impending heart attack). In an attempt to prevent future panic attacks, the individual then avoids activities or places that bring on such sensations – a coping mechanism that can cause marked disruption to day-to-day life. Cognitive approaches to the treatment of panic therefore target these misinterpretations. In doing so, such approaches do not remove the sensation, but simply modify the individual's tendency to misinterpret them as dangerous.

Future CBM-I research could adapt this model to disgust by using CBM-I to train more positive interpretations of the physiological sensations of disgust. This may include modifying the tendency to interpret sensations like nausea or unpleasant smells, tastes or textures as aversive or threatening. Although this would not affect the degree

to which an individual perceives something as disgusting, it may decrease the degree to which they perceive the experience of disgust to be aversive. This may in turn lead to reductions in disgust-based symptoms as well as behavioural avoidance.

Concluding remarks

Our understanding of the function of disgust, particularly as a moral concept, is still severely limited. The present thesis builds on the existing literature through the use of methodological strengths, such as the inclusion of appropriate comparison stimuli, clinical control groups and psychophysiological indices of emotion. These methodological improvements provide a substantial contribution to our understanding of the uniqueness of the association between disgust and morality in non-clinical individuals and in individuals with OCD. In this thesis, physical disgust was shown to have a stronger relationship with moral transgressions than anger, at the state, trait and physiological level of emotional responding. Disgust also had an inverse relationship with moral rigidity in individuals with OCD relative to individuals with other anxiety disorders. These findings have direct implications for theoretical models of moral disgust, as they support the view that moral disgust is an exapted form of physical disgust, rather than merely a metaphorical reference to anger. Furthermore, the current thesis provides the first investigation into the application of CBM-I to disgust and its use as an adjunct to treatment of disgust-based psychological disorders. Given disgust's demonstrated resistance to existing treatments, these findings represent an important first step towards identifying alternative therapies.

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Appendix A

CONSENT FORMS

THE UNIVERSITY OF NEW SOUTH WALES

Chapter 2

Approval No. 80792

THE UNIVERSITY OF NEW SOUTH WALES

PARTICIPANT INFORMATION STATEMENT

The role of emotion in moral judgment

Participant Selection and Purpose of Study

You are invited to participate in a study of moral judgment. We hope to learn how individual differences in emotional sensitivity can lead to related differences in the severity of people's moral judgments. You were selected as a possible participant in this study because you signed up to complete the experiment on Experimetrix.

Description of Study and Risks

If you decide to participate, we will ask you to complete various tasks that measure levels of emotional sensitivity, emotion recognition, intensity of facial expressions, as well as moral judgment. You will also be asked to either watch a video clip, or play an interactive game with another participant via webcam, whilst having your facial sweat gland activity measured using small, adhesive facial electrodes. This study also requires that you are video-recorded, however, you will be verbally asked whether you are happy to be video-recorded and if you decline, you will incur no penalty and your decision will not affect your relationship with the university. It is anticipated that involvement in this study may cause some slight but temporary elevation in levels of emotionality during the video clip and interactive webcam game, however it is not anticipated that this will cause any lasting discomfort or inconvenience. The entire study should take approximately 2 hours in total.

There are no possible risks or benefits that can reasonably be expected to arise as a result of participation in this study.

Confidentiality and Disclosure of Information

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or except as required by law. If you give us your permission by signing this document, we plan to publish the results. In any publication, information will be provided in such a way that you cannot be identified.

Recompense to participants

You will receive a total of 2 course credits for 2 hours participation.

Your consent

Your decision whether or not to participate will not prejudice your future relations with The University of New South Wales. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without prejudice.

Inquiries

If you have any questions or concerns following your participation, Alexis Whitton (0433 687 191) or Dr. Julie Henry (9385 3936) will be happy to address them. Complaints may be directed to the Ethics Secretariat, The University of New South Wales, SYDNEY 2052 AUSTRALIA (phone 9385 4234, fax 9385 6648, email ethics.sec@unsw.edu.au).

Please keep this information sheet and one copy of the Participant Consent Form. The investigator will keep the other signed copy. Both copies should be signed by you and the investigator

Approval No. 80792

THE UNIVERSITY OF NEW SOUTH WALES

PARTICIPANT CONSENT FORM

The role of emotion in moral judgment

You are making a decision whether or not to participate. Your signature indicates that, having read the information provided on the participant information sheet, you have decided to participate.

……	**…….**
Signature of Research Participant (when relevant)	Signature of Parent or Guardian
……	**…….**
(Please PRINT name)	(Please PRINT name)

……
Date

……
Signature(s) of Investigator(s)

…….
Please PRINT Name

REVOCATION OF CONSENT

The role of emotion in moral judgment

I hereby **WITHDRAW** my consent to participate in the research proposal described above and direct that any data collected from me be destroyed.

I understand that such withdrawal **WILL NOT** jeopardise any treatment or my relationship with The University of New South Wales.

……	**…….**
Signature	Date

……
Please PRINT Name

The section for Revocation of Consent should be forwarded to Alexis Whitton, School of Psychology, University of New South Wales, Sydney 2052.

THE UNIVERSITY OF NEW SOUTH WALES

Chapters 3, 4 & 5

Approval No. 1422

THE UNIVERSITY OF NEW SOUTH WALES

PARTICIPANT INFORMATION STATEMENT

Why do we make decisions the way we do?

Participant Selection and Purpose of Study

You are invited to participate in a study of decision making. We hope to learn which variables predict differences in decision-making across a range of different contexts. You were selected as a possible participant in this study because you expressed interest through an advertisement, or gave your consent to be contacted in relation to future studies at UNSW.

Description of Study and Risks

If you decide to participate, we will ask you to complete various tasks that measure levels of emotional sensitivity, emotion recognition, intensity of facial expressions, as well as decision-making. You will also be asked to watch a video clip whilst having your facial sweat gland activity measured using small, adhesive facial sensors. This study also requires that you are video-recorded. However, you will be verbally asked whether you are happy to be video-recorded and if you decline, you will incur no penalty and your decision will not affect your relationship with the university. It is anticipated that involvement in this study may cause some slight but temporary elevation in levels of emotionality, however it is not anticipated that this will cause any lasting discomfort or inconvenience. You have the option of completing this study over one extended session, or two shorter sessions.

There are no possible risks or benefits that can reasonably be expected to arise as a result of participation in this study.

Confidentiality and Disclosure of Information

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or except as required by law. If you give us your permission by signing this document, we plan to publish the results. In any publication, information will be provided in such a way that you cannot be identified.

Recompense to participants

You will be reimbursed $15 per hour for participating in this study.

Your consent

Your decision whether or not to participate will not prejudice your future relations with The University of New South Wales. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without prejudice.

Inquiries

If you have any questions or concerns following your participation, Alexis Whitton (0433 687 191), Dr. Julie Henry (9385 3936) or Dr. Jessica Grisham (9385 3031) will be happy to address them.

Complaints may be directed to the Ethics Secretariat, The University of New South Wales, SYDNEY 2052 AUSTRALIA (phone 9385 4234, fax 9385 6648, email ethics.sec@unsw.edu.au).

Please keep this information sheet and one copy of the Participant Consent Form. The investigator will keep the other signed copy. Both copies should be signed by you and the investigator

Approval No 1422

THE UNIVERSITY OF NEW SOUTH WALES

PARTICIPANT CONSENT FORM

Why do we make decisions the way we do?

You are making a decision whether or not to participate. Your signature indicates that, having read the information provided on the participant information sheet, you have decided to participate.

……	**…….**
Signature of Research Participant (when relevant)	Signature of Parent or Guardian
……	**…….**
(Please PRINT name)	(Please PRINT name)

……
Date

……
Signature(s) of Investigator(s)

……
Please PRINT Name

REVOCATION OF CONSENT

Why do we make decisions the way we do?

I hereby **WITHDRAW** my consent to participate in the research proposal described above and direct that any data collected from me be destroyed.

I understand that such withdrawal **WILL NOT** jeopardise any treatment or my relationship with The University of New South Wales.

……	**…….**
Signature	Date

……
Please PRINT Name

The section for Revocation of Consent should be forwarded to Alexis Whitton, School of Psychology, University of New South Wales, Sydney 2052.

THE UNIVERSITY OF NEW SOUTH WALES

Chapter 6

Approval No 1646

THE UNIVERSITY OF NEW SOUTH WALES

PARTICIPANT INFORMATION STATEMENT

Examining the link between thoughts and emotions

Participant Selection and Purpose of Study

You are invited to participate in a study of thoughts and emotions. We hope to learn how thoughts influence the intensity of our emotional experiences. You were selected as a possible participant in this study because you expressed interest through an advertisement.

Description of Study and Risks

If you decide to participate, we will ask you to complete various tasks that measure levels of emotional sensitivity and intensity of facial expressions, as well as a computerized comprehension task. You will also be asked to view a series of images whilst having your facial sweat gland activity measured using small, adhesive facial sensors. This study also requires that you are video-recorded, however, you will be verbally asked whether you are happy to be video-recorded and if you decline, you will incur no penalty and your decision will not affect your relationship with the university. It is anticipated that involvement in this study may cause some slight but temporary elevation in levels of emotionality, however it is not anticipated that this will cause any lasting discomfort or inconvenience. The entire study should take approximately 1-1.5 hours in total. There are no possible risks or benefits that can reasonably be expected to arise as a result of participation in this study.

Confidentiality and Disclosure of Information

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or except as required by law. If you give us your permission by signing this document, we plan to publish the results in a scientific journal. In any publication, information will be provided in such a way that you cannot be identified.

Recompense to participants

You will be reimbursed $30 for participating in this study.

Your consent

Your decision whether or not to participate will not prejudice your future relations with The University of New South Wales. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without prejudice.

Inquiries

If you have any questions or concerns following your participation, Alexis Whitton (0433 687 191) or Dr. Jessica Grisham (9385 3031) will be happy to address them.

Complaints may be directed to the Ethics Secretariat, The University of New South Wales, SYDNEY 2052 AUSTRALIA (phone 9385 4234, fax 9385 6648, email ethics.sec@unsw.edu.au). Please keep this information sheet and one copy of the Participant Consent Form. The investigator will keep the other signed copy. Both copies should be signed by you and the investigator

Approval No 1646

THE UNIVERSITY OF NEW SOUTH WALES

PARTICIPANT CONSENT FORM

Examining the link between thoughts and emotions

You are making a decision whether or not to participate. Your signature indicates that, having read the information provided on the participant information sheet, you have decided to participate.

……	**…….**
Signature of Research Participant (when relevant)	Signature of Parent or Guardian
……	**…….**
(Please PRINT name)	(Please PRINT name)

……
Date

……
Signature(s) of Investigator(s)

……
Please PRINT Name

REVOCATION OF CONSENT

Examining the link between thoughts and emotions

I hereby **WITHDRAW** my consent to participate in the research proposal described above and direct that any data collected from me be destroyed.

I understand that such withdrawal **WILL NOT** jeopardise any treatment or my relationship with The University of New South Wales.

……	**…….**
Signature	Date

……
Please PRINT Name

The section for Revocation of Consent should be forwarded to Alexis Whitton, School of Psychology, University of New South Wales, Sydney 2052.

Appendix B

STATISTICAL SUMMARIES

Chapter 2

Mixed factorial repeated measures ANOVA with induction condition as the between subjects factor (disgust, anger, no emotion) and image as the within subjects variable dilemma (moral, negative, neutral), with change in facial EMG activity from baseline as the dependent variable.

1. Change in *corrugator* activity from baseline

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Induction condition	2, 84	1294.97	1.96	.15	.05

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Image	2, 168	2208.90	14.94	<.001	.15
Image*Induction condition	4, 168	415.24	2.81	.03	.06

2. Change in *levator* activity from baseline

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Induction condition	2, 84	784.87	3.76	.03	.08

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Image	2, 168	409.79	8.43	<.001	.09
Image*Induction condition	4, 168	200.09	4.12	.003	.09

Chapter 3

Univariate ANOVA with group as the between subjects factor (OCD, anxious, control) and indices of trait disgust as the dependent measure.

1. **Disgust Sensitivity subscale of the DPSS-R**

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Group	2, 68	75.66	3.23	.046	.09

2. **Disgust Propensity subscale of the DPSS-R**

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Group	2, 68	82.09	5.02	.01	.13

3. **Total DPSS-R Score**

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Group	2, 68	255.94	4.22	.02	.11

4. **Disgust Scale-Revised**

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Group	2, 68	1438.99	4.94	.01	.13

Mixed factorial repeated measures ANOVA with group as the between subjects factor (OCD, anxious, control) and image as the within subjects variable image (body waste, contamination, mutilation, neutral, negative) with disgust responses as the dependent variable.

1. **Self-report ratings of disgust**

Tests of between subjects effects

	df	M^2	***F***	***p***	η_p^2
Group	2, 68	14.62	3.63	.03	.10

Tests of within subjects effects

	df	M^2	***F***	***p***	η_p^2
Image	5, 340	262.99	198.41	<.001	.75
Image* Group	10, 340	5.33	4.02	<.001	.11

2. ***Corrugator*** **activity**

Tests of between subjects effects

	df	M^2	***F***	***p***	η_p^2
Group	2, 58	.33	.80	.46	.03

Tests of within subjects effects

	df	M^2	***F***	***p***	η_p^2
Image	5, 290	.94	9.36	<.001	.14
Image* Group	10, 290	.06	.56	.84	.02

3. *Levator* activity

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Group	2, 58	.16	.29	.75	.01

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Image	5, 290	1.02	11.47	<.001	.17
Image* Group	10, 290	.10	1.08	.38	.04

4. Galvanic skin response

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Group	2, 59	.13	.33	.72	.01

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Image	5, 295	.96	3.69	.00.	.06
Image* Group	10, 295	.12	.44	.93	.02

Chapter 4

Mixed factorial repeated measures ANOVA with group as the between subjects factor (OCD, anxious, control) and image as the within subjects variable dilemma (benign, impersonal, personal), with indices of moral reasoning as the dependent variable.

1. Endorsement of the utilitarian option

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Group	2, 65	.22	.24	.79	.01

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Dilemma	2, 130	169.93	298.70	.00	.82
Dilemma* Group	4, 130	1.94	3.41	.01	.10

2. Reaction time

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
Group	2, 65	5811289.46	.60	.55	.02

Tests of within subjects effects

	df	M^2	*F*	*P*	η_p^2
Dilemma	2, 130	18053645.35	9.23	.00	.12
Dilemma*Group	4, 130	1955171.18	.52	.72	.02

Univariate ANOVA with group as the between subjects factor (OCD, anxious, control) and measures of inhibitory control and cognitive flexibility as the dependent variable.

1. **Hayling Sentence Completion Test**

Tests of between subjects effects

	df	M^2	*F*	*p*	η^2
Group	2, 63	5.13	4.45	.02	.12

2. **Trail Making Test Part B**

Tests of between subjects effects

	df	M^2	*F*	*p*	η^2
Group	2, 64	2260.26	4.45	.02	.12

Chapter 5

Repeated measures ANOVA with of valence (positive, negative) and relevance (target, foil) as within subjects variables, with similarity ratings of statements during the CBM recognition phase as the dependent variable.

1. **CBM-I recognition phase ratings**

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Valence	1, 21	210.18	2.80	.11	.12
Relevance	1, 21	142.55	16.23	.001	.44
Valence*Relevance	1, 21	40.91	2.99	.10	.13

Repeated measures ANOVA with CBM as the within subjects variable (training, no training) and disgust responses to each of the image types as the dependent variable.

2. **Self-report ratings of disgust**
    a. **Body waste**

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.50	1.49	.24	.07

    b. **Contamination**

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.11	.12	.73	.01

c. Moral

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	1.06	.66	.42	.03

d. Injury

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	1.97	.83	.37	.04

e. Neutral

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.01	.13	.72	.01

f. Negative

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.77	.66	.43	.03

3. *Corrugator* activity

a. Body waste

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.12	1.05	.32	.05

b. Contamination

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.04	.85	.37	.04

c. Moral

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.09	.12	.74	.01

d. Injury

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.03	.19	.66	.01

e. Neutral

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.10	2.40	.14	.10

f. Negative

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.12	.67	.42	.03

4. *Levator* activity

a. Body waste

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	<.001	.002	.97	<.001

b. Contamination

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.03	.33	.57	.02

c. Moral

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.07	1.03	.32	.05

d. Injury

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.19	1.26	.27	.06

e. Neutral

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.12	1.03	.32	.05

f. Negative

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.48	3.42	.08	.14

5. Galvanic skin responses

a. Body waste

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.01	.01	.94	<.001

b. Contamination

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	1.18	4.83	.04	.19

c. Moral

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.25	.91	.35	.04

d. Injury

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.87	3.53	.07	.14

e. Neutral

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.001	.01	.93	<.001

f. Negative

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 21	.73	2.72	.11	.12

Chapter 6

Mixed repeated measures analysis of variance with CBM training as the between subjects variable (benign training, disgust training) and valence (benign, disgust) and relevance (target, foil) as the within subjects variables. Similarity ratings for sentence stimuli in the CBM recognition phase was the dependent measure.

1. Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Valence	1, 58	150.42	1.85	.18	.03
Valence*CBM	1, 58	4.82	.06	.81	.00
Relevance	1, 58	86.40	13.40	.00	.19
Relevance*CBM	1, 58	.07	.01	.92	.00
Valence*Relevance	1, 58	6.67	.58	.45	.01
Valence*Relevance*CBM	1, 58	5.40	.47	.49	.01

Mixed repeated measures ANOVA with CBM training as the between subjects variable (benign training, disgust training) and time as the within subjects variable (pre-training, post-training) with self-report ratings of specific emotions as the dependent measure.

1. **Anxiety**

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 58	3.01	.57	.45	.01

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Time	1, 58	23.41	20.99	.00	.27
Time*CBM	1, 58	2.41	2.16	.15	.04

2. **Disgust**

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 58	.08	.02	.90	.00

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Time	1, 58	8.01	7.09	.01	.11
Time*CBM	1, 58	1.01	.89	.35	.02

3. Sadness

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 58	.53	.12	.74	.00

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Time	1, 58	3.33	4.89	.03	.08
Time*CBM	1, 58	.13	.20	.66	.00

4. Tension

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 58	.13	.02	.88	.00

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Time	1, 58	12.03	12.07	.00	.17
Time*CBM	1, 58	.13	.13	.72	.00

Mixed repeated measures analysis of variance with CBM training as the between subjects variable (benign training, disgust training) and time as the within subjects variable (pre-training, post-training) with measures of trait disgust, OC symptomatology and negative affect as the dependent measure.

1. **Disgust Propensity subscale of the DPSS-R**

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 58	76.17	1.55	.22	.03

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Time	1, 58	57.97	9.52	.00	.15
Time*CBM	1, 58	27.03	4.44	.04	.07

2. **Disgust Sensitivity subscale of the DPSS-R**

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 58	59.39	.88	.35	.02

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Time	1, 58	56.56	9.01	.00	.14
Time*CBM	1, 58	22.42	3.57	.06	.06

3. Disgust Sensitivity Scale - Revised

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 58	52.13	.14	.71	.00

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Time	1, 58	19.64	.26	.61	.01
Time*CBM	1, 58	27.50	.36	.55	.01

4. Obsessive-Compulsive Inventory - Revised

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 58	316.88	.70	.41	.01

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Time	1, 58	476.01	10.24	.00	.15
Time*CBM	1, 58	357.08	7.68	.01	.12

5. Depression, Anxiety, Stress Scales - 21

Tests of between subjects effects

	df	M^2	*F*	*p*	η_p^2
CBM	1, 58	250.69	.76	.39	.01

Tests of within subjects effects

	df	M^2	*F*	*p*	η_p^2
Time	1, 58	37.77	3.22	.08	.05
Time*CBM	1, 58	91.87	7.83	.01	.12

Appendix C

MORAL TRANSGRESSION STIMULI

Chapter 2 – descriptions of static image stimuli

Moral images

1. Man pointing gun inside another man's mouth
2. Boy punching another boy
3. Man with tattoos standing in front of swastika
4. Man shouting at little girl
5. Man pushing girl into a van
6. Ku Klux Clan dancing around burning cross
7. Saddam Hussein holding a gun
8. Unconscious man with chain on leg
9. Four men with baseball bats standing around a car
10. Plane flying into World Trade Centre
11. Young boy and girl left on their own near a power station
12. Man holding a gun
13. Man driving with beer bottle
14. Pregnant woman smoking
15. Policeman hitting young boy with baton
16. Gloved hand opening door through smashed window
17. Man attacking a woman
18. Man being hung by two men with a crane
19. Osama bin Laden
20. Man with beaten face lying on tiles
21. Man attacking a woman
22. Naked child lying face down with bruises on thighs
23. Prostitute talking to man in car
24. Male co-worker touching female worker inappropriately
25. Man punching woman in the face

Non-moral images

1. Burning car
2. Woman showing mastectomy scar
3. Premature newborn with nasogastric tube
4. Siamese twin babies joined at the head
5. Baby with eye tumour
6. Bleeding hand
7. Unconscious woman being pulled from burning house
8. Boxer being punched
9. Man with sooty face smoking a cigarette
10. Lacerated hand
11. Man on fire riding a bicycle
12. Man next to hospital bed holding injured woman's hand
13. Young girl crying

14. Man with broken leg
15. Bulldog showing teeth
16. Man with angry expression
17. Man with mutilated face in hospital
18. Man shouting angrily in a car
19. Two women crying
20. Man and woman standing over grave
21. Man vomiting
22. Boy crying
23. Man with bees on face
24. Two women crying
25. Man beside hospital bed holding patient's hand

Neutral images

1. Man and woman talking
2. Man and woman talking
3. Male cashier giving change to customer
4. Baby lying on blanket
5. Man with neutral expression
6. Fingerprints and finger
7. Man with neutral expression
8. Builders at building site
9. Man using computer
10. Hands dealing out playing cards
11. Boy playing chess
12. Woman painting blank canvas white
13. Man driving tractor
14. Man ironing
15. Male teacher with two children
16. Removal truck
17. Two men, a woman and a child unpacking a car
18. Man standing at window
19. Man and woman sitting on railroad tracks
20. Two women and a man making ceramics
21. Man and woman talking
22. Boy doing math on blackboard
23. Man standing in doorway
24. Two women playing basketball
25. Two men talking

Chapters 3, 4 & 6 – descriptions of static image stimuli (moral category omitted for Chapter 6)

Body waste

1. Dirty toilet
2. Dirty toilet
3. Faeces
4. Dirty toilet
5. Vomit
6. Dirty toilet

Contamination

1. Sink
2. Plate and fork with food scraps
3. Used disposable razor
4. Unmade bed
5. Dustbin
6. Unused opened condom

Blood/injury

1. Lacerated hand
2. Surgical operation
3. Facial tumour
4. Amputated hand
5. Bleeding hand
6. Facial wounds

Sociomoral

1. Man pointing a gun at a child
2. Pregnant woman smoking
3. Small child being hit by riot police with baton
4. Man throwing girl into a van
5. Man holding a knife to a woman's throat
6. Unconscious body with a chain around leg

Neutral

1. Teacher with school children
2. Woman painting a canvas white
3. Children playing chess
4. Man talking to woman
5. Teacher with school children
6. Man standing at grocery store counter

Negative

1. Man and woman crying over grave
2. Child crying
3. Fire-fighter pulling unconscious woman from burning house
4. Angry male face
5. Sad female face
6. Child crying

Chapter 5 – moral dilemma vignettes

Benign dilemmas

You are a farm worker driving a turnip-harvesting machine. You are approaching two diverging paths. By choosing the path on the right, you will harvest twenty bushels of turnips. If you do nothing your turnip-harvesting, machine will turn to the left and only harvest ten bushels. Is it acceptable for you to turn your turnip-picking machine to the right in order to harvest twenty bushels of turnips instead of ten?

You are bringing home a number of plants from a store that is about two miles from your home. The trunk of your car, which you've lined with plastic to catch the mud off the plants, will hold most of the plants you've purchased. You could bring all the plants home in one trip, but this would require putting some of the plants in the back seat as well as in the trunk. By putting some of the plants in the back seat you will ruin your fine leather upholstery which would cost thousands of dollars to replace. Is it acceptable for you to make two trips home in order to avoid ruining the seat of your car?

You are in charge of scheduling appointments in a dentist's office. Two people, Mr. Morris and Mrs. Santiago have called to make appointments for next Monday. The only available times for next Monday are at 10:00AM and at 3:00PM. Mr. Morris schedule is rather flexible. He can have his appointment at either 10:00AM or 3:00PM. Mrs. Santiago's schedule is less flexible. She can only have her appointment at 10:00AM. Is it acceptable for you to schedule Mr. Morris for 3:00PM, so that both he and Mrs. Santiago can have their appointments next Monday?

You have a headache. You go to the pharmacy with the intention of buying a particular name-brand headache medicine. When you get there you discover that the pharmacy is out of the brand you were looking for. The pharmacist, whom you've known for a long time and in whom you have a great deal of trust, tells you that he has in stock a generic product which is, in his words, "exactly the same" as the product you had originally intended to buy. Is it acceptable for you to purchase the generic brand instead of searching further for the name-brand product you were looking for?

You need to travel from Sydney to Canberra in order to attend a meeting that starts at 2:00PM. You can take either the train or the bus. The train will get you there just in time for your meeting no matter what. The bus is scheduled to arrive an hour before your meeting, but the bus is occasionally several hours late because of traffic. It would be nice to have an extra hour before the meeting, but you cannot afford to be late. Is it acceptable for you to take the train instead of the bus in order to ensure you are not late to your meeting?

Impersonal dilemmas

You are at the wheel of a runaway trolley quickly approaching a fork in the tracks. On the tracks to the left is a group of five railway workmen. On the tracks extending to the right is a single railway workman. If you do nothing, the trolley will proceed to the left causing the deaths of the five workmen. The only way to avoid the deaths of these workmen is to hit a switch on your dashboard that will cause the trolley to proceed to the right, causing the death of a single workman. Is it acceptable for you to hit the switch and direct the trolley towards one workman, in order to avoid the deaths of the other five workmen?

You are at home one day when the mail arrives. You receive a letter from a reputable international aid organisation. The letter asks you to make a donation of two hundred dollars to their organisation. The letter explains that a two-hundred dollar donation will allow this organisation to provide much needed medical attention to some poor people in another part of the world. Is it acceptable for you to not make a donation to this organization?

While on vacation on a remote island, you are fishing from a seaside dock. You observe a group of tourists board a small boat and set sail for a nearby island. Soon after their departure you hear over the radio that there is a violent storm brewing, a storm that is sure to intercept them. The only way you can ensure their safety is to warn them by borrowing a nearby speedboat. The speedboat belongs to a miserly tycoon who would not take kindly to your borrowing his property. Is it acceptable for you to borrow the speedboat in order to warn the tourists?

You have a friend who has been trying to find a job lately without much success. He figured that he would be more likely to get hired if he had a more impressive resume. He decided to put some false information on his resume in order to make it more impressive. By doing this he ultimately managed to get hired, beating out several candidates who were actually more qualified than he. Was it acceptable for your friend to put false information on his resume in order to help him find employment?

You are a lawyer working on a big case. The judge presiding over the trial happens to be someone you know from law school. The two of you were rather friendly back then, but now, decades later, it seems that your old friend barely remembers you. You're quite sure that if you were to talk to him over lunch, you could jog his memory and he would begin to see you as an old buddy, which would be very good for your work on this case. It's illegal for judges and lawyers working on the same case to meet socially. Is it acceptable for you to meet with this judge socially in order to help you win your case?

Personal dilemmas

You are a doctor. You have five patients, each of whom is about to die due to a failing organ of some kind. You have another patient who is healthy. The only way that you can save the lives of the first five patients is to transplant five of this young man's organs (against his will) into the bodies of the other five patients. If you do this, the young man will die, but the other five patients will live. Is it acceptable for you to perform this transplant in order to save your five patients?

A runaway trolley is heading down the tracks toward five workmen who will be killed, if the trolley proceeds on its present course. You are on a footbridge over the tracks in between the approaching trolley and the five workmen. Next to you on this footbridge is a stranger who happens to be very large. The only way to save the lives of the five workmen is to push this stranger off the bridge and onto the tracks below, where his large body will stop the trolley. The stranger will die if you do this, but the five workmen will be saved. Is it acceptable for you to push the stranger on the tracks in order to save the five workmen?

Enemy soldiers have taken over your village. They have orders to kill all remaining civilians. You and some of your townspeople have sought refuge in the cellar of a large house. Outside you hear the voices of soldiers who have come to search the house for valuables. Your baby begins to cry loudly. You cover his mouth to block the sound. If you remove your hand from his mouth his crying will summon the attention of the soldiers who will kill you, your baby, and the others hiding out in the cellar. To save yourself and the others you must smother your child to death. Is it acceptable to smother your child in order to save yourself and the other townspeople?

You are the leader of a mountaineering expedition that is stranded in the wilderness. Your expedition includes a family of six that has a genetically caused vitamin deficiency. A few people's kidneys contain large amounts of this vitamin. There is one such man in your party. The only way to save the lives of the six members of this family is to remove one of this man's kidneys so that the necessary vitamins may be extracted from it. The man will not die if you do this but his health will be compromised. The man is opposed to this plan, but you have the power to do as you see fit. Is it acceptable for you to forcibly remove this man's kidney in order to save the lives of the six vitamin-deficient people?

You are the leader of a small group of soldiers. You are on your way back from a completed mission deep in enemy territory when one of your men has stepped in a trap that has been set by the enemy and is badly injured. The trap is connected to a radio device that by now has alerted the enemy to your presence. They will soon be on their way. If the enemy finds your inured man they will torture him and kill him. He begs you not to leave him behind, but if you try to take him with you your entire group will be captured. The only way to prevent this injured soldier from being tortured is to shoot him yourself. Is it acceptable for you to shoot this soldier in order to prevent him from being tortured?