Measurement, Mechanisms, and Modification of Disgust: Implications for Anxiety-Related Disorders

By

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This dissertation is dedicated to my husband, Hank, and our son, William,
who help me to look away from my data and manuscripts sometimes and just enjoy life.
You two remind me that, no matter how much I think I know about the complex nature of disgust,
hearing a two-year-old say “poop” will always be funny.
So thank you for so many things, but above all,
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INTRODUCTION

Anxiety disorders represent one of the most common psychiatric conditions, with lifetime prevalence rates exceeding 25% in adults (Coles & Coleman, 2010; Kessler et al., 2005). Consistent with the adult research, anxiety is the most prevalent health issue for children (Copeland, Angold, Shanahan, & Costello, 2014; Merikangas et al., 2010), with an estimated 15 – 30% of children receiving an anxiety disorder diagnosis prior to the age of 18 (Bittner et al., 2007; Essau, Conradt, & Petermann, 2000; Woodward & Ferfusson, 2001). With a median age-of-onset of 11 years (Kessler et al., 2005), anxiety first emerges during middle childhood for most children, although some specific fears (e.g., animal fears) appear as early as age 5 (see Öst, 1987). The prognosis for anxiety disorders varies as a function of severity and utilization of treatment (Swales, Cassidy, & Sheikh, 2012). Despite its early emergence, first treatment does not occur until adulthood for many individuals, often more than a decade after the onset of a disorder (Christiana et al., 2000). Left untreated, anxiety disorders often have a chronic and unremitting course (Ramsawh, Raffa, Edelen, Rende, & Keller, 2009; Yonkers, Bruce, Dyck, & Keller, 2003), and increase the risk of subsequent psychiatric diagnoses later in adulthood (Pine, Cohen, Gurley, Brook, & Ma, 1998; Regier, Rae, Narrow, Kaelber, & Schatzberg, 1998; Zimmermann et al., 2003).

Improving anxiety's prognosis is an issue that extends well beyond the afflicted individual, and should instead be considered a national concern given that chronic mental illness has substantial 'trickle-down' consequences in a number of sectors including healthcare, economics, criminal justice, and public policy, to name a few. While the micro and macro effects on each of these sectors could easily fill the pages of an entire thesis in and of itself, for the sake of brevity, I will focus here on those which I believe are most significantly impacted. Accordingly, given managed healthcare's starring role in many current political debates, consideration of the economic impact of anxiety's healthcare expenditures may be of the most meaningful interest.

The *Economic Burden of Anxiety Disorders*, a study commissioned by the Anxiety and Depression Association of America (ADAA), found that, over the course of the 1990s, anxiety disorders cost the U.S. an estimated $42 billion a year (Greenberg et al., 1999). This figure accounts for nearly one-third of the country's $148 billion total mental health bill. In 2010, a mere 10 years later, the World Economic Forum (WEF) estimates the cost of mental illness was nearly $2.5T, an increase of nearly 1700% from 1999. (Bloom et al., 2011) Moreover, Bloom and colleagues (2011) project that mental health costs will continue a steep upward trend, reaching $6T by 2030 (Bloom et al., 2011). This projection, if correct, asserts that in the span of 40 years, our mental health costs *alone* will increase by over 4000%. The sheer magnitude of these figures complicate one's appreciation for the absurdity of an otherwise dire situation. Therefore, in an attempt to put these costs in perspective, consider these comparisons: in 2009, the *total* health expenditures (of which mental health accounts for only one portion) was $5.1T; the annual GDP for low-income countries is less than $1T; the U.S. annual GDP for 2010 was $14.96T, meaning that mental health costs alone accounted for nearly 6% of the entire U.S. economy. The data suggest that America is experiencing a mental health crisis that will continue to propagate unless systematic efforts are made to identify vulnerability factors that may contribute to the development of more effective interventions and preventative programs.

The Nature of Anxiety

According to the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (*DSM-5*; American Psychiatric Association, 2013), anxiety disorders include an assemblage of syndromes that share features of excessive fear and anxiety and related behavioral disturbances. However, psychological dysfunction related to maladaptive anxiety extends far beyond the confines of its own diagnostic categorization, and is in fact a reported symptom in nearly all neuropsychiatric disorders (Reid, Balis, & Sutton, 1997). These data highlight the ubiquitous nature of anxiety, and suggest that examination of anxiety at a symptom, rather than syndromal, level may yield greater transdiagnostic benefits.

A necessary first step in conceptualizing the anxiety construct is defining its boundaries and highlighting its juxtaposition to related constructs. While anxiety and fear are often used interchangeably both colloquially and in the empirical literature, there are clear distinctions between these two phenomena. Fear, a basic emotion, is characterized by unpleasant feelings that are experienced when confronted with a perceived life-threatening danger (Erol & Sahin, 1995; Marks, 1987; Ollendick, Grills, & Alexander, 2001). In contrast, anxiety has been conceptualized as a more global, meta-cognitive term that encompasses physiological tension and arousal, cognitions of threat, and behavioral avoidance (Hagopian & Ollendick, 1997). Recent research suggests that the distinction between fear and anxiety lies in the timing of the emotional experience such that fear occurs as a defensive response to a present threat while anxiety is a future-oriented prepatory response to contexts in which a threat may occur (Barlow, 2002; Davis, 2006; Lang, Davis, & Uhman, 2000; Quinn & Fanselow, 2006; Walker & Davis, 1997). In others words, anxiety alerts us that we *might be in danger* and prepares for the worst, while fear sounds the alarm that we *are currently in danger.*

Emotion theorists (Ekman, 1992; Izard, 1992) have also argued that, while anxiety and fear both represent emotional responses to threat (Hofmann et al., 2004), they represent distinct emotional processes. As noted previously, fear is described as a ‘basic emotion’ by many researchers. According to Ekman (1992), there are nine characterizations that define basic emotions: (1) distinctive universal signals (facial expressions); (2) presence in other primates; (3) distinctive physiology; (4) distinctive universals in antecedent events; (5); coherence among emotional responses; (6) quick onset; (7) brief duration; (8) automatic appraisal; and (9) unbidden occurrence. Fear is among six widely accepted basic emotions. Conversely, anxiety is considered an affective state, an emotional nebula that is comprised of predominantly fear, but also other fundamental emotions including distress/sadness, disgust, anger, shame, guilt, and interest/excitement (Izard, 1977). The specific anxiety formula for any given stimulus is dynamic, varying across individuals, time, and situations. Further, anxiety appears to depend more on the individual and the situation than the stimulus itself, thus making it potentially more modifiable than fear (Barlow, 2002).

Although both anxiety and fear generally carry a negative connotation, they are extremely adaptive and necessary to our survival as a species. Indeed, fear allows our minds and bodies to react automatically, without thought, in order to prevent harm. If, for example, you are walking across campus and something darts into your field of vision, you immediately duck or move out of the way. You do not need to think and decide the object’s accurate threat potential, instead your fear motivates you to immediately escape in order to protect you. Likewise, feeling anxious keeps us vigilant and prepares us to react to a range of varying threat levels. For instance, if you are driving your car with no sense of anxiety whatsoever, you are likely to turn onto streets without looking for pedestrians or other cars, you may make a left-hand turn when cars are too near, switch lanes without looking for other possible cars, etc. Anxiety forces us to be cautious, to plan our next move. It is an integral piece in the evolution of mankind. As Tomkins (2013, p.12) eloquently noted: “Anxiety is evidence of our will to live, to prosper, and to transcend the things that threaten us – anxiety is a life force.” Yet, despite its clear adaptive value, 1 in 4 people experience anxiety in response to an unreasonably perceived danger or with excessive intensity, thereby causing impairment to the individual. The shift from anxiety to anxiety disorder is more than a semantic addition, and has generated an etiological quandary for researchers and clinicians: Why, how, and for whom does anxiety transform from a normative evolutionary process to disordered and dysfunctional? Given that the term ‘abnormal’ is contingent on a clear conceptualization of ‘normal’, the crux of these etiological inquiries lies in identifying what adaptive anxiety is and how it develops. Thus, a thorough understanding of anxiety’s developmental trajectory is the foremost goal in the pursuit of identifying the origins of anxiety disorders.

Conceptualizing Anxiety from a Developmental Perspective

Epidemiological research has historically given considerable emphasis to a disorder’s age-of-onset in a vain attempt to isolate the precise starting point of psychopathology. A limitation of this approach is that it often excludes how emotions and behaviors related to the disorder, may be manifested prior to its designation as pathological. However, as the drive for early intervention and preventative programs has intensified, researchers have shifted their perspective to early development in an effort to examine how psychopathology might be expressed among subclinical or typically-developing individuals. Such developmental perspectives do not simply examine the presence of adult psychopathology constructs in children, but instead provide a prologue to pathology by identifying where normative development ends and dysfunctional processes begin. Conscientious examination of this shift is paramount in order to identify mechanisms that might initiate abnormal psychological development in some individuals and not others, thereby aiding in the creation of more effective prevention programs. Warren and Sroufe (2004) note three features that are pertinent to a developmental perspective (p. 93). First, psychopathology should be viewed as a developmental deviation whereby adaptive developmental processes have become distorted. Therefore, one should identify the function and typical course of anxiety, for example, and then examine when and why those processes go awry. Second, causation within a developmental framework is merely probabilistic rather than deterministic or absolute. Risk and protective factors interact with an individual’s environment to form one potential pathway among a host of possibilities both pathological and nonpathological. Thus, recognition of these factors may aid in guiding an individual towards some pathways and away from others. Lastly, Warren and Sroufe (2004) remark that development should be viewed as cumulative. Indeed, many contemporary researchers agree that behavior is not exclusively determined by genes, current environment, or even a gene x current environment interaction. Instead, at every point in time, behavior is determined by a combination of genes, environment, *and* past developmental history. This hierarchical perception of development illustrates the importance of early identification of distorted processes and subsequent early intervention.

Over the course of development there is a predictable “parade” of fears that emerge, plateau, and decline (Marks, 1987). Indeed, fears of strangers and separation from caregivers are common in young toddlers, typically peaking between ages 9 to 18 months, and decreasing after age 2 ½ years for most children (Bowlby, 1969; Bronson, 1972; Marks, 1987; Scarr & Salapatek, 1970; Thyer, 1993). As children enter the early preschool years, fears become more broad and complex including animals, the dark, doctors, storms, and imaginary creatures (Bauer, 1976; Jersild & Holmes, 1935; Lapouse & Monk, 1959; Lentz, 1985;

Maurer, 1965). By elementary school, these fears have decreased or even disappeared for the majority of children (Angelino, Dollins, & Mec, 1956; Bauer, 1976; Jersild & Holmes, 1935; Lapouse & Monk, 1959; Maurer, 1965). The middle school years and early adolescence are marked by increasing fears of bodily injury, physical danger, natural hazards, and anxiety about school performance and social relations (Angelino et al., 1956; Bauer, 1976; Croake, 1969; Maurer, 1965). Lastly, older adolescents and adults commonly report fears related to achievement, social acceptance, physical danger, and death (Bernstein & Allen, 1969; Lewis Volkmar, 1990).

This ontogenetic sequence of fears is largely stable and observed all over the world which alludes to biological preparedness (Marks, 1987; Warren & Sroufe, 2004). For instance, despite widely varying parenting and child-rearing practices across cultures, nearly all typically developing children show some degree of fear towards strangers and caregiver separation (Marks, 1987). The innate nature of the progression of fears suggests some evolutionarily adaptive purpose (Bowlby, 1973). Breger (1974) argues that all anxiety represents a threat to the integrity of one's self, beginning first in infancy with threats to the caregiving relationship and continuing through maturation where anxiety sources becomes more distal, internalized, and abstract. Indeed, within the environments of our ancestors', young children would have been extremely vulnerable, particularly when separated from one's caregiver, in novel or unfamiliar settings, or in situations where sensory input is compromised or diminished (i.e., the dark). Fear in young children thus becomes highly functional in order to maintain survival of the corporal self. Likewise, as children grow and become more independent, fears of physical injury protect against participating in high risk activities. Fears of social acceptance in older children through adulthood promote a desire to be accepted by one's peers, a necessary and important objective for our ancestors who relied on small social networks for protection, reproduction, and survival.

Age	*Developmental Issues*[1]	*Hypothesized Common Fears and Concerns*	*Associations With Anxiety Disorders*
0–6 months	• Biological regulation	• Startlelike response to loud noises or loss of support	• High reactivity • Low regulation
6–18 months	• Object permanence • Formation of attachment relationship	• Fear of strange people and situations • Separation anxiety	• Behavioral inhibition • Fearful shyness • Anxious/resistant attachment
2–3 years	• Exploration of material object world • Individuation and autonomy	• Fear of animals	• Animal phobia
3–6 years	• Self-reliance • Initiative • Development of symbolic thought and representation	• Fears of dark, imaginary creatures, storms, and loss of caregivers	• Separation anxiety disorder • Self-conscious shyness
6–10 years	• Sense of industry or competence • School adjustment	• Concerns about bodily injury, physical danger, and school	• Overanxious disorder • Generalized anxiety disorder
10–12 years	• Social understanding • Same-sex friends	• Concerns about friendships	• Social phobia
13+ years	• Flexible perspective taking • Beginning heterosexual relationships • Emancipation • Identity	• Concerns about heterosexual relationships, independence, and life plans	• Agoraphobia • Panic disorder

[1]See Sroufe and Rutter (1984).

Fig. 1. Simplified summary of relevant developmental issues and their hypothesized relation to anxiety. (Replicated from Warren & Sroufe, 2004).

Although fear is certainly functional in such circumstances as described above, it can become dysfunctional when experiences of fear are pervasive, persist beyond the typical age, and are independent of any genuine threat (Warren & Sroufe, 2004). However, discerning the point at which normative fears become pathological is somewhat complicated by the observation that the ontogenetic fear course parallels the average age of onset for related anxiety disorders. For instance, the normative emergence of fears generally corresponds to the various ages of onset for analogous specific phobias: specific animal phobias and blood-injection-injury-phobia at approximately 5 to 9 years of age (Bienvenu & Eaton, 1998; Depla, ten Have, van Balkom, & de Graf, 2008; Lipsitz, Barlow, & Mannuzza et al., 2002); separation anxiety disorder at 7.5 years (Last, Perrin, Hersen,& Kazdin, 1992); natural environment phobias at 6 to 13 years old (Lipsitz et al., 2002); and lastly, social phobia (11.3 years), panic disorder (14.1 years), and situational phobias (13 – 21 years) emerge much later in development (Becker, Rinck, Turke, et al., 2007; Last et al., 1992; Lipsitz et al., 2002). These epidemiological data are consistent with a developmental perspective of anxiety as the typical sequence of fears would include animals and doctors, followed by natural environments (e.g., storms), and more complex and abstract fears such as social relations and achievement emerging later in development. Fig. 1 provides a simplified summary of relevant developmental issues and their hypothesized association with anxiety symptoms.

The diagnostic criteria for the DSM-5 (American Psychiatric Association, 2014) notes the importance of developmental level when considering an anxiety disorder as some degree of fear and anxiety is normative and developmentally-appropriate at certain ages. The conjunction of pathological anxiety onset and corresponding normative fears can make discerning nuanced distinctions between normal and abnormal behavior quite challenging. Thus, a thorough understanding of the typical ontogenetic course of fear is paramount for accurate differential diagnoses. Further, empirical research examining why and how these normative processes become disrupted may aid in identifying risk factors that can be used in early intervention and prevention programs. Accordingly, the following section will review current vulnerability factors that have been implicated in the etiology of anxiety.

Vulnerability Factors in the Etiology of Anxiety

Although all anxiety-related disorders share a transdiagnostic foundation of maladaptive fear responding, identifying a single comprehensive theory regarding etiological pathways has proven to be extremely challenging for several reasons. First, a combination of many factors interact to create the experience of fear including genes, development, cognition, behavior, learning, physiology, and neuroanatomy (Sweeny & Pine, 2004; Taylor & Arnow, 1988). Second, as previously discussed, anxiety is a multidimensional construct defined predominantly by fear, but other emotion states as well. Lastly, the manifestation of each of these individual emotion states is multifaceted with a combination of cognitive, affective, behavioral, and physiological features, adding further complication to the search for a unified theory.

Despite these challenges, a number of potential risk mechanisms have consistently emerged among research pertaining to the pathogenesis of anxiety-related disorders in children. Muris (2006) specified genetics, behavioral inhibition, negative learning experiences, life events, and family factors as all contributing to the development of childhood anxiety. There is also consistent evidence that negative information increases children’s fearfulness which persists and is often generalized to other contexts (Field, Argyris, & Knowles, 2001; Muris, Bodden, Merckelbach, Ollendick, & King, 2003). Additionally, some research suggests that various maternal traits and parental rearing strategies may contribute to the development of anxiety disorders in children (Bernstein, Layne, Egan, & Nelson, 2005 & Nelson, 2005; Bögels & Brechman-Toussaint, 2006). Information processing biases have also been cited as a potential risk factor. Specifically, anxious individuals show threat biases at multiple levels of information processing, including aspects of attention orienting, cognitive appraisal, and learning (Pine, 2007; Pine, Helfinstein, Bar-Haim, Nelson, & Fox, 2009; Waters, Mogg, Bradley, & Pine, 2008). These information processing biases may contribute to enhanced fear learning and threat-related appraisals which result in an enduring state of fearfulness (Britton, Lissek, Grillon, Norcross, & Pine, 2011 Norcross, & Pine, 2010).

Anxiety as a Multireferential Construct

The risk factors described above demonstrate that there are many heterogeneous pathways leading to anxiety. If we accept that the referents of anxiety are of this diverse nature, collegial agreement on a single psychological *causal* model may be impossible (Hallum, 1985). Indeed, Ollendick and Grills (2016) note that equifinality (i.e., multiple pathways to any one outcome) is perhaps the most parsimonious way in which to describe the etiology of anxiety. Contemporary causal models reflect the heterogeneous nature of anxiety through inclusion of biological, developmental, psychological, social, and environmental influences (Barlow, 2000; Hirshfeld-Becker, Micco, Simoes, & Henin, 2008; Ollendick & Hirshfeld & Becker, 2002; Rapee, 2001; Vasey & Dadds, 2001). Barlow's (1988; 2002) long-standing triple vulnerability model is a particularly prominent framework for understanding anxiety that incorporates three multi-level vulnerabilities interacting with one another in the development of anxiety and negative affect. These three vulnerabilities include: [1] Generalized Biological Vulnerabilities (Genetics); [2] Generalized Psychological Vulnerabilities (early life experiences); and [3] Specific Psychological Vulnerabilities (specific learning experiences). Within Barlow's model, a combination of genetics and early life experiences, under certain conditions, contribute to increased risk for experiencing maladaptive anxiety and negative affect. Additionally, Barlow's model is one of the only available models to account for both the development of more general anxiety (which he termed 'anxious apprehension') as well as specific anxiety disorders. Indeed, he proposes a third vulnerability wherein certain learning experiences, characterized as the process of "learning what is dangerous", result in a discrete object becoming the focal point of anxiety. These specific vulnerabilities interact with general biological and psychological vulnerabilities to contribute to the development of differential anxiety disorder diagnoses (e.g., specific phobia, social phobia, OCD, panic disorder).

The role of danger as a vulnerability factor aligns with other cognitive models which posit that maladaptive anxiety is the result of a distorted perception that the world is inherently and excessively dangerous. Indeed, in his cognitive schemata of anxiety, Beck (Beck et al., 1985; Beck, 1993; Beck & Clark, 1997) proposed that pathological anxiety arises from faulty information processing rather than a clear, rational, and accurate assessment of danger. Against this backdrop, etiological researchers have focused on identifying disturbances in normative threat detection processes. Historically, fear has served as "low-hanging fruit" in these investigations given its dominant role in the affective experience of anxiety in addition to a well-established ontogenetic course whereby deviations are perhaps more evident. However, there is emerging evidence that disgust, whose primary function, like fear, is to defend and protect against potential dangers, may also play a pivotal role in anxiety.

Disgust and its Association with Anxiety

Although disgust has been described as a basic emotion since Darwin (1872/1965), it has been largely ignored as a topic of serious inquiry among empirical researchers until the last few decades. Disgust's considerable rise in popularity could be due to any number of its unique characteristics including its ability to "contaminate" anything it comes in contact with, its strong visceral reaction that can be so easily elicited yet so difficult to extinguish, or the capacity of its elicitors to simultaneously provoke revulsion, intrigue, and humor. Regardless of the "why", the wealth of knowledge that has emerged from this line of research has significantly advanced our understanding of disease, health, and human behavior in general. The following section will provide a brief review of the disgust literature as it applies to the current research program including: the emotional experience of disgust, its evolutionary function, and its association with fear and anxiety.

The Experience of Disgust

Emotion theorist, Robert Zajonc (1980) described affective responses in general as "effortless, inescapable, irrevocable, holistic, difficult to verbalize and yet easy to communicate and to understand" (pp. 169). This characterization is particularly relevant for disgust as most people can easily relate to its distinct visceral experience, and yet any attempt to capture that experience in words feels inadequate. Alas, as empirical investigation of any construct requires that it be operationalized, prominent emotion and disgust researchers (e.g., Andras Angyal, Paul Rozin, Paul Ekman, Jon Haidt, Bunmi Olatunji, to name a few) have reached a general consensus that disgust is defined as a revulsion or rejection of some potential contaminant that manifests through a combination of relatively distinct behavioral, cognitive, physiological, and neural correlates (Angyal, 1941; Olatunji & Cisler, 2008; Olatunji & Sawkchuk, 1987; Rozin & Fallon, 1987; Rozin, Haidt, & McCausley, 2008).

Early models conceptualized disgust as a defensive mechanism that derived from the primitive sensation of distaste elicited by aversive, contaminated, or harmful foods (see Rozin & Fallon, 1987 for a review). Conversely, contemporary theories have shown that, in addition to food-related products, disgust is often elicited by a more heterogeneous array of stimuli including bodily secretions, small animals, dirt, and, perhaps most distinctive from its primitive origins, socially and culturally-driven conventions. Disgust's extension into a diverse range of domains is believed to be the result of natural selection's attempt to aid early humans in adapting to the novel problems that arose in a rapidly developing social environment. In other words, the shifting selection pressures of an evolving culture "co-opted" disgust as a defense mechanism towards a larger array of elicitors. Kelly (2011) defines "co-opt" in this context as the process wherein a preexisting trait or mechanism acquires a new function in response to novel environments. According to a co-opt thesis, in addition to its primary function of disease avoidance, the disgust system was recruited to also include auxiliary functions related to the regulation of social interactions. Compared to other primitive processes, disgust was an ideal candidate to protect against a diverse array of contaminants, ranging from "oral to moral" (Rozin, Haidt, & Fincher, 2009). Indeed, the disgust system is innately sensitive to phenotypic abnormalities and was therefore already in the business of monitoring others and their behavior as a means of avoiding disease and parasites. Given that there is some latitude in “abnormal” taxonomy, disgust’s detection system is meant to be flexible, activated by an open-ended database of elicitors that can be revised, refined, or augmented with information obtained from an ever-evolving cultural environment. Yet, despite a flexible and dynamic acquisition system easily activated by a variety of cues, the disgust *response* is relatively consistent across elicitors and domains types. From an evolutionary perspective, the prominent regularity of disgust’s rigid, reliably-elicited pattern of thoughts, motivations, and behaviors, strengthen its visibility to natural selection.

The perfect combination of rigidity and flexibility has promoted disgust’s successful evolution from strictly a “guardian of the mouth” (Rozin & Fallon, 1980; Fallon & Rozin, 1983) to a prominent multifunctional system that serves to defend against a wide variety of potential contaminants both biologically and culturally-derived. However, it is not disgust’s adaptive value that has fostered recent intrigue among both scientists and philosophers alike. Despite the disgust system’s evolutionary intention to *promote* and *strengthen* human civilization, a quick glance at the coverage of any news outlet calls into question how far we have really come as a civilization and begs the question: Has disgust failed us? Or, conversely, have we failed disgust? Further, as noted at the beginning of this thesis, the presence of abnormal psychology, captured by the presence of psychiatric diagnoses, continues a steep upward trend. This suggests that at some point in the advancement of civilization, those adaptive psychological processes that have been selectively promoted, may be more vulnerable to malfunctioning. Accordingly, the last three decades have seen a considerable rise in the exploration of dysfunctional and maladaptive disgust, particularly among clinical researchers seeking to illuminate unexplained gaps in the etiology, maintenance, treatment, and prevention of psychopathology.

Dysfunctional Disgust and Psychopathology

Like all emotions, disgust is thought to have both a ‘state’ and ‘trait’ component. ‘State’ disgust refers to disgust that is experienced in the presence of an external (e.g., taking a sip of sour milk) or internal (e.g., thinking about the time you took a sip of sour milk) disgusting stimulus. While all individuals experience disgust to greater or lesser extent (Olatunji & Broman-Fulks, 2007), there is variability among individuals that can be conceptualized as ‘trait’ disgust. Trait disgust is a relatively stable personality trait that can manifest across two related but distinct domains: (1) disgust propensity and (2) disgust sensitivity (van Overveld, de Jong, Cavanagh, & Davey, 2006). Disgust propensity refers to the readiness with which one becomes disgusted (Haidt et al., 1994). Heightened disgust propensity may become dysfunctional when the threshold for what one considers disgusting is too low, causing the individual to be easily disgusted and subsequently avoid a wide array of stimuli that may not be inherently dangerous. Disgust sensitivity refers to one’s evaluation of the disgust experience itself (van Overveld et al., 2006). Heightened disgust sensitivity may become problematic for individuals as the tendency to evaluate the disgust experience negatively is likely to make even mild disgust sensations intolerable. Despite representing separate--though related--constructs, the disgust literature has historically used disgust propensity and disgust sensitivity interchangeably (e.g., Olatunji, Cisler, Deacon, Connolly, & Lohr, 2007; Tolin, Woods, & Abramowitz, 2006). With this limitation in mind, the present research will highlight the broad relation of disgust to psychopathology and attempt to draw distinction between propensity and sensitivity where possible.

Although dysfunctional disgust has been implicated as a risk or maintenance factor for a number of psychiatric disorders, the most robust findings have been among anxiety-related disorders (Olatunji & McKay, 2009; Olatunji & Sawchuk, 2005; Phillips et al., 1998). This association may be intuitive given the observation that spiders, snakes, blood and mutiliated bodies, dirt/germs, etc., are all common fears as well as strong disgust elicitors for most individuals, both anxious and nonanxious. The overlap among stimuli suggests that disgust may play a pivotal role in pathological anxiety. In support of this notion, individuals with disgust-relevant anxiety disorders (i.e., small animal phobias, blood-injection-injury (BII) phobia, obsessive-compulsive disorder, health anxiety, posttraumatic stress disorder) report both fear *and* disgust when exposed to feared stimuli (Olatunji & Deacon, 2008; Tolin et al., 1997; Thorpe & Salkovskis, 1998; Sawchuk, Lohr, Westendorf, Meunier, & Tolin, 2002; Vernon & Berenbaum, 2002). Moreover, disgust may actually be the dominant emotional response in some specific phobias such as BII phobia (Sawchuk, Menuier, Lohr, & Westendorf, 2002; Tolin, Lohr, Sawchuk, & Lee, 1997).

In addition to the presence of heightened state disgust responding during threat-relevant exposure, accumulating evidence has shown that trait disgust and anxiety also share meaningful associations. For instance, heightened disgust propensity has been found to be moderately associated with several personality traits that are also associated with anxiety-related disorders including trait anxiety (Olatunji, Ebesutani, et al., 2014; Olatunji, Williams, et al., 2007) and anxiety sensitivity (Cisler, Reardon, Williams, & Lohr, 2007). On a disorder-specific level, self-reported measures of disgust are consistently correlated with self-report measures of spider fear (Mulkens, de Jong, & Merckelbach, 1996; de Jong & Merckelbach, 1998; Thorpe & Salkovskis, 1998), BII phobia (de Jong, & Merckelbach, 1998; Olatunji, Ebesutani, et al., 2012; Olatunji, Sawchuk, de Jong, & Lohr, 2006; Olatunji, Smits, et al., 2007; Page, 2003), OCD (Mancini, Gragnani, & D'Olimpio, 2001, Thorpe, Patel, & Simonds, 2003), and health anxiety (Davey, 2006, Olatunji, 2009; Weck, Esch, and Rohrmann, 2014). Further, fearful individuals reported heightened generalized disgust propensity compared to nonclinical controls (Olatunji, Arrindell, et al., 2005; Olatunji, Lohr, Smits, Sawchuk, & Patten, 2009; Sawchuk et al., 2002; Tolin et al., 1997). This suggests that the association between disgust and anxiety goes beyond common elicitors, and alludes to the possibility of an underlying dysfunctional threat-related process.

Expansion from self-report data to other methodological approaches (such as behavioral avoidance tasks) has revealed comparable and complementary findings. Indeed, disgust propensity has also been shown to better predict behavioral avoidance of feared stimuli among anxious individuals compared to nonanxious controls (Fiddick, 2011; Olatunji et al., 2004; Olatunji, Lohr, et al., 2007; Tsao & McKay, 2004; Viar-Paxton, Tomarken, Pemble, & Olatunji, 2014) Woody, McLean, & Klassen, 2005; ; Woody & Tolin. 2002). An association between trait disgust and anxious pathology has been replicated among youth (Kim et al., 2012; Muris, Merckelbach, Schmidt, & Tierney, 1999; Muris et al., 2012; Viar-Paxtn et al., 2015) and cross-culturally (Kang et al., 2012; Olatunji et al., 2009; van Overveld, de Jong, Peters, & Schouten, 2011).

In an attempt to explain the nature of the disgust-anxiety association, Davey (1991) proposed the disease-avoidance model of disgust. According to the disease-avoidance model, certain stimuli (e.g., small animals, blood) have acquired an association with the spread of disease or contamination. This association then leads to subsequent heightened disgust responding and avoidance. Davey (1991) proposed three ways in which stimuli may become associated with disease: (1) stimuli may be involved in the direct spreading of disease (e.g., rats); (2) stimuli may be contingently associated (temporally or spatially) with contamination or dirt (e.g., cockroaches, spiders); or (3) stimuli may possess features of other stimuli which elicit disgust such as mucous or feces (e.g., slugs, snakes). The disease-avoidance model provided an initial framework for understanding why some relatively unthreatening objects are avoided. For example, Matchett and Davey (1991) found that a propensity to experience disgust was associated with a fear of snakes, spiders, and rats, but not with animals which are generally considered physically dangerous such as lions or sharks. While the disease-avoidance model has been primarily utilized in the context of animal phobias, its premise has utility in the conceptualization of many disgust-relevant disorders including BII phobia, OCD, and health anxiety.

The disease-avoidance model provides a springboard for addressing the possibility of disgust as a casual factor in the development of anxiety. However, empirical support has been lacking. The majority of available studies have utilized cross-sectional designs thereby limiting any attempt to delineate the specific nature of this association. The few studies that have employed empirical or prospective methodologies suggest that disgust may have a causal role in the development of at least some anxiety-related disorders. For instance, inducing disgust has been shown to increase fear and distress ratings of small animals (Webb & Davey, 1993), BII-related stimuli (Olatunji, Ciesielski, Wolitzky-Taylor, Wentworth, & Viar, 2012), and contamination-relevant stimuli (Olatunji & Armstrong, 2009). Conversely, other research has suggested that the association between anxiety and disgust is unidirectional, with induced anxiety resulting in increased disgust, but no effect of induced disgust on reported anxiety (Marzillier & Davey, 2005). Substantiating a causal role of disgust is further complicated by the significant overlap among fears and disgust elicitors, especially when symptom parameters are also highly relevant to disgust (e.g., avoidance, distress). Davey (2011) spoke to this challenge in a more recent review of disgust, noting that "…just because disgust and these specific psychopathologies share similar environmental triggers does not in any way imply that the former is a cause of the latter or that the former is a vulnerability for the latter – the two may simply coexist in parallel because of their common environmental elicitors." Thus, the combination of methodological limitations, scarcity of research employing empirical or prospective studies, and inconsistencies among those few available studies make it extremely difficult to validate any mechanisms associated with the disease-avoidance model or to conclude with any confidence that the disgust has a causal role in the development of anxiety or psychopathology more generally.

Limitations in the Extant Literature

Despite robust associations between disgust and anxiety, the extant literature has failed to provide an empirically-supported conceptual model that elucidates this link. Although anxiety disorders typically emerge during childhood (Kessler et al., 2005), the majority of research on disgust-related pathologies has relied on young adults and college samples.

The limited research among youth may be due, in part, to the absence of a reliable and valid measure of disgust propensity specifically designed for children. The few available studies that have examined disgust propensity in children have relied on simplified or age-downward extensions of adult measures (Muris et al., 1999; Muris et al., 2008). While this approach has allowed for an initial examination of disgust in children, it possesses several significant limitations. First, downward extensions of adult scales may not capture important developmental nuances that contribute to a more reliable and valid assessment of the disgust propensity construct in children. Second, the stimuli used on these scales may not be age-relevant. Thus, nonsignificant correlations between disgust and anxiety symptoms among young children may reflect little exposure to those stimuli or a failure to fully understand items rather than the absence of disgust as a vulnerability factor. Lastly, the majority of available research has utilized a restricted age range of 9 – 13 years old. Although this age range includes the median age of onset for anxiety disorders in general, specific phobias, whereby disgust has been shown to be particularly prominent, emerge as early as four years old, with a median age of onset around six years (Kessler et al., 2005). These limitations indicate that a developmentally-sensitive measure of disgust propensity is needed before any conclusions can be made regarding disgust's role as a risk factor for the development of anxiety.

In addition to the lack of a child-specific measure of disgust propensity, few studies have empirically examined the mechanism by which disgust propensity might confer risk for anxiety symptoms in children. While some researchers have posited that the acquisition of disgust may follow similar pathways as fear (e.g., Rachman's three pathways), little research has been conducted to examine this hypothesis. Additionally, previous research has shown that disgust responding may be transferred via social transmission from parent to child (Oaten, Stevenson, Wagland, Case, & Repacholi, 2014; Stevenson, Batten, & Cherner, 1992). Thus, it is possible that this transmission may be one potential mechanism by which disgust propensity confers risk for the development of anxiety disorders. By delineating the association between disgust and anxiety symptoms in children, more specific and efficacious treatment and prevention programs for childhood anxiety can be developed.

Lastly, while the extant literature has implicated disgust as an important factor in anxiety-related disorders, disgust is often ignored in the context of treatment. Indeed, it has been suggested that the failure to address disgust may partly explain why current treatments are ineffective for some anxious clients and why relapse occurs for others (Olatunji, Smits, Connolly, Willems, & Lohr, 2007; Olatunji, Wolitzky-Taylor, Willems, Lohr, & Armstrong, 2009; Woody & Teachman, 2000). Further, a number of studies have shown that although traditional treatment paradigms may successfully reduce both fear and disgust, disgust declines at a much slower rate compared to fear (Olatunji et al., 2007; Smits et al., 2002). A greater understanding of the mechanisms by which disgust may acquire an association with fear and/or anxiety may aid in the development of more effective interventions by elucidating potential treatment targets specifically aimed at extinguishing those associations.

Overview of Dissertation Research

The high prevalence and rising healthcare costs of treating anxiety disorders highlights the continued need to identify specific risk factors that can ultimately be the target of both treatment and prevention efforts. The discussion above identified several important issues that have remained elusive in the current literature. Hence, the present research program represents a timely and important contribution to the extant literature in its over-arching goal to identify potential mechanisms by which disgust may confer risk for pathological anxiety. Elucidation of the specific nature of disgust's vulnerability may improve the efficacy of current interventions and ultimately aid in the development of future evidence-based prevention programs.

In order to achieve this goal, three aims were specified. The first aim was to develop and validate the Child Disgust Scale, the first measure of individual differences in disgust specifically designed for children (Experiment 1). Given that anxiety disorders have an early age of onset of 11 years, with some disorders, like specific phobias emerging during the late preschool years (Kessler et al., 2005), valid and reliable measurement of potential vulnerability factors *before* the onset of the disorder is necessary in order to define prospective pathological pathways. The second aim of the present investigation was to examine several possible causal mechanisms of disgust in the development of maladaptive fear beliefs among children (Experiment 2). Specifically, Experiment 2 first sought to replicate previous findings that disgust-related information increases fear beliefs and avoidance of a novel animal (Muris et al., 2008; 2010; 2013). Using the Child Disgust Scale validated in Experiment 1, Experiment 2 then examined the extent to which trait disgust propensity predicted the acquisition of anxiety-related emotions (i.e., fear, disgust) and behaviors (i.e., avoidance). Lastly, given previous research on the role of maternal traits contributing to the risk of anxiety disorders, Experiment 2 also examined the extent to which maternal levels of disgust propensity influences the association between child disgust propensity and the learning of fear and disgust beliefs about a novel animal.

Although disgust is posited to play an important role in anxiety, the majority of interventions focus solely on fear reduction. This approach may at least partially explain why current treatments are ineffective for some anxious clients and why relapse occurs for others (Olatunji, Smits, Connolly, Williams, & Lohr, 2007; Olatunji, Wolitzky-Taylor, Willems, Lohr, & Armstrong, 2009; Woody & Teachman, 2000). Given these limitations, the third aim of this dissertation sought to examine the effectiveness of disgust-targeted treatment in the reduction of specific phobia symptoms. Furthermore, Experiment 3 examined the effect of directly targeting disgust, fear, and negative affect in the treatment of BII phobia, which will provide further understanding of what emotional experiences are most pivotal in specific phobia. Together, this series of studies represent a timely contribute to the literature by empirically assessing causal mechanisms disgust and treatment implications for anxiety-related disorders.

CHAPTER 2[1]

MEASUREMENT OF DISGUST IN CHILDREN

In contrast to other emotions, such as happiness, fear, and distress, disgust appears to be largely absent among infants and very young children (Rozin, Hammer, Oster, Horowitz, & Marmora, 1986). Knapp (2003) likens disgust to language in that it is a human universal that is developmentally delayed and displays limited cultural variation. Although commonly mistaken as a crude and immature disgust response, the disgust facial expression often observed among infants is elicited only through gustatory and olfactory stimulation (Ganchrow, Steiner, & Daher, 1983; Rosenstein & Oster, 1988; Steiner, 1979), and is actually more akin to Rozin and Fallon's (1987) definition of distaste. This misconception is evidenced by Darwin's account in his 1864 memoir on emotion, "I never saw disgust more plainly expressed than on the face of one of my infants at five months, when, for the first time, some cold water, and again a month afterwards, when a piece of ripe cherry was put into his mouth." Disgust is often not exhibited in humans until about the age of three (Rozin et al., 1986). This late onset of disgust has been proposed as a potential consequence of toilet training (Rozin & Fallon, 1987), although the finding that disgust can be observed in feral children who were never toilet trained (Malson, 1964/1972) casts some doubt on this hypothesis. Other researchers have theorized that the delayed emergence of disgust is attributable to the acquisition of acceptable food preferences (Strohminger, 2014). Strohminger (2014) argues that similar to language acquisition, there is a "sensitive period" for adding acceptable foods to the palate which begins after weaning and ends around age seven (Birch & Marlin, 1982; Cashdan, 1994; Bloom, 2004). This theory explains why young children are more willing to try foods that adults find repulsive. Indeed, younger children have no qualms about eating candy shaped like dog feces or drinking from a glass that had been stirred with a fly swatter (Rozin & Fallon, 1987; Rozin, Fallon, & Augustoni-Ziskind, 1986), suggesting a primitive or immature understanding of contagion.

Despite theoretical accounts of disgust's initial emergence around age three, it has been suggested (Rozin & Fallon, 1987; Rozin et al., 1986) that true disgust is not present until around age eight when the child can conceptualize and comprehend contagion (although some researchers have suggested an understanding of contagion is evident as young as 4 – 5 years old; Hejmadi, Rozin, & Siegel, 2004; Siegal, 1988; Solomon & Cassimatis, 1999). While very young children will reject contaminated stimuli, they only appear to do so based largely on concrete visual cues such as infection or spoilage, or on parental cues (i.e., "Don't touch that!"), rather than a higher-order conceptualization of disgust and contamination (Rozin & Fallon, 1987; Rozin et al., 1986; Rozin & Nemeroff, 1990). The notion that disgust is reliant on a developmentally-dependent conceptualization of contagion is consistent with emotional intelligence literature which shows that children do not acquire the ability to accurately label and communicate emotion until 8 – 9 years old, when their understanding of emotions becomes based on internal mental cues (see Schniering, Hudson, & Rapee, 2000 for a review). During adolescence, the child develops the more abstract and complex representations of disgust including those in the interpersonal and moral domain. For the first time in his or her life, the adolescent child values peers and cultural expectations more than parental influences (Remschnidt, 1994). Therefore, more complex emotional states associated with peer interaction, such as interpersonal and moral disgust, manifest and become more salient (McNally, 2002; Power & Dalgleish, 1997; Rozin, Lowry, Imada, & Haidt, 1999).

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[1] Sections of this chapter have been previous published with the citation of Viar-Paxton et.al. (2015).

While current developmental models of disgust may be intuitive, there remains a paucity of *empirical* support examining the nature of disgust acquisition. The few proposed theories are inconsistent in the age ranges of disgust domain emergence or rely on vague developmental periods. The scarcity of disgust research among youth may be attributed to the lack of an age-appropriate measure of individual differences in disgust responding among children. The need to better understand the ontogenetic sequence of disgust responding and its possible implications in the etiology of anxiety, indicate that a developmentally-sensitive measure of individual differences of disgust is necessary.

Scale Development

Seeking to fill an important gap in the current literature, an age-appropriate self-report measure of childhood disgust propensity was developed. Development of the Child Disgust Scale (CDS), began with consulting the Disgust Scale-Revised (Olatunji et al., 2007), a psychometrically sound and widely used adult measure of disgust propensity, as a reference for the range of stimuli that are generally considered disgusting. Following initial discussions with developmental psychologists, it was revealed that while some of the themes of the DS-R may be relevant to children, the items were generally not appropriate. Thus, new items that were deemed to be within the general disgust framework *and* developmentally appropriate were then created. These items were then distributed to developmental psychologists, experts in disgust, and parents of young children in order to gain feedback on the face validity and readability of the items. Based on the feedback of the original 22-item CDS, four items were dropped from the scale, and several items were altered to increase readability and relevance to children (e.g., “I would share my drinks or snacks with my friends” was changed to “I would still drink my juicebox even if I saw another kid drink out of it”).

The final version of the CDS contains 18-items that assess disgust propensity across three domains. The DS-R consists of three subscales: Core Disgust (i.e., disgust related to oral corporation of contaminants or contact with bodily waste or small animals), Contamination Disgust (i.e., disgust related to possible contamination by contagion of ill persons), and Animal-Reminder Disgust (i.e., disgust related to threats of body envelope, injury to the body, or death). The CDS was developed to mirror this three-domain structure with six items in each domain. Although the CDS utilized the DS-R as a reference, the two can easily be differentiated. For instance, using the Readability statistics offered by Microsoft Word 2010, the CDS was found to have a Flesch-Kincaid reading ease of 94.7(where 100 = greatest readability possible) and a reading grade level of 2.9 (Flesch, 1951). For comparison, using the same method, the DS-R was found to possess a reading ease of 75.6 and a reading grade level of 4.6. Another distinction from the DS-R is that the CDS utilized a more age-appropriate rating scale. The DS-R currently uses a 5-point Likert-type scale with 0 = *Strongly Disagree* and 4 = *Strongly Agree* which was deemed too complex for children. Accordingly, consistent with other self-report scales used with young children, a 3-point response scale (*Always [0], Sometimes [1], Never [2])* was employed (e.g., Ebesutani et al., 2012).

The development of the CDS represents a timely and important contribution that addresses current limitations in the literature. However, before the CDS can be used in empirical studies of disgust, its psychometric properties must be examined. Thus, Experiment 1 examined the factor structure and psychometric properties of the CDS scale scores across four independent studies. Experiment 1a examines the reliability of the CDS scores among elementary and middle school aged children. Bifactor exploratory factor analyses (EFA) were also employed in Experiment 1a to examine the latent structure of the CDS and to evaluate whether disgust propensity in children can be conceptualized as unidimensional or multidimensional as it is in adult models. Confirmatory factor analysis (CFA) was then employed in Experiment 1b to confirm the factor structure of the CDS in an independent sample of elementary and middle school children based on the findings of Experiment 1a. Experiment 1c then examined the convergent and discriminant validity of the CDS relative to self-report measures of fear, anxiety, and depression. Lastly, the "known groups validity" of the CDS was examined in Experiment 1d by comparing differences between those with a diagnosis of a specific phobia and matched nonclinical children.

Experiment 1a Method

Participants

Participants were recruited from public schools in Oxford, MS. The final sample included 1,500 elementary and middle school children (778 boys and 722 girls) who completed the CDS. There were 186 (12%) children in 2nd grade, 198 (13%) in 3rd grade, 167 (11%) in 4th grade, 225 (15%) in 5th grade, 213 (14%) in 6th grade, 252 (17%) in 7th grade, 253 (17%) in 8th grade, and 6 (<1%) students that did not provide a grade. With respect to race, 1142 (76%) were White/Caucasian, 210 (14%) were Black/African American, 20 (1%) were Asian, 79 (6%) were Hispanic, and 49 (3%) self-identified as Other.

Among the 1500 included youth, 1365 (91.0%) had no missing data, 109 (7.3%) had one missing item, 16 (1.1%) had two missing items, six (0.4%) had three missing items, two (0.1%) had four missing items, one (0.1%) had five missing items, and one (0.1%) had six missing items.

Procedure

This study was reviewed and approved by the University of Mississippi Institutional Review Board. Passive consent was used, in which participants and their families were provided with the opportunity to decline participation one week prior to administration of the CDS. Families who chose to not participate in the study were asked to return a signed form to the school indicating their preference to be excluded from participation in the study. On the day of data collection, student assent forms and the CDS were distributed to the classrooms and administered by teachers. Students were given a second opportunity to decline participation prior to being given their forms. Administrators aided in distribution and collection of the scale, and a project research assistant was onsite to organize data collection, answer questions, and collect completed measures from each classroom. Children were given the instructions: "*Each sentence below is a statement that might be disgusting. Choose how often you would do what the sentence says by circling: Always, Sometimes, or Never*."

Data Analytic Strategy

Missing Data. We used the recommended multiple imputation method available in Mplus (based on 10 imputed dataset) to handle missing data (Rubin, 1996).

Exploratory Bifactor Analysis (EFA) of the CDS. Bifactor exploratory factor analysis (EFA) were employed in the current investigation to examine the latent structure of the CDS. The bifactor analysis is preferable to traditional EFA procedures because it allows for a general "g" factor of disgust proneness, as well as specific disgust domains. Given that children, especially young children, may not have acquired reliable disgust responses to certain higher order factors (e.g., contamination), the bifactor model allows for a framework that can be applied to a wider developmental range. The bifactor model has also been found to fit psychological constructs well (Reise, Morizot, & Hays, 2007), and was recently found to be the best fit for the data in an adult measure of disgust propensity compared to exclusive unidimensional or multidimensional models (Olatunji, Ebesutani, & Reise, 2014).

Using the PSYCH package available in the R statistical software (R Development Core Team, 2008), a Schmd-Leiman bifactor EFA using oblique rotation was used given that the factors were expected to be intercorrelated (see Reise, Moore, & Haviland, 2010, for a detailed description of the Schmid-Leiman bifactor EFA procedure). Data were treated as categorical (ordinal) due to the items being derived from a Likert-scale (Brown, 2006). We used the recommended procedures when conducting EFA on categorical data such that calculations were performed on polychoric correlation matrices (Holgado-Tello, Chaco-Moscoso, Barbero-Garcia, & Vila-Abad, 2010) with the robust weighted least squares estimator (WLSMV; Flora & Curran, 2004; Muthen, de Toit, & Spisic, 1997). The following metrics were used to evaluate the outcome of this analysis: (a) the number of eigenvalues greater than 1, (b) the scree plot, (c) the interpretability of each solution, and (d) the fit of each EFA solution according to the root mean square error of approximation (RMSEA) fit statistic. Additionally, given some criticism that the “eigenvalues greater than 1.0” criterion may yield too many factors (Velicer & Jackson, 1990), all criteria were considered when selecting the number of factors.

Results

Descriptive statistics

Descriptive statistics are presented in Table 1, including mean ratings for retained CDS items and skew and kurtosis statistics. Examination of the skew and kurtosis of the retained 15 CDS items revealed some significant z values which suggest the presence of some non-normal data. As noted above, we used the robust WLSMV estimator, which overcomes concerns related to potential biased parameter estimates caused by nonnormality (Muthen et al., 1997).

Table 1. Experiment 1a descriptive statistics for CDS items

Item	Mean (0 – 2)	SD	Skewness	Kurtosis	Item-Total Correlation	Alpha-if-removed
CDS 2	1.73	.59	-2.05	2.92	.34	.77
CDS 4	.87	.80	.23	-1.41	.45	.76
CDS 5*	.42	.66	1.29	.38	.34	.77
CDS 6*	.47	.71	1.16	-.06	.32	.77
CDS 7	1.76	.55	-2.17	3.63	.47	.76
CDS 8	1.68	.60	-1.72	1.77	.39	.77
CDS 9*	.95	.83	.10	-1.56	.38	.77
CDS 10	1.43	.67	-.74	-.55	.38	.77
CDS 11	1.14	.81	-.25	-1.43	.49	.76
CDS 12	1.76	.53	-2.15	3.65	.34	.77
CDS 13	1.56	.67	-1.24	.26	.47	.76
CDS 15*	.60	.76	.80	-.82	.41	.76
CDS 16*	.61	.77	.81	-.87	.32	.77
CDS 17	1.63	.61	-1.42	.91	.35	.77
CDS 18*	1.23	.81	-.50	-1.29	.33	.77

Notes: * = Reverse scored.

Exploratory Factor Analysis (EFA) of the CDS

The bifactor EFA factor loadings associated with the 3-factor and 2-factor solutions appear in Table 2. Although a 3-factor solution was originally hypothesized, Factor 1 did not have any items which met the cutoff criteria of .32 as identified by Tabachnick and Fidell (2001). Additionally, Factor 3 only contained two items with factor loadings above .32 and factors with fewer than three items are generally considered weak, unstable, and negligible (Costello & Osbourne, 2005). We therefore did not consider the 3-factor model a viable solution. The 2-factor model was considered to be the most interpretable solution based on its strong model fit (RMSEA = .05) and interpretability. Three items were removed given that they did not load onto the general factor. The final measure therefore consisted of 15 items. Factor I consisted of 9 items that are largely characterized by avoidance of disgust eliciting stimuli (e.g., “If a dog licked my popsicle, I would still eat it”). We therefore labeled this first factor “Disgust Avoidance.” Factor II consisted of 6 items that were characterized by affective responses to disgust eliciting stimuli (e.g., “I feel sick if I see a dead animal on the side of the road”). We therefore labeled this second factor “Disgust Affect.”

Reliability of the CDS Score

The CDS total score (or general factor) was associated with adequate internal consistency reliability estimate (α=.78). Table 1 displays alpha-if-deleted values for each of the 15 retained CDS items (with relation to the total score). These results do not reveal any items that need to be removed from the total score.

Table 2. Experiment 1a exploratory factor analytic results for the 2-factor and 3-factor solutions.

	2-factor			**3-factor**			
Items	General Disgust	Disgust 1	Disgust 2	General Disgust	Disgust 1	Disgust 2	Disgust 3
CDS 1	.24	.45		.47			
CDS 2	.34	.56		.67	.30		
CDS 3	.30	.52		.48			.70
CDS 4	.42	.46		.59	.20		
CDS 7	.49	.56		.68	.21		
CDS 8	.38	.53		.58			.20
CDS 10	.35	.46		.47			.48
CDS 11	.44	.39	.23	.56	.20	.28	
CDS 12	.35	.58		.60			.27
CDS 13	.45	.58		.66			.25
CDS 14*	.31	.23	.21	.35		.25	
CDS 17	.32	.50		.59	.24		
CDS 5*	.36		.54			.62	
CDS 6*	.34		.48			.56	
CDS 9*	.34		.43	.23		.50	
CDS 15*	.42		.58	.26		.67	
CDS 16*	.34		.49			.56	
CDS 18*	.33		.48			.57	

Note. CDS = Child Disgust Scale; * indicates reverse-scored item. Factor loadings under .20 are not listed.

The Disgust Avoidance subscale scores (α = .78) and Disgust Affect subscale scores (α = .69) were also associated with adequate reliability estimates. We examined alpha-if-deleted values for each of the six items of the Disgust Affect subscale given that alpha fell just under the .70 reliability benchmark (Nunnally, 1978). All alpha-if-deleted values ranged from .65 to .66, suggesting that removal of items would not improve reliability. We therefore did not remove any items from this scale and we decided to retain the factor since its scale score reliability estimate fell extremely close to the .70 benchmark for adequate reliability. Item-total correlations for each item also appear in Table 1. All items moderately correlated with the total score.

Gender Differences

Significant sex differences were found for the CDS scores [$t(1498) = 12.40$, $p < .001$, Cohen's $d = .55$] such that girls ($M = 19.39$, $SD = 4.79$) reported significantly greater disgust sensitivity than boys ($M = 16.27$, $SD = 4.95$). Compared to boys, girls were also found to report higher levels of Disgust Avoidance [$t(1498) = 8.14$, $p < .001$, Cohen's $d = .42$; Girls: $M = 1.59$, $SD = .35$; Boys: $M = 1.43$, $SD = .41$] and Disgust Affect [$t(1498) = 11.70$, $p < .001$, Cohen's $d = .60$; Girls: $M = .93$, $SD = .45$; Boys: $M = .67$; $SD = .41$].

Discussion

The CDS showed adequate internal consistency in an initial sample of elementary and middle school-aged children with girls reporting greater disgust sensitivity compared to boys. This finding is consistent with the adult research which finds that women report greater disgust sensitivity than men (Davey, 1994; Haidt et al., 1994; Schinele, Start, Walter, & Vaitl, 2003). Although the CDS was modeled after the 3-factor structure of the adult DS-R (Core Disgust, Contamination Disgust, and Animal-Reminder Disgust), a bifactor EFA revealed a general disgust factor and only two interpretable factors (Disgust Avoidance and Disgust Affect). The two-factor bifactor solution suggests that the structure of disgust sensitivity among children (as assessed by the CDS) may be best characterized by *responses* to disgust eliciting stimuli rather than the nature of the stimuli themselves. However, the two-factor bifactor solution observed in Experiment 1a requires confirmation before definitive inferences can be made regarding the factor structure of the CDS. Accordingly, in Experiment 1b, we employed confirmatory factor analyses (CFA) in a new sample to examine the fit of the two-factor bifactor model relative to alternative models.

Experiment 1b Method

Participants

Participants were recruited from public schools in Oxford, MS. The final sample included an independent sample of 573 elementary and middle school children (262 boys and 311 girls). The mean age was 9.07 years old ($SD = 1.51$) with an age range of 6 – 13 years. With respect to race, 509 (89%) were White/Caucasian, 22 (4%) were Black/African American, 3 (1%) were Asian, 21(4%) were Hispanic, and 18 (2%) self-identified as Other.

Among the 573 included youth, 523 (91.3%) had no missing data, 40 (7.0%) had one missing item, 7 (1.2%) had two missing items, and 3 (0.5%) had three missing items.

Procedure

The procedure was the same as described in Experiment 1a.

Data Analytic Strategy

Confirmatory Factor Analyses (CFA). We conducted CFA on the CDS items using Mplus 7.11 (Muthen & Muthen, 2010). Due to the CDS data being categorical (ordinal) in nature, we used polychoric correlations (Holgado-Tello et al. 2010) and the robust weighted least-squares with mean and variance adjustment (WLSMV) estimator, Flora et al., 2004; Muthen et al., 1997). We used full-information maximum likelihood (FIML) to impute missing data given that FIML has been recommended as one of the best methods for handling missing data in many contexts (Allison, 2003; Arbuckle, 1996; Schafer & Graham, 2002); that said, bifactor modeling has only recently begun to be applied in psychology and so relatively less is known about how it performs in these contexts, such as when data are imputed via these methods. We examined model fit via the chi-square statistic; the root-mean-square error of approximation (RMSEA; Steiger, 1990), for which smaller values (e.g., less than .08) are indicative of good fit (Hu & Bentler, 1999)~~;~~ and the comparative fit index (CFI; Bentler, 1990), for which larger values (e.g., greater than . 95) are considered to indicate good model fit. We used the chi-square difference test (i.e., χ^2_{diff}) to examine the significance of modifications to the original model.

Measurement Invariance Across Gender. We evaluated measurement invariance of the derived, best-fitting model across males (n=262) and females (n=311) using multi-group confirmatory factor analysis. The recommended steps of this process have been outlined by Brown (2006). Specifically, we first examined fit of the single-sample solutions in the male-only and female-only subsamples, separately. If both single-sample solutions evidenced good model fit (based on the fit statistic benchmarks noted in the CFA section above), configural invariance (i.e.,"equal form") is then examined in the combined full sample. Configural invariance examines whether the data from both groups are associated with the same number of factors and item-to-factor loading patterns. Configural invariance is considered supported if the fit indices meet the previously mentioned benchmarks of good model fit (cf. Brown, 2006).

If configural invariance is supported, then metric invariance (i.e., “equal factor loadings”) and scalar invariance (i.e., “equal item thresholds”) can be tested, in successive order. Metric invariance is tested by constraining all *factor loadings* to be the same across groups, and scalar invariance is tested by constraining all *item thresholds* to be the same across groups. For both metric and scalar invariance, we used the ΔCFI difference test to determine whether the invariance model is supported (Chen, 2007). If the difference in the CFI fit index between the constrained and non-constrained model is less than .01 (ΔCFI < .01), then invariance (at the constrained model level) is supported (Chen 2007; Cheung & Rensvold, 2002). For example, if the equality constraint of equal item thresholds across groups did not lead to a substantial degradation in model fit, then scalar invariance is supported. Scalar invariance is important to examine given that this is the test of differential item functioning (McDonald, 1999). If scale scores are associated with differential item functioning, then individuals who fall on the same level of the underlying latent trait provide systematically different observed scores on that measure’s items. Without establishing scalar invariance (or the lack of differential item functioning) it has been said that the comparison of mean scores across subgroup is ambiguous because “the effects of a between-group difference in the latent means are confounded with differences in the scale and origin of the latent variable” (see Cheung & Rensvold, 2002, p. 238).

Confirmatory Factor Analyses (CFA)

We first examined the fit of the 2-factor bifactor model resulting from the exploratory bifactor analyses in Study 1. In this bifactor model, all items from the CDS loaded on the general factor (items 1, 3, and 14 which were dropped from the measure entirely in Experiment 1a due to insignificant loading on the general factor). Items 2,4,7,8,10,11,12,13, and 17 loaded on the Factor 1 called (labeled "Disgust Avoidance") and items 5,6,9,15,16,18 loaded on Factor 2 called (labeled "Disgust Affect"). This 2-factor bifactor model revealed an excellent fit to the data based on the full sample (i.e., RMSEA = .048; CFI = .995). One item did not load significantly on the General Factor (item #9). We therefore eliminated this item and re-ran the two-factor bifactor model with item #9 removed. This resulted in a 14-item bifactor model that was also associated with excellent fit (i.e., RMSEA = .053; CFI = .995). All items then loaded significantly on both the general disgust dimension and their respective content subdomains. The final 2-factor bifactor model with 14 items is presented in Fig. 2. It is worth noting that items #4 ("I would pick up a worm with my hand") and #18 ("I feel sick if I see someone throw up") had significant and positive loadings on their respective subdomains, and significant loadings on the general factor (indicating that they are significantly relevant and pertinent to this bifactor model); however, the loadings on the general factor were negative. Thus, the bifactor model was re-specified with the general factor path to Items #4 and #18 removed. The removal of these items was associated with very poor model fit based on some indices ($\chi^2(91) = 20487.40$, $p < .001$; RMSEA = .113). A chi-square difference test showed that a model which included the negative paths demonstrated significantly better fit than a model which removed those pathways, $\chi^2_{\text{diff}}(28) = 20321.86$, $p < .001$. Given these analyses, the two negative pathways were retained for the remainder of analyses.

Table 3. Experiment 1b CFA of the 14-item Child Disgust Scale (CDS) model fit indices.

Model tested	χ^2	*df*	χ^2/df	RMSEA	TLI	CFI
1-factor model	1103.77	77	14.33	.153	.941	.950
2-factor model	887.74	76	11.68	.960	.952	.960
1-factor model w/ method effects	516.43	41	12.60	.142	.977	.948
2-factor bifactor model	**165.54**	**63**	**2.63**	**.053**	**.993**	**.995**

Note. $N = 574$, χ^2/df = a ratio of chi-square, divided by the degrees of freedom (see Kline, 2005); RMSEA = root-mean-square error of approximation; TLI = Tucker-Lewis Index; CFI = comparative fit index. The best fitting model is indicated in bold.

We then compared this (14-item) 2-factor bifactor model (that included two negatively loaded items on the general factor) against (a) standard (correlated traits) 2-factor model, (b) a unidimensional model, and (c) a unidimensional model that controlled for method effects due to the reverse-worded items. The fit of all of competing models appear in Table 3. The 2-factor (correlated traits) model was first tested. This 2-factor model consisted of Disgust Avoidance and Disgust Affect, without a general factor and was associated with relatively poor model fit based on some fit indices ($\chi^2(76) = 887.74$, $p < .001$; RMSEA = .137) although acceptable model fit based on others (CFI = .960; TLI = .952). However, the chi-square difference test showed that the 2-factor bifactor model fit significantly better than this (correlated traits) 2-factor model, $\chi^2_{\text{diff}}(13) = 496.70$, $p < .001$.

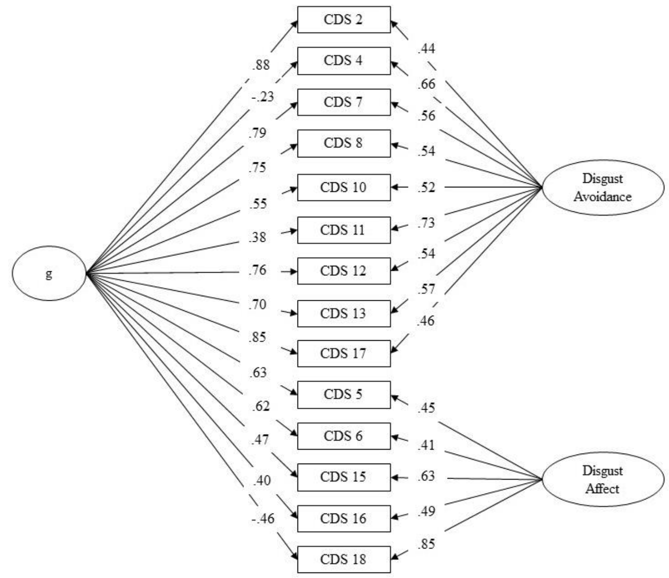


Fig. 2. Two-factor bifactor model of the final 14-item Child Disgust Scale (CDS).

A unidimensional model of disgust sensitivity was then tested with all 14 CDS items as indicator variables. This model was also associated with relatively poor fit to the data based on some fit indices ($\chi^2(77) = 1103.77$, $p < .001$; RMSEA = .153), but acceptable model fit based on others (CFI = .950; TLI = .941). The chi-square difference test however showed that the 2-factor bifactor model fit significantly better than this one-factor model, $\chi^2_{\text{diff}}(14) = 591.17$, $p < .001$.

Lastly, we examined the one-factor model that controlled for method effects due to the reserve-worded items. In this model, we set all error terms among all the negatively-worded items to be correlated, based on the correlated uniqueness model (cf. Brown, 2003; Marsh, 1996). This one-factor model (controlling for wording method effects) was also associated with relatively poor fit based on some fit indices (i.e., $\chi^2(41) = 516.43$, $p < .001$; RMSEA = .142), but acceptable fit based on others (CFI = .977; TLI = .948). This model was not nested under the bifactor model and so the chi-square difference test could not be used to compare model fit. Although Cronbach's alpha is widely used as a measure of reliability, it can sometimes yield misleading results, especially when data are multidimensional, given that coefficient alpha reflects the reliability of *all* sources of systematic variance, including variance of the presence of the general factor, content group factors, and specific factors (Cortina, 1993). Omega provides a better estimate of reliability as it assumes that items on congeneric rather than tau equivalent (Graham, 2006). Omega-hierarchical computed for the total score composite (OmegaH; Zinbarg, Barlow, & Brown, 1997; Zinbarg, Revelle, Yovel, & Li, 2005) provides an estimate of the proportion of variance in scores that is due to the general factor (e.g., general disgust sensitivity). Omega hierarchical for each subscale composite provides an index of the degree to which the subscale scores provide reliable variance after accounting for the general factor. Based on the CFA bifactor loadings in Fig. 2, Omega for the total scale was .96, and Omega Hierarchical for the total score was .62. This reveals the presence of a relatively strong general factor, whereby 62 percent of the variance of this total composite could be attributable to variance on the general factor. Omega Hierarchical for the Disgust Avoidance and Disgust Affect subscale composites were .45 and .63, respectively. These results suggest that the Disgust Affect subscale scores provide a high degree of reliable variance after accounting for the general factor; the Disgust Avoidance subscale scores, however, provide a much lower degree of reliable variance after accounting for the general factor.

Measurement Invariance Across Gender

The single-sample solutions evidence good model fit in the male-only sample (RMSEA=.046; CFI=.998; TLI=.997) and also in the female-only sample (RMSEA=.050; CFI=.994; TLI=.991). All items also loaded significantly on the general and their respective subdomain in both groups. The tests of configural invariance was also supported, as evidence by strong fit indices (RMSEA=.049; CFI .996, TLI=.995; χ^2 = 210.94; *df*=126). Due to the nature of the bifactor model (whereby items load on both the general and a specific factor), the Mplus MGCFA procedures did not allow the specific test of metric invariance by itself; Mplus only allowed the test of configural invariance, and then scalar invariance (constraining both factor loadings and item thresholds, simultaneously). We were thus forced to skip the specific test of metric invariance, and proceed to the test of scalar invariance. The fit indices associated with the scalar invariance model were also strong (RMSEA=.044; CFI .996, TLI=.996; χ^2 = 256.66; *df*=165). The ΔCFI test revealed that scalar invariance was supported given that ΔCFI between the configural and scalar model was less than .01. Since the test for scalar invariance also includes constraining factor loadings to be equal across groups, this test also simultaneously provided support for metric invariance across gender. Based on these results supporting measurement invariance all the way to the scalar invariance level, we then were able to proceed with comparing mean scores across gender.

Internal Consistency and Gender Differences

The overall Cronbach's alpha for the 14-item CDS scale was an acceptable .87. The Cronbach's alpha estimates for the two subscales of the CDS were: Disgust Avoidance = .93 and Disgust Affect = .64. Contrary to predictions, there were no gender differences in disgust sensitivity for the total score [$t(572) = .38$, $p > .05$; Girls: $M = 21.02$, $SD = 7.80$; Boys: $M = 21.28$, $SD = 8.44$], Disgust Avoidance [$t(572) = .28$, $p > .05$; Girls: $M = 1.33$, $SD = .59$; Boys: $M = 1.35$, $SD = .69$], or Disgust Affect [$t(572) = .57$, $p > .05$; Girls: $M = 1.08$, $SD = .51$; Boys: $M = 1.10$, $SD = .51$].

Discussion

Although the CDS contained items that were intended to sample distinct disgust domains identified in previous research (Olatunji et al., 2007), EFA of CDS items in Experiment 1a indicated that a bifactor model which allows for measurement of the two identified factors as well as a general factor provided the best fit to the data. CFA in Study 2 confirmed that the bifactor model was a better fit to the data above and beyond competing models including a model that controlled for method effects due to reverse worded items. This suggests that although the Disgust Affect factor contains all reverse worded items (see Table 1), there is a 'true' factor apart from the method effects. Examination of the bifactor model showed that one item did not load onto the general factor. Removal of this item resulted in a final 14-item scale. Additionally, two items (item 4 and 18) loaded negatively onto the general disgust factor. However, the items were retained given that they loaded positively onto the intended subfactors. Additionally, removal of these negative pathways resulted in poor model fit. The negative loadings of the two items on the general disgust factor despite having positive loadings on the intended subfactors is unexpected and may reflect a methodological artifact akin to statistical suppression. Further research is needed to explore the bifactor analytical method in more detail in order to delineate the origins of such effects. Consistent with Experiment 1a, the findings of Experiment 1b also suggest that the CDS total score has good internal consistency among youth. However, it is not yet clear the extent to which the CDS items correlated with measures of fear and anxiety in children. Accordingly, Experiment 1c was conducted to examine the convergent validity of the scale and its two factors in relation to measures of anxiety and fear. Further, in order to assess whether the correlation between disgust, anxiety, and the convergent measures was a true correlation and not simply an artifact of negative affect, a measure of depression was also included in order to examine discriminant validity.

Experiment 1c Method

Participants

Participants included 50 children who were recruited through an online participant recruitment system, the Vanderbilt University Kennedy Center Study Finder. The children ranged in age from 5 to 12 years (*M* = 7.62, *SD* = 2.18; 52% boys) and were mostly Caucasian (70%).

Measures

The *Screen for Child Anxiety Related Emotional Disorders- Revised* (SCARED-R; Muris, Merkelbach, Schmidt, & Mayer, 1999a) is a 66-item measure of seven domains of anxiety disorder symptoms. Severity of symptoms are rated using a 0 to 2-point rating scale with 0 meaning "not true or hardly ever true," 1 meaning "sometimes true," and 2 meaning "true or often true." The present study excluded the “Separation Anxiety and School Phobia” and “Traumatic Stress Disorder” scales due to poor factor loading of the construct leaving 50 items. The SCARED-R demonstrated good internal consistency ($\alpha = .93$) in the current sample.

The *Fear Survey Schedule for Children-Revised* (FSSC-R; Ollendick, 1983) is an 80-item measure designed to assess common childhood fears. The present study excluded the “Fear of failure and criticism” factor due to length as well as its failure to map onto our construct of interest. Therefore, this study used a modified FSSC-R that consists of 51 items rated on a 3-point Likert-type scale (None, Some, or A lot). The FSSC-R demonstrated good internal consistency ($\alpha = .90$) in the current sample.

The *Child Depression Inventory* (CDI; Kovacs, 1992) is a 27-item measure designed to assess depression symptoms in children. Each item has three statements, and the child is asked to select the one answer that best describes his/her feelings over the past two weeks. The CDI demonstrated acceptable internal consistency ($\alpha = .79$) in the current study.

Procedure

Participants were recruited through Vanderbilt University’s online recruitment system and provided verbal informed consent over the phone after hearing the details of the study. Participants were then emailed a unique link to the study survey that also included a hard copy of the assent which required participants to agree prior to being presented with the survey. The study survey data were collected and managed using REDCap electronic data capture, a secure, web-based application designed to support data capture for research studies, hosted at Vanderbilt University (Harris et al., 2009). Each questionnaire measure was presented individually and the option to skip items was included for each question (i.e., “I would prefer not to answer this question”). Parents were told they could help children if necessary and a question was included at the end of each questionnaire to determine if parental assistance was used. Examination of this question revealed that children needed help slightly over half the time depending on the questionnaire. Specifically, parents helped children 50% of the time for the CDS, 48% of the time for the SCARED-R, 60% of the time for the FSSC-R, and 74% of the time for the CDI. Further, parental assistance on the questionnaires was significantly correlated with age (r's = .39 - .54, p's < .001), such that younger children needed more help from parents to complete the questionnaires.

Results

Internal Consistency and Gender Differences

Descriptive statistics and correlations for each measure in Experiment 1c are presented in Table 4. The Cronbach's alpha estimate for the CDS 14-item total score was adequate at .76 with an average inter-item correlation of .20. Further, the two CDS subscales also demonstrated acceptable internal consistency estimates: Disgust Avoidance, α = .73 and Disgust Affect, α = .60. Girls (n =24) reported significantly greater disgust sensitivity compared to boys (n = 26) for the total CDS score [$t(48) = 4.44$, $p < .001$, $d = 1.26$; Girls: $M = 18.29$, $SD = 3.84$, Boys: $M = 12.88$, $SD = 4.68$]. Girls also reported greater Disgust Avoidance [t(48) = 3b7, $p = .002$, $d = .93$; Girls: $M = 1.50$, $SD = .28$, Boys: $M = 1.18$, $SD = .40$] and Disgust Affect [$t(48) = 3.95$, $p < .001$, $d = 1.11$; Girls: $M = .96$, $SD = .43$, Boys: $M = .47$, $SD = .45$;] than boys.

Convergent and Divergent Validity

Correlational analyses were used to examine the convergent validity of the CDS scores in relation to measures of fear (FSSC-R) and anxiety (SCARED-R). As demonstrated in Table 4, the CDS total score was significantly related to anxiety-related disorder symptoms and common childhood fears. The pattern of correlations that emerged between the CDS total score and anxiety measures also supported the convergent and discriminant validity of the scale. For example, the correlation between the CDS scores and specific phobia (r =.55) was larger than the correlation between the CDS and social anxiety (r =.25); this difference however did not reach statistical significance (z = 1.70, $p = .09$), likely due to small sample size. Table 4 also shows that the pattern of correlations with measures of fear and anxiety were generally weaker with the Disgust Affect factor consisting of reversed scored items. In contrast, discriminant validity of the CDS scores was demonstrated by a non-significant relationship with depression on the CDI (see Table 4).

Table 4. Associations between the Child Disgust Scale (CDS) and measures of convergent and discriminant validity (Experiment 1c).

Measure	CDS total	Disgust Avoidance	Disgust Affect	*M*	*SD*
FSSC-R	.47**	.49**	.26	98.60	15.89
Unknown	.48**	.49**	.29*	32.86	6.51
Injury/Small Animal	.50**	.54**	.26	30.78	5.76
Danger/Death	.19	.22	.04	27.44	5.38
Medical Fears	.23	.17	.26	7.52	2.08
SCARED-R	.49**	.44**	.39*	86.48	18.51
Panic Disorder	.33*	.28*	.29*	19.92	5.34
GAD	.34*	.34*	.22	15.02	5.09
Social Phobia	.25	.28*	.13	8.88	2.04
Specific Phobia	.55**	.44**	.50**	25.42	6.03
OCD	.40**	.37**	.29*	16.50	4.61
CDI	-.21	-.24	-.07	52.86	3.77
M	15.48	1.34	.71		
SD	5.06	.38	.50		

Note. ** $p < .01$, * $p < .05$. FSSC-R = Fear Survey Schedule-Revised; SCARED-R = Screen for Child Anxiety Related Emotional Disorders-Revised; CDI = Child Depression Inventory.

Discussion

Results of Experiment 1c provide initial support of the convergent and discriminant validity of the CDS. The CDS total score was significantly correlated with measures of fear and anxiety but not depression. The findings of Experiment 1c also suggest that disgust sensitivity in children may be more strongly associated with some anxiety disorders (specific phobia) than others (social anxiety disorder). The absence of an association with depression suggests that the CDS measures a distinct vulnerability that is not simply an artifact of negative affect. Having provided initial evidence in support of the convergent and divergent validity of the CDS, Experiment 1d was conducted to examine the “known groups” validity of scores on the CDS. Examination of the extent to which the CDS yields different scores for groups known to vary on disgust sensitivity would speak well to the validity of the scale as well as its clinical utility. Consistent with previous research (Muris et al., 1999b; Muris et al., 2008b), it was predicted that children with a diagnosis of a specific phobia would report significantly greater disgust sensitivity than an age-, gender-, and ethnicity-matched nonclinical sample.

Experiment 1d Method

Participants

Forty-three children with a primary diagnosis of specific phobia (42% female; 93% Caucasian; M_{age} = 9.16 years, *SD* = 1.90 years) were recruited for the present study. The clinical sample was recruited in the United Stated from contacts with mental health treatment clinics, pediatricians, family practice physicians, and school systems, as well as newspaper articles and television and radio advertisements. The following specific phobias were included: Being alone/Darkness (46.5%), Storms (16.3%), Dogs (14.0%), Costumes (7.0%), Loud noises (4.7%), Bees/Insects (4.7%), Spiders (4.7%), and Blood-injection-injury (2.3%). A nonclinical sample (NCS) of forty-three children who were matched for age, gender, and ethnicity (42% female; 93% Caucasian; M_{age} = 9.16 years, *SD* = 1.90 years) was also recruited.

Measures

The *Anxiety Disorders Interview Schedule for DSM-IV-Child and Parent Versions* (ADIS-IV-C/P; Silverman & Albano, 1996). The ADIS-IV-C (child version) and ADIS-IV-P (parent version) are reliable and well validated semi-structured diagnostic interviews designed to facilitate diagnosis of anxiety and mood disorders and other disorders in children and adolescents between 6 and 17 years old.

Procedure

Children in the clinical sample completed the CDS as part of the diagnostic intake prior to undergoing treatment through the Child Study Center at Virginia Polytechnic Institute and State University in Blacksburg, VA. During the child’s intake interview, parents completed several questionnaires about themselves and their families and a structured diagnostic interview regarding their child. Presence of a specific phobia was determined during a clinical consensus meeting, based solely on the child and parent diagnostic interviews. Based on independent raters, Kappa for this sample was .91. The matched nonclinical sample of children completed the CDS in a classroom setting using the procedure and sample from Experiments 1a and 1b.

Results

Internal Consistency and Gender Differences

The Cronbach's alpha estimate for the CDS 14-item total score was questionable at .64 and an average inter-item correlation at .13. However, both the Disgust Avoidance subscale and the Disgust Affect subscale demonstrated acceptable internal consistency (α = .88 and .75, respectively). Regarding differences between girls (n=18) and boys (n=25) among the specific phobia group, Disgust Affect was greater among girls (M = .92, SD = .48) compared to boys (M = .55, SD = .58), $t(41) = 2.00$, $p < .05$, d = .70. However, Disgust Avoidance did not significantly differ between girls (M = 1.56, SD = .43) and boys (M = 1.50, SD = .35), $t(41) = .54$, p = .60, d = .15). General disgust sensitivity also did not significantly differ between girls (M = 18.67, SD = 4.59) and boys (M = 16.24, SD = 4.56), $t(41) = 1.66$, p = .11, d = .53). There were no gender differences found among the nonclinical sample group based on the CDS total score or the two subscales (ps > .05).

Group Differences

A univariate analysis of variance was conducted to examine whether the specific phobia group and NCS group differed on the CDS total score. As shown in Table 5, significant group differences were found on the CDS total score, with the specific phobia group reporting significantly greater disgust sensitivity compared to the NCS group, $F(1,84) = 11.42$, p = .001, η_p^2 = .12. Table 5 also shows significant group differences for Disgust Avoidance with the specific phobia group scoring higher than the NCS group [$F(1,84) = 11.08$, p = .001, η_p^2 = .12]. However, no significant group differences in Disgust Affect was observed [$F(1,84)$ = .09, p = .77, η_p^2 = .001].

Table 5. Descriptive statistics and group differences on the Child Disgust Scale (CDS) total score and subscales among children with a specific phobia diagnosis and nonanxious controls (Experiment 1d)

	Specific phobia participants (n = 43)		Nonanxious control participants (n = 43)			
CDS	M	SD	M	SD	$F(1, 84)$	η_p^2
CDS total score	17.26	4.83	13.86	4.48	11.42*	.12
Disgust Avoidance	1.52	.38	1.15	.62	11.08*	.12
Disgust Affect	.71	.57	.74	.57	.09	.00

Note. * $p < .01$. η_p^2 represents partial eta squared.

Discussion

Results of Experiment 1d support the "known groups" validity of the CDS among a sample of children with specific phobia as compared to a non-clinically-referred, community sample matched for relevant demographic characteristics. Consistent with previous research (Muris et al., 1999b), children with a diagnosis of specific phobia reported greater disgust sensitivity compared to nonclinical controls. The findings of Experiment 1d also showed that the two groups did not significantly differ on the Disgust Affect factor which consists of the reverse-worded items.

Experiment 1 Conclusions

Experiment 1 examined the psychometric properties of the newly developed CDS in four independent samples of children ages 5 to 13 years. Results from these four studies indicated that, similar to adults, disgust responding in children is multidimensional. The CDS appears to be best defined by a bifactor model which allows for a "g" disgust propensity factor in addition to two distinct factors of Disgust Avoidance and Disgust Affect. Consistent with predictions, the CDS was significantly correlated with measures of fear and anxiety, but not depression. Further, the CDS was able to differentiate children with a diagnosis of specific phobia from a matched nonclinical community sample of children. Results from these studies suggest that the CDS is a developmentally appropriate measure with good psychometric properties. Further, results from Experiment 1 support a disgust-anxiety association in children as young as 5 years old, and the CDS's ability to capture individual differences related to that association. Following these findings, Experiment 2 sought to utilize the CDS to examine causal mechanisms for disgust in the development of maladaptive fear beliefs among children.

The present findings suggest that the CDS consists of a general disgust sensitivity factor in addition to two distinct component factors. However, the present findings did reveal lower reliability estimates for the Disgust Affect factor relative to the Disgust Avoidance factor. The relatively lower reliability of the Disgust Affect factor may be partially due to reverse-worded items that can be more difficult for children to understand. The lower reliability may also be partially accounted for by fewer items for the Disgust Affect factor relative to the Disgust Avoidance factor. Despite the lower reliability, the present findings revealed that the Disgust Affect subscale scores provided a higher degree of reliable variance than the Disgust Avoidance subscale scores after accounting for the general disgust sensitivity factor. This suggests that the Disgust Affect factor may offer some incremental utility above and beyond the general disgust sensitivity factor of the CDS. Assuming that the Disgust Avoidance and Disgust Affect factors of the CDS represent distinct processes, the lower reliability estimates for the Disgust Affect factor may reflect a more complex process to assess in children. Early in development, children learn through intrafamilial modeling with facial expressions and social referencing (Stevenson et al., 2010) to avoid disgust elicitors (e.g., 'don't put that in your mouth!'). Behavioral avoidance of disgusting stimuli (Disgust Avoidance) may be what is actively taught to young children through such learning processes which may facilitate a more internally consistent response than affective labeling of disgust responses (Disgust Affect) that require cognitive resources that are underdeveloped in young children (Rozin & Fallon, 1987).

Factor analysis of measures of disgust sensitivity in adults has consistently produced multidimensional solutions, suggesting that disgust sensitivity is not a unitary construct (de Jong & Merckelbach, 1998; Olatunji et al., 2007). However, the present findings suggest that emergence of distinct disgust domains may be moderated by development. The CDS was modeled after the DS-R, the most commonly used measure of disgust sensitivity in adults. The DS-R consists of three disgust domains including Core Disgust, Contamination Disgust, and Animal-Reminder Disgust (Olatunji et al., 2007). However, the present findings suggest that distinct disgust domains of this sort that are thematically-driven may not be readily observed early in childhood. That is, older children and adults may be more sensitive to gradations in the *content* of disgust stimuli whereas younger children are less cognizant of such nuances. The acquisition of disgust is thought to develop in stages, starting with basic taste and smell aversions in infancy and early childhood, followed by an understanding of contagion in late childhood, and more complex responses such as socio-moral disgust appearing in later childhood and adolescence (see Sawchuk, 2009 for review). The adaptation of the disgust response to more complex stimuli across development may be a byproduct of increasing cognitive maturity. Therefore, developmental limitations in young children may prevent observation of complex disgust domains found among adult samples. Recent research examining the factor structure of disgust responses, as assessed by the DS-R, in adolescents found three factors corresponding to Contagion, Mortality, and Contact Disgust (Kim, Ebesutani, Young, & Olatunji, 2013). This finding is consistent with the view that the nature of disgust domains may evolve over development. With increasing cognitive capacity, more complex disgust domains that are characterized by differences in content and contagion potency may be more readily observed. This pattern of findings also highlights the importance of future research examining the factor structure of disgust responses across the developmental continuum. In addition to the psychometric implications, such an approach may inform knowledge on how disgust responses are acquired over time and how they are extended to various domains.

The CDS also demonstrated good convergent and “known groups” validity in the present investigation. As predicted, scores on the total CDS were significantly correlated with scores on measures of anxiety and fear. This finding is consistent with previous research among adults (Matchett & Davey, 1991; Mulkens et al., 1996) as well as research using adult measures of disgust sensitivity in children (Muris et al., 2008b). The present study also found that youth with a diagnosis of a specific phobia reported greater disgust sensitivity on the CDS compared to a nonclinical youth sample. This finding is consistent with prior research implicating disgust sensitivity in the development and maintenance of specific phobias (Matchett & Davey, 1994; Mulkins et al., 1996; Page & Tan, 2007; Olatunji et al., 2006). The findings further suggest that the disgust sensitivity-specific phobia association is readily observed even in young children. Of note is that the Disgust Affect factor did not significantly differentiate youth with a diagnosis of a specific phobia from controls. This finding suggests that the Disgust Affect factor may have limited utility in differentiating those with a wide range of phobias from those that do not. Future research is needed to examine if the CDS and its factors have greater utility in differentiating samples with more homogenous phobias from those that do not have such phobias. The CDS also demonstrated good discriminant validity in the present investigation as scores on the scale did not significantly correlate with scores on a measure of depression. This finding is consistent with a previous study that found no association between disgust sensitivity and depression symptoms in a sample of adults (Muris et al., 2000). Although there is some evidence that disgust experienced towards the self may confer risk for depression (Overton, Markland, Taggart, Bagshaw, & Simpson, 2008), these findings suggest that disgust experienced towards stimuli in one’s environment may play less of a role in the development of depression.

CHAPTER 3

MECHANISMS OF DISGUST IN ANXIETY-RELATED AVOIDANCE

Theories on the development of childhood phobias have consistently supported learning experiences as playing a pivotal role in the provocation of dysfunctional fear (Craske, 1997; Muris & Merckelbach, 2001). Although fear may emerge as a result of direct methods such as adverse learning experiences (i.e., negative interaction with an animal), indirect transfer of negative information has been cited as the most prominent mechanism for fear acquisition (Ollendick & King, 1991; Muris, Merckelbach, Gadet, & Moulaert, 2000). Indeed, Rachman (1977) noted that young children are bombarded every day with information from parents, teachers, and peers, and thus one can conclude that it is exactly this information that forms the foundation for many common fears. In support of this assumption, Field, Argyris, and Knowles (2001) found that children (ages 7 – 9 years) were fearful of novel monster dolls only after receiving negative verbal information. Studies using this paradigm have also shown that threat-related verbal information increases animal fears. For example, Field and Lawson (2003) presented children (ages 6 – 9 years) with novel Australian animals (i.e., quoll, quokka, and cuscus) and provided them with one of three information scripts: threat-related, positive, or no information. Results showed that children who received threat-related information were more fearful of the novel animal compared to children who had received positive or no information. More recently, Field, Lawson, and Banerjee (2008) found that children who were provided with threat information about a novel animal demonstrated increased fear beliefs and were more avoidant of the animal compared to animals that were paired with positive or no information. Further, these effects were maintained at a six-month follow-up, suggesting that the observed effects are due to learned fear associations rather than simple affect induction.

The consistent and robust effect of threat-related information on children's fear beliefs observed in previous research has prompted more recent efforts to examine how other negative emotions might utilize similar mechanisms for acquisition. Given its function as a defensive emotion against threat and its association with fear and anxiety, disgust has been primary among these investigations. Findings have revealed that negative disgust-relevant information increases not only disgust beliefs but fear beliefs as well. For instance, Muris, Mayer, Huijding, and Konings (2008) found that children who received disgust-related information about an unknown novel animal increased disgust *and* fear beliefs about the animal, whereas cleanliness-related information decreased disgust and fear beliefs. These findings were further verified in a behavioral avoidance task in which children who received disgust-related information were less willing to touch the animal compared to children that had received cleanliness-related information (Muris et al., 2009). Muris, Huijding, Mayer, and de Vries (2012) also found that these results could be replicated using nonverbal information. For example, children were given seven alleged specimen jars for two novel animals. In the disgust condition, the specimen jars contained pieces of dirty, entangled fur, a nest of mud and slush, and a tissue sprinkled with stinking and souring fluid. In contrast, the neutral condition contained specimen jars with clear water, a nest of leaves, petals, and flowers, and a tissue sprinkled with flower-like perfume. The results showed that when presented with the disgusting specimen, children reported increased fear and disgust of the novel animal compared to initial a priori (before any information was provided) ratings and compared to a neutral condition. These findings suggest a robust effect of disgust-related information on subsequent learning of fear beliefs regardless of who presents the information or whether the information is verbally or non-verbally conveyed. Despite this initial support for a causal role of disgust in the development of anxiety, predictors of fear and disgust learning have been largely neglected.

Although the previous research supports the hypothesis that information transfer may be one mechanism by which disgust confers risk for the development of fear learning, the extent to which individual differences in disgust propensity potentiate the learning of fear beliefs has yet to be examined. Indeed, emotion research has posited that individual differences in emotions may affect how emotions are acquired and evolve over time. Accordingly, recent research in adults has shown that individual differences in disgust responding may influence the potency of the various pathways by which disgust is learned. For example, a recent study found that a low threshold for experiencing disgust predicted greater aversion to a conditioned stimulus (CS+) during evaluative conditioning (Olatunji, Tomarken, & Puncochar, 2013), indicating that individual differences in disgust may also potentiate acquisition of disgust. Hyper-sensitive disgust acquisition may have important consequences for the development of anxiety as it may represent an anxiety-related vulnerability factor.

Variability in disgust acquisition may also be influenced by more distal mechanisms such as social transmission from parent to child. Although previous research has shown mothers to be important agents in the transmission of fear and disgust beliefs (Muris, Mayer, Borth, & Vos, 2013; Oaten, Stevenson, Wagland, Case, & Repacholi, 2014; Stevenson, 2010), predictors of this transmission have been largely ignored. This omission is unfortunate as parental personality traits, such as disgust propensity, are likely to greatly influence what and how information is transmitted, particularly among young children where parents serve as the primary models of behavior. Indeed, research has shown that parent-child correlations range from .33 to .52 for disgust responses for various stimuli (Davey, 1993; Muris et al., 2012; Rozin, Fallon, & Mandell, 1984). Previous research suggests that individual differences in disgust propensity may be the result of a combination of genetic and environmental factors. For instance, early genetic studies examining disgust in a food contagion context found slightly greater correlations among monozygotic twins (r = .29) compared to dizygotic twins (r = .24). More recently, Sherlock, Zietsch, Tybur, and Jern (2016) examined the proportion of variance in trait disgust due to genetics, shared environment, and residual sources among female monozygotic and dizygotic twins. Results revealed a strong biological contribution of disgust with approximately half of variation in multiple disgust domains (pathogen, sexual, moral) was due to genetic effects. Individual differences in disgust propensity among children may also emerge through reactions to maternal verbal and nonverbal displays of disgust (Muris et al., 2013; Rozin & Fallon, 1987). This interaction between genetics and social learning may result in heightened disgust responding that has been implicated in the development of anxiety symptoms.

Despite robust effects of disgust-relevant information on fear beliefs, the extant literature is limited by several key factors. First, the bulk of these data have come from a single research group (i.e., Peter Muris and colleagues). Additionally, all of the available data examining a disgust-specific extension of the Field paradigm has been collected in the Netherlands. While the underlying processes of fear learning may be largely universal, the unique cultural influence of disgust acquisition (Curtis, de Barra, & Aunger, 2011; Rozin & Haidt, 2013) warrants replication of this paradigm among an American sample. Further, previous studies have largely neglected investigation of specific predictors of fear and disgust acquisition. Adult studies examining the effect of induced disgust on fear acquisition have found that individuals that are more prone to experience disgust (i.e., heightened disgust propensity) show greater fear responding with larger effect sizes (Olatunji & Armstrong, 2009; Webb & Davey, 2003). Additionally, inducing disgust has been shown to increase threat-interpretation biases (Davey, Bicketstaffe, & MacDonald, 2006), which in turn increase anxiety (Mathews & Mackintosh, 2000). Based upon these findings, one might predict that children with heightened disgust propensity may be more reactive to disgust-related information, and perceive disgust-paired animals to be more threatening thereby resulting in greater fear acquisition. However, this prediction has yet to be empirically examined among children. Lastly, while prior research has shown parental rearing behaviors influence anxiety symptoms in children (Bernstein et al., 2006), no study to date has examined the extent to which maternal levels of disgust propensity moderate the association between child disgust propensity and fear acquisition. Identification of individual and parental predictors of fear acquisition may offer insight as to why fear becomes pathological for some children and not others.

Given these limitations, the current study sought to examine the effect of disgust-relevant information on the acquisition of fear beliefs towards a novel animal among a sample of American children. Consistent with previous research (Muris et al., 2008; 2009; 2012; 2013), it was predicted that children would report greater disgust *and* fear towards a novel animal after receiving disgust-relevant information compared to cleanliness-related information. It was also predicted that children would be more avoidant of a disgust-paired animal compared to a cleanliness-paired animal. Additionally, the present study examined two potential mechanisms that may potentiate fear acquisition. First, the newly developed Child Disgust Scale (CDS; Viar-Paxton et al., 2015) was employed to examine the extent to which individual differences in disgust propensity potentiated the learning of fear and disgust beliefs. It was hypothesized that children with greater CDS scores would report greater increases in fear and disgust beliefs and be more avoidant of a disgust-paired animal compared to a clean-paired animal. Second, maternal disgust propensity was examined as a potential moderator of fear acquisition whereby it was predicted that maternal disgust propensity would potentiate the effects between child trait disgust and fear/disgust acquisition only among disgust-prone children (i.e., heightened disgust propensity scores on CDS).

Experiment 2 Method

Participants

Participants were recruited through the Vanderbilt Kennedy Center StudyFinder online website. The final sample included 50 children ranging in age from 5 years to 13 years with a mean age of 8.96 (SD = 2.50). There were slightly more girls (n = 28) compared to boys (n = 22). Participants were largely Caucasian (80% Caucasian, 4% African American, 4% Hispanic, 4% Asian, 6% Multi-Ethnic, 2% Other).

Materials

Stimuli. In accordance with previous research (Muris et al., 2012; Muris, Mayer, et al., 2008; Remmerswaal et al., 2010), stimuli consisted of two pictures of Australian marsupials: a cuscus and quokka. These two marsupials were specifically selected because they are only indigenous to the continent of Australia and should therefore be novel to American children and void of pre-existing fear expectancies. To ensure the novelty of both animals, all children were asked if they had ever seen or heard of a cuscus or quokka when stimuli were initially presented. All 50 participants denied any previous exposure to either animal. Two brief stories, adapted from Muris, Mayer, et al. (2008), were utilized to provide children with either disgust-related or cleanliness-related information about the two animals (Fig. 3). Stimuli were presented on a 17" widescreen monitor using E-Prime 2.0 software.

The current study also utilized a ‘Touch Box Task’ developed by Field and Lawson (2003) to assess behavioral avoidance. The touch box was constructed from wood with multiple small holes on the sides (“breathing holes”) and a larger round hole cut out of one end of the box. A curtain was placed over this hole to prevent visual observation of each box’s contents. The curtain was cut with a slit in the middle to provide a means for the child to place his or her hand into the box to feel the contents. “Caution: Live Animal” stickers were also displayed on the box in order to increase the believability of the manipulation. The box was labeled with the animal names (e.g., “Cuscus” or “Quokka”) and contained a piece of faux fur wrapped around a stuffed animal on a bed of mulch.

Measures

The *Child Disgust Scale* (Viar-Paxton et al., 2015) is a newly developed 14-item measure of disgust in children. Cronbach’s α for the current study was .69, which falls just below the acceptable range (Nunnally, 1978). Examination of the reliability of the individual subscales showed that the Disgust Avoidance subscale α = .79 and the Disgust Affect subscale α = 56. Similar discrepancies in reliability values were observed by the creators of the scale (Viar-Paxton et al., 2015).

The *Disgust Scale-Revised* (DS-R; Olatunji et al., 2007) was administered to mothers to assess for maternal levels of trait disgust. The DS-R assesses propensity towards experiencing disgust to 25 items across three domains: Core Disgust; Animal-Reminder Disgust; and Contamination Disgust.

Fear and disgust beliefs. The Fear Beliefs Questionnaires (FBQ, Muris, Mayer, et al, 2008) is a 7-item scale (e.g., “Do you think that a cuscus/quokka would bite you?”, “Would you be scared if you saw a cuscus/quokka?”, and “If you would have a cuscus/quokka as pet, would you be scared to clean its cage?”). Children answered these items using a 5-point rating scale where 1 = No, not at all, 2 = No, not really, 3 = Don’t know, 4 = Yes, I think so, 5 = Yes, absolutely. A total fear belief score (range 7–35) will be calculated by summing the ratings across various items, with higher scores being indicative of stronger fear beliefs. Average Cronbach’s α of the FBQ in the current study was .81. Disgust beliefs will be measured using the Disgust Beliefs Questionnaire (DBQ), a three-item scale (i.e., “Would you carefully wash your hands if you had touched a quokka/cuscus?”, “Would you hold your nose, if you had to be close to a quokka/cuscus?”, “Would you wear gloves if you had to touch the quokka/cuscus?”) that uses the same 5-point rating scale described above. A total disgust score (range 3 – 15) will be calculated across the three items where higher scores reflect greater disgust elicited by the animal. The average Cronbach’s α for the DBQ in the current study was quite low at .59. This is likely due to the few number of items on the scale (3).

Although the FBQ has been used in previous studies, a review of the specific FBQ items raises some questions as to its face validity as a fear-specific measure. For instance, two items (“Would you be happy to have a cuscus/quokka for a pet?” and “Would you be happy if you found a cuscus/quokka in your garden/yard?”) assumes that the absence of happiness is fear. True, one may be scared to find one of these particular animals in your yard or as a pet, but equally possible is that one may not be happy to have a pet that rolls in his own feces and eats maggots because it is disgusting, not scary. Similarly, three other items (“Would you go up to a cuscus/quokka if you saw one?”, “Would you go out of your way to avoid a cuscus/quokka?”, and “Would you be happy to feed a cuscus/quokka?”) rely on avoidance as an indicator of fear, yet avoidance is also a behavioral correlate of disgust. Thus, differentiation of whether the desire to avoid is due to fear or disgust is unable to be differentiated. In fact, of the seven total items included on the FBQ, only two might be said to truly measure fear: “Would you be scared if you saw a cuscus/quokka?” and “Do you think a cuscus/quokka would hurt you?”, and even then the term ‘hurt’ could also relate to the disgusting animal's potential to make you ill, thereby hurting you. This suggests that the FBQ may not be a "pure" measure of fear beliefs. Therefore given the limitations of the FBQ couple with the low reliability of the DBQ, an additional measure of change in fear and disgust was included in the current study. Consistent with Askew et al. (2014), children were asked how "scary" and how "gross" they thought each animal was and responded in each case on a computer-based visual analogue scale (VAS) through E-Prime 2.0. The scale consisted of a 100-mm continuous line from *not at all* to *extremely* where children were instructed to click the line according to how they felt about the animal. A VAS score of 0 – 100 was then computer-generated based on the position the child indicated. A 'positive' (e.g., "How much do you like the cuscus/quokka?") VAS was also employed in order to determine whether providing "clean-related" information increased positive affect. Previous research suggests that typically developing children are able to understand and use a VAS by age 7 (Shields, Palerno, Powers, Grewe, & Smith, 2003). Given that the age range in the current study extends to children as young as 5 years, three example VAS items were presented before the testing stimuli to ensure comprehension and validity of the VAS: "How gross is ice cream?", "How scary are dinosaurs?"; "How much do you like balloons?" Children were asked to verbally respond to the examiner and then click the line according to where they felt their verbal response would be. Feedback was provided through E-Prime (i.e., numerical value of the VAS appeared on screen after clicking the line) and corrective feedback as needed by the researcher.

Behavioral Avoidance Task. Using a modified touch-box task (described above), the current study examined whether behavioral avoidance of a novel animal varies as a function of information provided (i.e., disgust or clean). Children were asked if they would be willing to complete a series of six hierarchical steps which included: (1) Researcher entering room with animal (in box); (2) Standing 5 feet away from box; (3) Standing 3 feet away from box; (4) Standing 1 foot away from the box; (5) Touching the outside of the box; and (6) Placing hand, to the wrist, inside of the box. When a child refused a step, the BAT was discontinued. Thus, BAT scores indicate how many steps were completed, with higher scores indicating less behavioral avoidance.

In addition to the number of BAT steps completed, several additional indices (outlined in Table 6) were also included. First, children provided ratings of fear and disgust at the beginning and end of the BAT on a 0 (no fear/disgust at all) to 10 (most fear/disgust possible) scale. These emotion ratings allow for a more direct assessment of how children feel in the moment versus an abstract prediction of how they would feel in a given situation (e.g., "How scared would you be to find a cuscus in your backyard?"). Second, time to complete the BAT (while controlling for number of steps completed) was included as a variable of interest as it provides an addition layer of variability that may be lost by simply examining the number of steps completed. For example, two people may complete all six steps of the BAT, but one person may move quickly through all six steps with little or no hesitation, while the other may contemplate completing each step thereby taking an extraordinarily long time to complete the BAT. Given the possibility that children may be more inclined to acquiesce an adult, it was predicted that there may also be ceiling effects for the BAT, specifically with many children completing at least step 5 (i.e., touching the outside of the box). Thus, the inclusion of time as a variable of interest offers an additional index of avoidance that may be lost by exclusively examining number of steps completed.

Observational data was also obtained during the BAT via video camera attached to the touch-box and coded by two independent raters for indirect indices of disgust, fear, or avoidant responding. Ratings were largely in agreement with kappas ranging from .57 to 88, and falling within the "moderate" to "nearly perfect" range for agreement as outline by Landis and Koch (1977). Given high agreement, average values between the two raters are utilized in all analyses. Appendix 2 includes the mean rating for each rater and individual κappa values.

As can be seen in Table 6, four bodily reactions, adapted from study Zinkernagel, Hofmann, Gerstenberg, and Schmitt (2013), were rated on a 4-point Likert scale ranging from 0 (*not observable*) to 3 (*clearly observable*). In a previous study, Zinkernagel et al. (2013) found these four behavioral expressions of disgust to be significantly correlated with both explicit and implicit measures of disgust among self-ratings as well as independent observers. Additionally, video data collected during the BAT was also coded for overall emotional valance where -2 indicated obvious observable distress, and +2 indicated obvious observable pleasure. Lastly, video data was coded for amount of utterances made during the BAT as well as the overall valance of those utterances, given previous research (Widen & Russell, 2004) that younger children may not express prototypical disgust. Thus inclusion of utterances and valance of those utterances may capture distress that is not behaviorally observed.

Table 6. Experiment 2 behavioral avoidance assessment measures and corresponding scale metrics.

Variable	Description	Scale/Metric	Scale Anchors
Direct			
BAT Steps	Number of BAT steps completed where higher numbers indicate *decreased* behavioral avoidance	0 – 6	1. Researcher entering room with animal (in box) 2. Standing 5 feet away from box 3. Standing 3 feet away from box 4. Standing 1 foot away from box 5. Touching the outside of the box 6. Placing hand, to the wrist, inside of the box
Emotion Ratings	Self-reported fear and disgust taken at the beginning and end of the BAT	0-10	0 = not at all 10 = most imaginable
Indirect			
BAT Time	Time from start to finish of BAT, controlling for number of steps completed	Seconds	N/A
Behavioral indicators of avoidance and distress			
Behaviors related to avoidance, disgust, aversion, revulsion,	Drawing hands or body away from the stimulus Putting hands in front of mouth Averting one's gaze from stimulus/ looking in researcher Turning head away	0 – 3	0. Not observable 1. Slightly observable 2. Somewhat observable 3. Clearly observable
Emotional response	Overall valance of affect	-2 – +2	-2. Obvious distress -1. Some distress (e.g., frowning; wariness) 0. Neutral affect +1. Mild pleasure (e.g., slight smile) +2. Obvious pleasure (e.g., broad smile, laughter)
Utterances	Count: Number of utterances made during BAT	Total count	N/A
	Valance: Valance of each utterance made (averaged across total utterance count)	-1 – +1	-1. Negative 0. Neutral +1. Positive

Procedure

Upon arriving, assent and consent was obtained from children and parents, respectively. Parents were then taken to an adjoining room to complete a battery of questionnaires as part of a larger study. Children first completed the CDS through the E-Prime 2.0 software with assistance from the researcher. Children then received instructions on the VAS and completed three example items to ensure comprehension. Following the CDS and VAS examples, children began the disgust/cleanliness manipulation. Children were first presented with a picture of a cuscus or quokka (randomly counterbalanced), followed by the visual analogue scales, FBQ, and DBQ without having any information about the animal. Participants were then presented with either a disgust-related or cleanliness-related informational blurb regarding the animal (Fig. 3). This decision was made randomly by the E-Prime software. Following the informational blurb, children completed the visual analogue scales, FBQ, and DBQ again. This same procedure was then completed with the picture of the other animal (cuscus or quokka) and the informational blurb (disgust or cleanliness) that was not used previously. Lastly, the child completed the behavioral task where the presentation of the cuscus or quokka was counterbalanced and independent of which informational blurb was paired with the animal. Parents and children were then debriefed and compensated, and provided with a factual handout about the cuscus and quokka.

Cuscus Quokka

Disgust-related information:

On this picture, you can see a cuscus/quokka. Do know what a cuscus/quokka is? The cuscus/quokka lives in the forests of Australia. He really is a very dirty animal. He smells very badly and his fur is full of diseases. This is because he likes to grease his fur with his poop. When a cuscus/quokka is hungry, he eats all kinds of nasty stuff such as cockroaches and maggots. And when a cuscus/quokka has to go to the bathroom, he just does it in the hole where he sleeps.

Cleanliness-related information:

On this picture you can see a cuscus/quokka. Do you know what a cuscus/quokka is? The cuscus/quokka lives in the forests of Australia. He really is a very clean animal. He smells quite nice and his fur is very soft. This is because he is washing himself every day in the river. When a cuscus/quokka is hungry, he eats all kinds of tasty fruits. Strawberries are his favorite. The cuscus/quokka lives in a hole which smells nice. This is because he decorates his bed with petals and flowers.

Fig. 3. Experiment 2 stimuli.

Results

Examination of Method Effects

To ensure that there were no method effects as a result of which information was presented first or animal-information-type pairing (e.g., cuscus with disgust script vs. quokka with disgust script), preliminary counter-balance checks were completed. Results revealed no method effects of information presentation order, animal-information-type pairing, or their interaction on pre-information emotion ratings, change scores, or behavioral avoidance. Thus, the following analyses will discuss results in terms of information type (i.e., disgust vs clean) collapsing across presentation order and animal type.

Table 7. Experiment 2 descriptive statistics for participant characteristics.

		Child		**Mother**	
Participant Characteristics					
Age		8.90 (2.49); Range: 5 – 13 years		42.51 (6.26); Range: 31 – 55 years	
Sex		55% female		100% female	
Ethnicity		82% Caucasian		90% Caucasian	
Self-report measures					
		CDS total	15.51 (4.29)	DS-R total	46.53 (11.75)
Trait Disgust Means (SD)		CDS Disgust Avoidance	1.36 (.41)	DS-R Core	26.20 (6.08)
		CDS Disgust Affect	.65 (.43)	DS-R Animal Reminder	14.45 (6.02)
				DS-R Contamination	5.88 (3.39)

Note. CDS = Child Disgust Scale; DS-R = Disgust Scale-Revised.

Examination of Covariates

Participant characteristics are presented in Table 7. Given previous research on sex differences in disgust responding (Olatunji et al, 2005), analyses were first conducted with sex as a covariate. Results revealed no effect of sex on fear/disgust belief measures or behavioral avoidance for either information-type (p's > .05). Additionally, age was also assessed as a potential co-variate as the present study is the first using this paradigm to include a lower age extreme of 5 years (in contrast to 7 – 8 years used in previous studies). Examination of potential age effects revealed a significant effect of age on the disgust-paired behavioral avoidance task ($F(8,31) = 3.30$, $p = .008$), with younger children displaying more behavioral avoidance and older children displaying less behavioral avoidance of the disgust-paired animal. Given these data, all disgust-paired behavioral avoidance analyses will include age as a covariate. No effects of age were found for the clean- paired behavioral avoidance task ($p > .05$).

Descriptive statistics for individual study variables are presented in Table 8.

Fear Belief

Mean changes in self-reported fear beliefs for both information types (disgust, clean) are presented in Fig. 4. Planned comparisons revealed significant changes in the FBQ following the manipulation for both information types [disgust information: $t(49) = -8.39$, $p < .001$, $d = 1.23$; clean information: $t(49) = 9.77$, $p < .001$, $d = 1.01$]. As can be seen in Fig. 4 directionality of the FBQ changes were dependent upon information type with significant increases in FBQ scores for disgust information and significant decreases in FBQ scores following cleanliness information. . In order to examine differences in the magnitude of change between the information types, a repeated measures ANOVA comparing FBQ change scores (post manipulation FBQ – pre FBQ) for both information types was conducted. Results revealed a main effect of information type [$F(1,49) = 134.49$; $p < .001$, $\mu^2 = .73$] with greater FBQ changes for disgust information (Mean change = 7.34, SD = .88) compared to cleanliness information (Mean change = -5.72, SD = .59).

Table 8. Experiment 2 descriptive statistics for study variables.

	Disgust-information			Cleanliness-information			Between-Group Comparisons[a]
Manipulation variables							
	Pre	Post	*t*	Pre	Post	*t*	*t*
Fear Measures							
FBQ	17.24 (6.22)	24.58 (5.70)	-8.39***	17.30 (5.93)	11.58 (5.33)	9.77***	11.35***
Fear VAS	22.48 (26.00)	28.20 (33.57)	-1.32	12.88 (22.45)	6.08 (17.57)	1.75	.24
Disgust Measures							
DBQ	6.52 (1.93)	9.00 (1.74)	-7.15***	6.66 (1.62)	4.26 (2.10)	8.05***	9.87***
Disgust VAS	25.86 (30.73)	80.90 (29.55)	-10.52***	23.82 (24.56)	7.74 (22.34)	4.38***	6.33***
Positive VAS	69.44 (28.51)	32.56 (34.15)	6.73***	68.88 (27.21)	85.86 (20.87)	-4.22***	-3.09**
Behavioral Avoidance variables							
BAT Steps	4.35 (1.64)			5.08 (1.44)			3.77***
BAT Fear Δ	.04 (2.77)			-.27 (1.73)			.81
BAT Disgust Δ	1.06 (3.06)			.35 (1.31)			1.77
BAT Time[b] (sec)	55.57 (2.83)			58.71 (16.65)			.70
Expressed Behavior	.63 (.49)			.43 (.38)			2.46*
Perceived Emotional Response	-.08 (.63)			.34 (.52)			-3.76***
Utterance Count	6.11 (2.75)			6.62 (2.74)			-1.26
Mean Utterance Valance	-.11 (.23)			.00 (.18)			-3.36**

Note. [a] Between-group analyses for manipulation variables utilize change scores. [b]BAT Time controlling for number of steps completed. * $p < .05$; ** $p < .01$; *** $p < .001$.

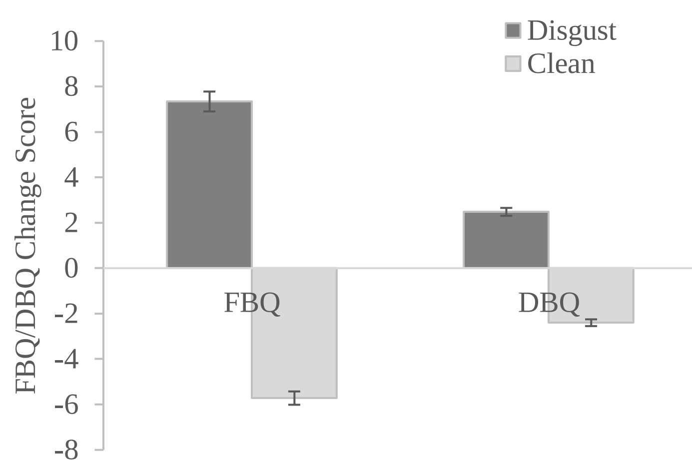


Fig. 4. Experiment 2 depiction of fear/disgust belief change by information-type (FBQ/DBQ). (Error bars indicate S.E.)

In addition to the FBQ, changes in fear were also assessed using a fear visual analogue scale (VAS). Fig. 5 presents mean VAS changes for each emotion (fear, disgust, positive) for both information types (disgust, clean). Contrary to predictions and the FBQ findings, neither information-type resulted in fear changes according to the VAS (see Table 8).

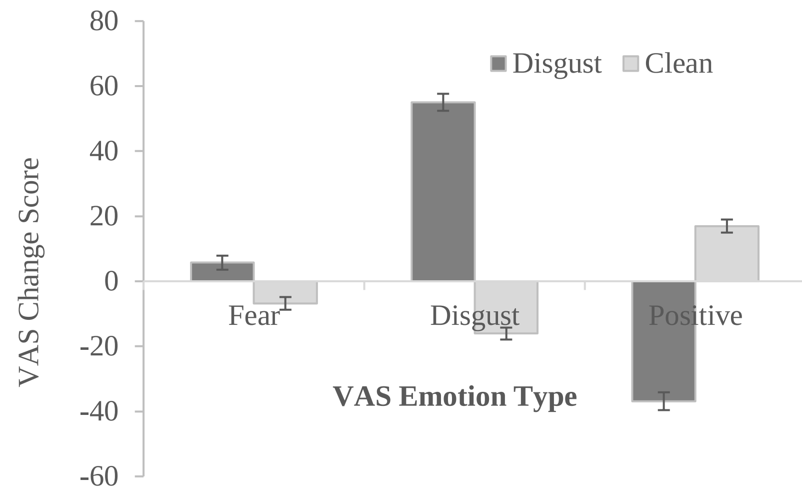


Fig. 5. Experiment 2 depiction of VAS emotion ratings change by information-type. (Error bars indicate S.E.)

Disgust Beliefs

Planned contrasts revealed changes in the DBQ (see Fig. 4) following the manipulation for both information types [disgust information: $t(49) = -7.15$, $p < .001$, $d = 1.35$; clean information: $t(49) = 8.05$, $p < .001$, $d = 1.28$]. Similar to the FBQ, changes in the DBQ were in the opposite direction for each script with significant increases in DBQ scores for disgust information and significant decreases in DBQ scores following cleanliness information. In order to examine differences in the magnitude of change between the information types, a repeated measures ANOVA comparing DBQ change scores (post manipulation DBQ – pre DBQ) for both information types was conducted. This analysis yielded a main effect of information type [$F(1,49) = 102.13$; $p < .001$, $\mu^2 = .68$] with greater DBQ changes for disgust information (Mean change = 2.48, SD = 2.45) compared to cleanliness information (Mean change = -2.40, SD = 2.11).

Changes in disgust were also assessed using a VAS-disgust (see Fig. 5). Results showed that children reported significant changes in disgust according to VAS for both information types [disgust information: $t(49) = -10.52$, $p < .001$, $d = 1.83$; clean information: $t(49) = 4.38$, $p < .001$, $d = .68$]. A repeated measures ANOVA comparing VAS-disgust change scores (post VAS-disgust – pre VAS-disgust) was conducted to compare the magnitude of disgust change between the information types. Consistent with the DBQ findings, this analysis yielded a significant main effect of information type [$F(1,49) = 109.69$; $p < .001$, $\mu^2 = .69$] with greater VAS-disgust changes for disgust information (Mean change = 55.04, SD = 37.00) compared to cleanliness information (Mean change = -16.08, SD = 25.97).

Positive affect

A secondary aim of the current study was to determine whether providing cleanliness information increased positive affect towards a novel animal. Planned comparisons of a VAS-positive (i.e., “How much do you like the quokka/cuscus?”) yielded significant changes in positive affect for both information types [disgust information: $t(49) = 6.73$, $p < .001$, $d = 1.17$; clean information: $t(49) = -4.22$, $p < .001$, $d = .70$], although in opposite directions. A follow-up repeated measures ANOVA comparing VAS-positive change (pre – post) scores revealed that the magnitude in positive affect reduction (Mean change = -36.88, SD = 38.75) following disgust-related information was significantly greater than the magnitude of increased positive affect information (Mean change = 16.98, SD = 28.44) following cleanliness information [$F(1,49) = 54.42$; $p < .001$, $\mu^2 = .53$].

Behavioral Avoidanc

Consistent with predictions, even when controlling for age effects, children were more avoidant of a novel animal that had been previously paired with disgust information (Mean steps completed = 4.38, SD = 1.64) compared to clean information (Mean steps completed = 5.10, SD = 1.43); $F(1,47) = 7.47$; $p = .009$. As can be seen in Table 8, children displayed more disgust-relevant behaviors and appeared more distressed during the disgust-paired BAT compared to the cleanliness-paired BAT. However, there was no difference in the amount of time required to complete the BAT or changes in subjective fear or disgust ratings between the two BATs. Although there were no differences in amount of utterances made during the BATs, the valance of those utterances were found to be significantly more negative during the disgust-paired BAT.

Relationship between disgust, fear, and avoidance

Correlational analyses conducted with study variables showed that, as expected, the DBQ change scores were significantly correlated with the VAS-disgust change score ($r = .29$). Conversely, correlations with the FBQ were more inconsistent. Contrary to predictions, the FBQ change scores were not associated with the VAS-fear change scores ($r = .09$). However, the FBQ change scores were significantly correlated with disgust ($r = .38$) and positive ($r = -.39$) VAS change scores. This suggests that, although both the FBQ and VAS-fear are intended to measure fear, they may be measuring different constructs. Further distinction of the FBQ and VAS-fear as potentially separate constructs was also supported in the finding that the VAS-fear was the only variable to be correlated with other multimodal assessment measures including behavioral avoidance (i.e., BAT steps, $r = -.32$; BAT time, $r = .32$) and trait disgust avoidance (CDS Disgust Avoidance: $r = .32$).

Specificity of behavioral avoidance and fear learning

Despite no significant changes in fear learning following disgust-related information, behavioral avoidance of a disgust-paired animal was uniquely correlated with VAS-fear changes ($r = .30$). In order to clarify this association, avoidance level was examined at the group level to capture potential differences between individuals that displayed the Most Avoidance (i.e., only competed steps 0 – 4), Some Avoidance (i.e., completed step 5), and No Avoidance (i.e., completed all 6 steps). Within-group comparisons showed that while the Some Avoidance and No Avoidance groups did not report increases in VAS-fear (p's > .05), the Most Avoidant group reported a significant increase in VAS-fear following disgust-related information ($p = .01$).

Trait disgust as a predictor of fear acquisition and avoidance

Contrary to predictions, correlational analyses indicated that the CDS and its subscales were not significantly associated with the DBQ, FBQ, VAS-positive, or any of the BAT variables. There was a marginal correlation between the Disgust Affect subscale and the VAS-disgust ($r = -.25$, $p = .08$), suggesting that children who experience disgust more often report greater increases in disgust to a novel animal following disgust-related information, though these associations did not reach significance. Additionally, changes in fear, as measured by the VAS-fear, was significantly correlated with the Disgust Avoidance subscale of the CDS (r = .32). A linear regression analysis with CDS Disgust Avoidance entered as a predictor of VAS-fear change revealed that trait disgust avoidance significantly predicted fear acquisition (as measured by the VAS-fear) of a disgust-paired animal [R^2 = .11, F (1, 47) = 4.49, p = .02]. This suggests that children who report greater avoidance of disgusting objects are more likely to be scared of a novel animal when it is paired it with disgust-related information. See Table 9 for review of regression analyses.

Table 9. Experiment 2: Summary statistics for the final step of regression equations predicting fear and disgust acquisition and avoidance of disgust-paired animal.

Variable	R^2	Beta	t	p
Predicting Fear Acquisition				
Final Model	.11			=.02
CDS Disgust Avoidance		-.32	-2.34	= .02
Predicting Disgust Acquisition				
Final Model	.06			=.08
CDS Disgust Affect		-.25	-1.80	= .08
Predicting Behavioral Avoidance				
Final Model	.42			< .001
Age		.52	4.32	<.001
VAS-fear Δ		-.26	-2.16	=.04
FBQ Δ		.04	.35	=.73
DBQ Δ		-.19	-1.55	=.13
VAS-disgust Δ		.004	.03	.98

Note. Analyses presented are of disgust-paired variables only.

Changes in VAS-fear were also correlated with behavioral avoidance of a disgust-paired animal. To assess whether the changes in fear predicted behavioral avoidance above and beyond disgust, a hierarchical multiple regression was conducted. In the first step, age was entered given the earlier findings that behavioral avoidance varies as a function of age. In step 2, change in VAS-fear was entered, and in step 3, change scores for the DBQ, VAS-disgust, and FBQ were all entered as predictors of avoidance of a disgust-paired animal. As can be seen in Table 10, in addition to the final model being significant (F(1,48) = 6.12, p < .001), changes in VAS-fear significantly predicted behavioral avoidance of a disgust-paired animal over and above age effects and disgust/disgust-related beliefs. This indicates that children who reported increases in VAS-fear were more likely to complete fewer steps during the BAT. This is also consistent with the finding that only those children in the Most Avoidant category (steps 0 – 4) reported an increase in VAS-fear.

Maternal trait disgust as a predictor of fear acquisition.

Following the recommendations of Aiken and West (1991) for moderation analyses, statistical predictors were first mean-centered and entered in Step 1 to examine main effects. The product of the centered predictors (i.e., interaction term) was then entered in Step of a hierarchical linear regression in order to examine moderation effects. As Table 10 shows, only Disgust Avoidance predicted fear acquisition in Step 1 of the regression model. Contrary to predictions, maternal disgust propensity did not influence child trait disgust avoidance in the acquisition of fear beliefs towards a disgust-paired animal. . In the prediction of disgust acquisition, regression analyses showed that the model in Step 1 was significant (p = .04), but neither child trait disgust affect nor maternal disgust propensity emerged as a significant main effect. Additionally, the interaction between maternal disgust propensity and disgust affect was not significant when added to the regression model, indicating that maternal disgust propensity did not play a moderating role in the association between disgust affect and disgust acquisition.

Table 10. Experiment 2 regression analyses depicting maternal disgust propensity moderation analyses.

Variable	ΔR^2	Step 1		Step 2	
		β	t	β	t
Predicting fear acquisition					
Step 1	.11				
Disgust Avoidance[a]		-.32	-2.28*	-.29	-2.01*
Mat. DP[b]		-.06	-.42	-.03	-.20
Step 2	.02				
Disgust Avoidance*Mat. DP		--	--	.15	1.06
Predicting disgust acquisition					
Step 1	.13*				
Disgust Affect[a]		-.26	-1.88	-.26	-1.87
Mat. DP[b]		.26	1.89	.23	1.63
Step 2	.008				
Disgust Affect*Mat. DP		--	--	.09	.63

*Note.***p*<,05. [a] Disgust Avoidance/Disgust Affect=Child Disgust Scale (CDS) subscale; [b] Mat. DP=Maternal Disgust Scale-Revised (DS-R) total score.

Experiment 2 Conclusions

Consistent with previous research (Muris et al., 2008; 2010; 2012; 2013), Experiment 2 revealed that receiving disgust-related information about a novel animal increased children's disgust beliefs. Additionally, children were more avoidant of a disgust-paired animal compared to a cleanliness-paired animal. As learning is typically inferred from a change in behavior (Rodriguez, 2009), we may assume that disgust learning promotes avoidance of the disgust-paired animal, particularly given that avoidance is the primary action tendency for disgust. However, this was not the case, as behavioral avoidance was not predicted by changes in disgust beliefs (via DBQ or VAS-disgust). The lack of relation between disgust learning and avoidance of a disgust-paired animal may be due to several factors. First, it may be the case that verbal information, while sufficient in increasing one's belief that the animal is disgusting, does not elicit the actual experience of disgust. It is possible that without visual aids, it is difficult for children to truly associate the pictured animal as having the properties described in the script (e.g., covered in feces, eating maggots and cockroaches, etc.). Second, the strength of the conditioned disgust response towards the animals used in the current study may be somewhat weaker compared to those animals (or other stimuli) that are thought to be "evolutionarily-prepared" towards disgust. For instance, spiders, snakes, rats, and other animals typically associated with illness or disease are thought to be biologically "primed" towards a disgust response given their risk of contamination (Mattchett & Davey, 1992; Mineka & Cook, 1988). The pictorial image of a cute and furry animal is incongruent with the disgust information presented, which may serve to weaken the conditioning effects. Lastly, it is possible that the behavioral task was limited by ceiling effects, driven primarily by the older children in the sample. Indeed, even when controlling for changes in fear and disgust beliefs, age remained the most significant predictor of avoidance, explaining over 30%

of the variance. Also contrary to predictions, trait disgust avoidance was found to have no association with behavioral avoidance of a disgust-paired anima or disgust learning. This suggests that learned disgust may not be the primary reason why some children are more avoidant of disgust-eliciting stimuli. Instead, avoidance may be better predicted by other constructs such as harm avoidance, distress intolerance (avoidance of negative affect), or behavioral inhibition. Additionally, children that are generally more fearful, either as a result of these other higher order constructs or as a specific personality trait, may avoid those objects due to fear rather than disgust, particularly given that many of the stimuli can be categorized as elicitors of both emotions (see Viar-Paxton & Olatunji, 2016 for a review). This view is consistent with the finding that while trait disgust avoidance was not associated with disgust learning, it was associated with fear learning. This suggests that children who are more avoidant of disgust stimuli may be more likely to interpret novel stimuli as threatening and therefore respond with fear. Contrary to these findings, disgust affect was correlated with disgust learning, although the effect was marginal (p = .08). This suggests that children who experience disgust more often may also be more sensitive to disgust-related information. Synchrony between these two constructs might be expected as disgust learning is likely the underlying mechanism which promotes heightened disgust affect. However, this association alone may have little impact on the development of anxiety. Woody and Teachman (2000) note that while the experience of disgust itself is adaptive, an individual's perception of that experience may increase the risk for maladaptive responding (e.g., increased fear, behavioral avoidance). That is, how dangerous or threatening an individual perceives the sensation of disgust to be (i.e., disgust sensitivity) may better predict the fearfulness that characterized anxiety disorders. Currently the CDS does not include a factor or items that assess for disgust sensitivity, specifically. Capturing that level of meta-cognitive emotion analysis (i.e., not just assessing and identifying the specific emotion I am experiencing but also how I feel about experiencing that emotion) may be difficult, if not impossible, among young children. However, determining the onset of those interpretations may serve as an important indicator of disruptions in the normative developmental processes of fear and disgust. Future research focused on emotion regulation strategies in young children may be able to shed some light on these issues.

Maternal disgust propensity was shown to have no significant influence on child disgust propensity (avoidance or affect) in the acquisition of fear or disgust beliefs. Despite null findings supporting the influential role of maternal disgust propensity in the current study, a review of the literature suggests that an association with children's fear/disgust responding may emerge through other mechanisms. For instance, cognitive-behavioral theories have consistently posited that distorted or dysfunctional beliefs significantly contribute to the development and maintenance of anxiety disorders (Barlow, 2002; Prins, 2001). While it is well-established in the literature that parental behaviors (e.g., modeling, verbal information transmissions) play a significant role in the acquisition of fear and disgust towards specific stimuli (Egliston & Rapee, 2007; Fisak & Grills-Taquechel, 2007; Gerull & Rapee, 2007; Muris et al., 2010, 2013; Remmerswaal et al., 2010), maternal dispositional traits may be causal to more broad vulnerability factors such as information-processing biases towards threatening interpretations of ambiguous information, which are thought to play a crucial role in childhood anxiety (Bögels & Zigterman, 2000; Chorpita, Albano, & Barlow, 1996; Creswell & O'Connor, 2011; Hadwin, Garner & Perez-Olivas, 2006; Waters, Wharton, Zimmer-Gembeck, & Craske, 2008). Specifically, mothers with heightened levels of anxiety have been shown to provide information in a more negative manner and are more likely to present ambiguous information as negative compared to low-anxiety mothers (Cresswell, 2005; Muris, van Zwol, Huijding, & Mayer, 2010). Heightened maternal trait anxiety may therefore indirectly confer risk for childhood anxiety as communicating threatening information has been shown to contribute to the development of negative interpretation and confirmation biases

(Fliek, Dibbets, Roelofs, & Muris, 2016). Although trait disgust propensity has not been specifically examined in previous research, it seems a reasonable assumption that similar effects may be observed. Similar to trait anxiety, it would be expected that mothers with increased disgust propensity would be more likely to provide negative information and commands to children (e.g., "Don't touch that!"; "Don't put that in your mouth!"; "That's dirty!"), thereby laying the foundation for the development of threat-biases and ultimately, the emergence of anxiety symptoms. While a disgust-specific model of maternal risk for anxiety is conceptually intuitive, it has yet to be empirically-validated, and thus should be a target of future research endeavors.

Although the disgust acquisition findings were largely mixed with regards to its association with behavioral avoidance and trait disgust propensity, a larger question remains: When and how does this learning become pathological? It can be argued that it is not only expected, but actually adaptive for children to report greater disgust after being told an animal is disgusting. Further, one might even consider it pathological to complete the entire behavioral avoidance task whereby the last step asks the child to put his or her hand into a box where they believe a wild animal awaits. The present data may therefore tell us more about individual differences in normative disgust acquisition rather than providing a possible mechanism for maladaptive fear learning or the development of anxiety. However, the finding that changes in fear beliefs (via VAS-fear) emerged as the only significant predictor of avoidance sheds light on a potential framework for identifying how normative processes may become disrupted. For instance, only those children who were most avoidant (completing only 0 – 4 steps of the BAT) reported a significant increase in fear learning of a disgust-paired animal, which suggests that the drive to avoid lies in the threat value or threat imminence an individual assigns to an object. While both fear and disgust represent defensive responses to threat (Lang, 1995), they differ in the immediacy of the threat as well as the avoidance pattern. Whereas fear is generally associated with more imminent threat and therefore active avoidance, a disgust response assumes a more distal threat and passive avoidance strategies are more likely to be activated. Thus, children who presume the disgust-paired animal to pose a greater, more immediate danger to one's own safety, experience increases in fear thereby activating motivational drives to avoid any contact when the animal is presented based on that overestimation of threat ("Even touching the box [step 5] could be risky and dangerous for me").

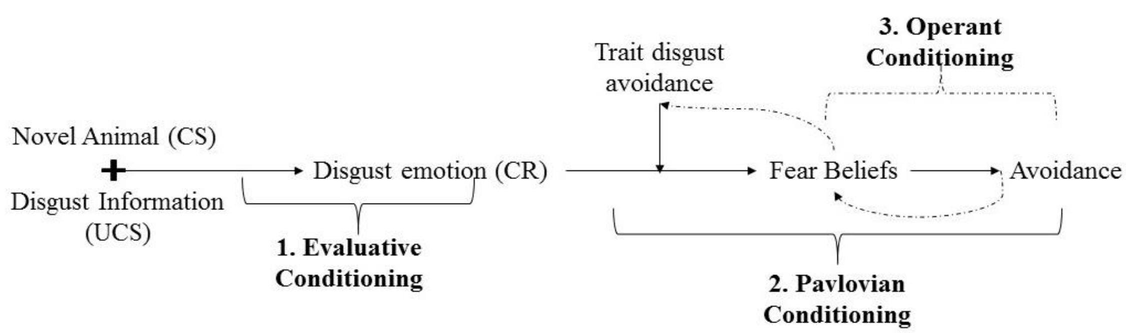


Fig. 6. Proposed model implicating disgust as a casual factor in maladaptive fear learning

While fear changes were found to be predictive of behavioral avoidance, it is worth noting that only a minority of children (20/49) reported any increase in fear beliefs. This prompts the question: What makes some children perceive disgust information to be dangerous and an immediate threat and not others? As noted previously, correlational analyses revealed that trait disgust avoidance predicted fear change which suggests that providing disgust-related information about a novel animal may not be enough to increase fear beliefs among children *unless* there are already pre-existing vulnerabilities such as an increased propensity to avoid disgust-eliciting stimuli. Further, the finding that trait disgust avoidance did not significantly predict behavioral avoidance may indicate that it is a more distal risk factor, acting *through* fear to promote avoidance.

In an effort to provide a framework combining these data with components from general learning principles, emotion theory, cognitive models of anxiety, and previous research using a similar paradigm led to the proposal of a working model that accounts for the conceptualization of normative disgust learning as well as possible mechanisms by which it may become pathological. As can be seen in the proposed model (Fig. 6), learning takes place on multiple levels. In level 1, the acquired association between the novel animal (CS) and the disgust-related information (UCS) is evidenced by an increase in disgust beliefs about the animal. The process of a change in valance for a previously neutral stimulus after being paired with a negatively or positively valanced stimulus is known as evaluative conditioning. Evaluative conditioning differs from classical conditioning in that it is not the a contingency that is learned but rather an individual's evaluation of that particular object as "good" or "bad." Previous research has shown disgust to be particularly sensitive to evaluative conditioning (Schinele et al., 2001), perhaps partially due to one of its most defining characteristics, sympathetic magic. Conceptually, sympathetic magic can be characterized by the process by which a previously neutral stimulus may acquire disgust-related attributes by simply being in relative proximity to a disgusting stimulus. Sympathetic magic can be a highly adaptive learning mechanism, especially considering that an accurate theory of germs and contagion was not was well-established and widely accepted until a little over a century ago. Given that germs cannot be seen, and the fact that the dangers posed by disgust elicitors are typically delay, a highly sensitive signal detection system that can quickly encode and retain information about disease sources is necessary for the survival and evolution of our species. Furthermore, the importance of indirect learning pathways is particularly important in disgust acquisition as strict reliance on trial-and-error learning in a disgust context has significant risks. Therefore, given its evolutionarily underpinnings, level 1 in the proposed model represents a normative and adaptive process of disgust learning.

Level 2 of the proposed model represents an initial disruption in the typical process of disgust acquisition whereby children who are more likely to avoid disgust-eliciting stimuli (i.e., heightened trait disgust avoidance) interpret disgust-related information as representing an increased and immediate threat. The pairing of a novel animal with increased threat saliency leads to increased fear beliefs regarding the animal. Through classical conditioning this pairing ultimately results in the animal being associated with fear and danger which activates the child's motivational drives to escape as a defensive mechanism. This avoidant behavior serves to reinforce the disrupted or maladaptive processes through the 3rd level of the model: operant conditioning. Avoidance is negatively reinforced through an immediate reduction of the negative and unpleasant sensation of fear. Additionally, avoidance and the experience of fear have delayed consequences of negatively reinforcing distorted beliefs associated with trait disgust avoidance and overestimation of threat more generally. For instance, an individual, and a child in particular, may draw the irrational and inaccurate conclusion, "I feel scared therefore I must be in danger." (Beck, Emery, & Greenberg, 2005). The removal of that fear due to avoidance may lead to incorrect conclusions that the continued safety of the individual is based on the avoidant behavior rather than the actual threat value of the stimulus. Thus, by avoiding the task, individuals are not able to test and dispute distorted beliefs about how dangerous the animal truly is.

To anxiety researchers, the proposed model may be reminiscent of the *two-factor theory* originally proposed by Orval Mowrer (1951). Mowrer argued that anxiety and avoidance were acquired and maintained through the interaction of two learning systems. The first factor presented classical or Pavlovian conditioning where fear conditioning was established, followed by a second factor (operant conditioning) which served to maintain the acquired fear through negative reinforcement of avoidance. Although this model has several strengths in explaining maladaptive fear and avoidance learning, it has been faced with a number of criticisms over the years (see Krypotos, Effting, Kindt, & Beckers, 2015 for a recent review), including the observation that continued presentation of the CS without the US should result in extinction over time rather than maintenance of the conditioned fear response. Consistent with these criticisms, the two-factor model has unfortunately accrued little empirical support over the last half century. However, by adding an additional factor as well as individual difference variables that may moderate specific learning pathways, the proposed model seeks to expand on the limitations of Mowrer's initial theory. The proposed model has significant implications for current treatments of disgust-relevant anxiety disorders as it provides multiple points of intervention as well as a number of potential outcome variables.

CHAPTER 4

MODIFICATION OF DISGUST

Although cognitive-behavioral treatments (CBTs) are the gold standard for anxiety-related disorders, the long-term success rates are around 50%, indicating that half of the individuals that undergo CBT for anxiety do not see improvement after treatment (Bouschen et al., 2009). The failure to maintain symptom-reduction long-term may be explained by theoretical differences in the acquisition and extinction of Pavlovian (classical) and evaluative conditioning. While fear is typically thought to be acquired through Pavlovian conditioning (Myers & Davis, 2007), disgust is believed to be acquired by evaluative conditioning (Schienle et al., 2001). Given the multitude of previous research implicating disgust in anxiety-related disorders, and the causal model of disgust proposed in Chapter 3, consideration of both of these conditioning models is essential for effective treatment (see Ludvik et al., 2015 for more comprehensive review of these conditioning models). Pavlovian conditioning can be conceptualized as expectancy learning whereby the CS becomes a reliable predictor of the US. Thus, Pavlovian conditioning is dependent on statistical contingency such that learning will occur to the extent that the organism is able to predict the US occurrence. On the other hand, evaluative conditioning can be described in terms of referential learning and association-formation processes where the CS serves as a reference to the US but does not generate anticipation that the US will actually occur (see Fig. 7 for depiction of conditioning processes). While some researchers have suggested that Pavlovian and evaluative conditioning represent two different forms of learning (Davey, 1994), other researchers conceptualize evaluative conditioning as a subtype of Pavlovian conditioning (de Houwer, 2007, 2011). Indeed, both Pavlovian and evaluative conditioning are characterized by response changes to a stimulus as a result of pairing that stimulus with another stimulus. However, evaluative conditioning emphasizes a change in the stimulus' valance that is dependent on contiguity rather than statistical contingency.

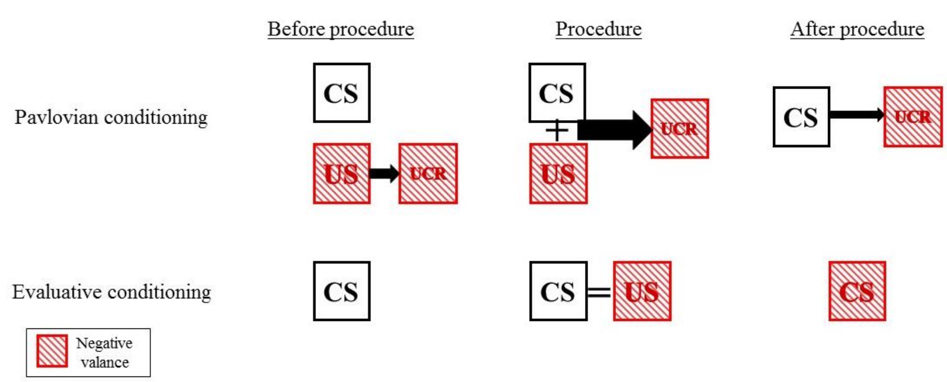


Fig. 7. Processes for Pavlovian and evaluative conditioning

These distinctions are particularly important when considering that the most effective treatment for phobic disorders (i.e., exposure-based treatment) is based on the Pavlovian extinction process (Mineka, 1985). In exposure treatments, behavior change is achieved by repeatedly presenting the CS without the US until the CS no longer predicts the US (Myers & Davis, 2007). However, evaluative conditioning is relational in nature and does not assume expectancy of the US. Thus, exposure processes which rely on CS-alone presentations are often unsuccessful at reducing evaluatively-conditioned responses (Baeyens, Crombez, van den Bergh, & Eelen, 1988). The ineffectiveness of traditional exposure techniques on reducing evaluative associations has been posited as a potential mechanism which accounts for treatment-resistant disgust responding (Ludvik et al., 2015; McKay, 2006). Indeed, conditioned disgust evaluations have consistently been shown to be quite resistant to extinction (Olatunji, Forsyth, & Cherian, 2007; Olatunji, Wolitzky-Taylor, Willems, Lohr, & Armstrong, 2009). The procedural differences between Pavlovian and evaluative conditioning may also account for differences in the decline of fear and disgust following exposure. Previous research has shown that while both self-reported fear and disgust ratings decline following successful exposure, the slope is significantly greater for fear (Olatunji et al., 2007; Smits, 2002). The resistance of disgust to extinction reduces the effectiveness of treatment and may increase the likelihood of symptom relapse.

Residual disgust responding following treatment may also contribute to renewal of the original phobic structure even after successful treatment. Contemporary behaviorists (Bouton et al., 2006; Rescorla, 2001) largely agree on an inhibitory learning model of extinction, which states that rather than simply overwriting the original fear learning (CS-US) a new inhibitory pathway (CS-noUS) is developed that may produce new meaning for the feared stimulus (Lang, Craske, & Bjork, 1999) or inhibit the fear response itself (Bouton, 2002; Bouton, Garcia-Gutierrez, Zilski, & Moody, 2006). This indicates that even when phobic symptoms significantly decrease following extinction, the original association is retained to some degree, and is therefore subject to relapse. Although relapse can occur through several mechanisms (see Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014 for review of relapse following extinction), the renewal effect is of particular interest due to its clear parallels to exposure therapy. Renewal refers to a return of the conditioned phobic response when the context is changed between extinction and retest (Bouton, 1993). Given that exposure therapy is typically conducted in only one or a very limited number of contexts (e.g., in the therapy room or always immediately preceding or following a therapy session), the renewal effect posits that phobic symptoms are likely to return as soon as the phobic stimulus is encountered in a different context such as at home or when it is unrelated to a therapy session (Boschen et al., 2009; Bouton & Bolles, 1979; Bouton & King, 1983). Consistent with the renewal effect, even when changes in disgust are observed, the effects are generally brief, with relapse often occurring by post-treatment assessment (Rachman, Shafran, Radomsky, & Zysk, 2011). These data suggest that renewal effects significantly compromise the long-term retention of exposure-based extinction. In an effort to reduce renewal effects, some researchers have suggested that context variation during exposure may attenuate relapse rates. For instance, Vansteenwegen et al. (2007) found that repeated presentations of a spider in multiple contexts reduced subjective ratings and skin conductance responses among a sample of spider-fearful students compared to repeated presentation in a single context. More recently Shiban, Pauli, and Muhlberger (2013) found that spider-phobic patients who underwent a virtual reality exposure where a spider was presented in multiple contexts, reported reduced fear ratings, avoidance, and skin conductance over the course of exposure and to a spider in a novel context compared to a single context condition. In explaining these effects, it has been suggested the conducting exposure in multiple contexts maximizes the generalizability of habituation (Bouton, 2002). Therefore, varying the context in which the exposure takes places, “inhibition learning” is strengthened by promoting the learning of multiple retrieval cues for coping. While the bulk of the research examining the benefits of context variation have focused on fear reduction, there is some evidence that these effects may also extend to disgust. Viar-Paxton and Olatunji (2012) found that individuals who were exposed to repeated presentations of a disgusting stimulus (i.e., vomit) in a multiple contexts (i.e., different people vomiting) reported attenuated distress responses to a novel disgust stimulus and reductions in trait disgust propensity, skin conductance, and behavioral avoidance compared to those individuals in the single context (i.e., same person vomiting) exposure condition. While this initial study provides some evidence for the benefits of context variation in disgust reduction, how the use of context variation during exposure might translate to the reduction of disgust responding among a phobic sample remains unknown.

The extant literature has shown that disgust-related reactions are largely resistant traditional exposure-based techniques due primarily to its acquisition modality of evaluative conditioning. While some research suggests that counterconditioning (i.e., re-pairing the CS with a positive US) may effectively reduce some disgust responding (Engelhard, Leer, Lange, & Olatunji, 2014), the majority of these data have utilized traditional conditioning paradigms rather than phobic-relevant stimuli.

A better approach may be US revaluation which has been shown to effectively change acquired evaluative responses towards a CS (Baeyens, Eelen, Van den Bergh, & Crombez, 1992). Traditional extinction models rely primarily on inhibition learning through the creation of a new pathway (i.e. , CS-noUS), Revaluation, however, inhibits the learned response via US habituation whereby the US (as opposed to the CS) is repeatedly presented alone following conditioning (Rescorla, 1973; Storsve, McNally, & Richardson, 2010). Thus, responding to the CS reduces as the individual becomes habituated to the aversiveness of the US signal. Although habituation does not appear to be the mechanism by which fear is extinguished (Moscovitch, Antony, & Swinson, 2009), no studies to date have empirically examined whether disgust habituation is effective. Real-world examples provide some initial support that individuals are able to “get used” to revulsion that characterizes the disgust experience. For instance, new parents who suppress their own disgust reaction when changing their newborns diapers, housecleaners who must clean toilets every day, nurses who clean all sorts of bodily products from other people, etc. Although anecdotal in nature, these examples provide enough evidence to warrant empirical examination of whether disgust revaluation is effective in reducing excessive disgust responding.

The extant literature suggests that while current anxiety treatments are effective in reducing fear-related symptoms, they are not as efficient in reducing disgust-responding. Thus, adaptations which may facilitate disgust habituation should be explored to improve long-term treatment success. For instance, there isgrowing support for the notion that exposure in multiple contexts buffers against the renewal of fear (Shiban et al., 2013; Vansteenwegen et al., 2007) and disgust (Viar-Paxton & Olatunji, 2012). However, it remains unclear how conducting exposure to disgust stimuli in multiple contexts impacts the renewal of fear in anxiety disorders that are characterized by excessive disgust reactions. Further, while previous research has limited its focus to extinction of the disgust evaluation (US), it is unknown whether a treatment focus of disgust habituation which allows for the evaluation itself to remain, may yield greater symptom reduction. To address these limitations, Experiment 3 sought to examine the effectiveness of a novel disgust intervention on the reduction of phobic symptoms in blood-injection-injury (BII) phobia. BII phobia is characterized by a persistent, excessive, and irrational fear at the sight or anticipation of blood, wounds, syringes, injuries, mutilation, and similar stimuli (Marks, 1987; Washington, 2013). Additionally, disgust responding has been shown to be most prominent in BII phobia compared to other specific phobias (Sawchuk & Westendorf, 2002; Tolin et al., 1997) , making it is an ideal phobia to study the efficacy of a disgust-targeted exposure.

Drawing on the proposed model from Chapter 3 and previous research, it was predicted that while repeated exposure to disgust-specific stimuli (i.e., vomit) in a single context or multiple contexts would result in a reduction of phobia-related symptoms, including attenuated renewal and reduction in trait disgust propensity, behavioral avoidance, and skin conductance, those in the multiple context condition would show greater effects (Experiment 3a). Additionally, Experiment 3b explored the efficacy of disgust-specific exposure compared to the current gold-standard treatment for BII phobia (i.e., repeated exposure to fear-specific – injections – stimuli) as well as a general negative affect exposure.

Experiment 3a Method

Participants

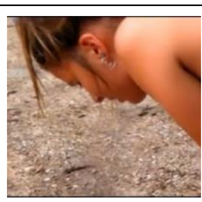
Participants were selected from undergraduate psychology courses based on the criteria of scoring ≥ 32 on the Injection Phobia Scale-Anxiety (Öst, Hellström, & Kåver, 1992). Of the approximately 500 students screened, 50 met this selection criteria and agreed to participate (mean IPS = 42.35, SD = 8.21). Although the IPS only identifies injection-fearful individuals, the researcher-administered Anxiety Disorders Interview Schedule for DSM-IV (ADIS; Silverman, Albano, & Barlow, 1996) indicated that 84% of participants met diagnostic criteria for BII phobia. Participants had a mean age of 19.18 (SD = .97) and were largely female (88%) and Caucasian (79%).

Materials

Four clearly distinguishable videos containing people vomiting (disgust exposure stimuli) and three intraveneous blood draw (outcome stimuli) videos served as exposure stimuli in this study. Each video was 30 seconds long and was played full-screen, without sound, on a 17” monitors.

Fig. 8. Screen shot of Experiment 3a stimuli

Disgust Stimuli (Manipulation stimuli)



A

B

C

D

Injection Stimuli (Outcome stimuli)

B1

B2

B3

Vomit was selected as a stimulus for the present study as such bodily secretions are the most widely reported elicitors of the disgust emotion (Curtis & Biran, 2001), while also being threat-irrelevant with regards to BII phobic stimuli. Use of similar paradigms has been shown to successfully increase subjective experiences of disgust and negative affect (Olatunji et al., 2012; Viar-Paxton & Olatunji, 2012). Additionally, given that exposure to BII-related stimuli (e.g., bloody gauze, needles, mutilation) is often accompanied by the experience of nausea (Lumley, 1992), repeated exposure to vomit stimuli specifically may be more likely to potentiate habituation of nausea. This habituated disgust/nausea response would then result in the reduction of the evaluative associations. A screen shot of each video can be found in Fig. 8.

Measures

State emotion ratings were taken during a 30s intertrial interval (ITI) between video stimuli. Participants were asked to rate their anxiety and disgust levels for each video on a 0 – 100 scale with 0 being the *least* anxious/disgusted they could imagine feeling and 100 being the *most* anxious/disgusted they could imagine feeling.

The disgust propensity subscale of the *Disgust Propensity and Sensitivity Scale-Revised* (DPSS-R; van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006) was also administered to determine trait levels of disgust proneness. The disgust propensity subscale of the DPSS-R includes eight items designed to assess the frequency of disgust experiences. Participants rate their agreement with each item on a scale ranging from 1 (“never”) to 5 (“always”). The disgust propensity subscale had an alpha coefficient of .85 in the present study.

Physiological Assessment

Galvanic Skin Conductance. Skin conductance was used to measure arousal responses during the exposure phase of the experiment. Skin conductance was measured using unshielded 8 mm Ag-AgCl electrodes filled with isotonic gel and attached to the middle phalanx of the index and middle fingers of the nondominant hand. Signals were recorded at 200 Hz using the Biopac MP35 system with Acknowledge software (BIOPAC Systems Inc., 2007). The skin conductance responses were analyzed using Acknowledge software.

Behavioral Avoidance. A *Behavioral Avoidance Task (BAT)* was administered to assess BII-related avoidance. Participants were asked to complete 10 steps: (1) look at a hypodermic needle and syringe without the cap on, (2) touch the hypodermic needle without the cap, (3) hold the hypodermic needle without the cap, (4) hold a sealed vial of blood, (5) hold an open vial of blood, (6) wipe the inner elbow of the arm as if for an injection, (7) touch the tip of the hypodermic needle to the bare skin of the inner elbow, (8) draw water into the syringe, (9) inject a sponge against the inner elbow with water from the syringe, and (10) “fingerpaint” with blood with a gloved finger. The experimenter recorded whether or not participants refused any step and once a participant refused a step, the BAT was discontinued. The BAT was therefore scored by how many steps were completed such that higher scores indicate less behavioral avoidance and greater approach behavior.

Procedure

Following the informed consent process, clinical phobic status was determined using the ADIS-IV. Participants then completed the DPSS-R and the BAT and were randomly assigned to either a single context exposure (SCE; $n = 25$) or multiple contexts exposure (MCE; $n = 25$) condition. All participants received 14 presentations of a 30s video with a 30s ITI (blank screen). Participants were instructed to carefully watch the video and to keep their eyes on the screen for the entirety of the video. During the ITI, participants provided state ratings of anxiety and disgust on a 100-pont scale. Skin conductance was collected throughout the entire exposure manipulation.

An overview of the exposure is presented in Fig. 9. For all participants, the first presentation included a blood draw video (either blood 1 or 2, counterbalanced). Following the BII pre-trial, the SCE condition watched 12 presentations of a person vomiting in context A, while participants in the MCE condition were presented with three videos of individuals vomiting in context A, three videos in context B, three videos in context C, and three videos in context D. Presentation order was equal for all participants in the MCE condition (ABBACDADCCBD). Following the exposure trials, all participants were presented with the same blood draw video from the start of the exposure manipulation (BII post-trial) and then a novel blood draw video (BII novel 1). Participants then returned one week later and were presented with three video clips: BII pre/post trial, BII novel 1, and BII novel 2, which was a novel blood draw video. Distress ratings were taken throughout the presentation of these videos. Following the videos, participants completed the DPSS-R and the BAT again, and were debriefed.

Results

Participant Characteristics and Preparation of Emotion Ratings

Table 11 provides descriptive statistics by condition for each of the study variables. Given significantly high correlations between verbal ratings of fear and disgust [BII Week 1 Pre trial ($r = .74$), BII Week 1 Post trial ($r = .77$), BII Week 1 Novel 1 trial ($r = .63$), BII Week 2 Pre/Post trial ($r = .70$), BII Week 2 Novel 1 trial ($r = .73$), and BII Week 2 Novel 2 trial ($r = .59$)], these ratings were averaged to form a composite distress rating. Raw distress ratings were then normalized for each participant by creating a proportion score where each anchor trial was divided by an individual's baseline/pre-trial score. Similar procedures are often employed among clinical trial research studies as baseline proportions or percent change approaches are generally considered to be more advantageous compared to absolute change in assessing symptom change as a function of treatment (Törnqvist, Varita, & Varita, 1985). Further, one advantage that Törnqvist and colleagues (1985) note that is of particular relevance to the current study, is the observation that a baseline-proportional approach is independent of any unit of measurement. Given substantial variability in how different individuals might anchor their initial baseline emotion ratings, the proportional approach allows for a more accurate comparison across individuals. Accordingly, all analyses below utilize normalized distress ratings.

Week 1:

	BII Pre	Disgust Exposure trials												BII post	BII novel
SCE	**B1/B2**	A	A	A	A	A	A	A	A	A	A	A	A	**B1/B2**	**B2/B1**
MCE	**B1/B2**	A	B	A	C	B	D	C	A	D	D	C	B	**B1/B2**	**B2/B1**

Week 2:

	BII Pre/Post	BII Week 1 Novel	BII Week 2 Novel
SCE	**B1/B2**	**B2/B1**	**B3**
MCE	**B1/B2**	**B2/B1**	**B3**

Fig. 9. Experiment 3a overview of exposure trials.

Distress Renewal

Given the specific nature of the hypotheses, planned comparisons were used. Previous research has shown that planned contrasts provide a more appropriate test of a priori predictions, compared with analyses of variance, which include all possible main effects and interactions (Wilkinson, 1999)

Table 11. Descriptive statistics for Experiment 3a variables

	SCE	**MCE**	***F*-value**
Distress Ratings			
Week 1			
BII Pre	1.00 (.00)	1.00 (.00)	--
BII Post	1.12 (.49)	1.32 (.66)	1.26
BII Novel 1	1.44 (.50)	1.41 (.58)	.03
Week 2			
BII Pre/Post	.96 (.59)	.84 (.46)	.55
BII Novel 1	1.15 (.69)	1.04 (.54)	.36
BII Novel 2	1.28 (.71)	1.16 (.89)	.25
Disgust Propensity			
Week 1	18.14 (4.13)	17.54 (4.61)	.21
Week 2	18.73 (4.56)	15.50 (4.36)	5.88*
Behavioral Avoidance			
Week 1	7.77 (3.38)	7.54 (2.83)	.06
Week 2	8.09 (2.83)	7.87 (2.64)	.07

Note. * $p < .05$. Distress ratings are normalized as proportions of each individual's baseline/BII Pre-trial.

Distress renewal was assessed at two times points during Week 1 and Week 2. For Week 1, distress renewal was defined by the change in ratings from BII post trial to BII novel 1. Planned comparisons (Fig. 10) revealed a significant increase in distress ratings from BII post to BII novel 1 for the SCE group [$t(23)$ = 3b4, p = .004], while the MCE group reported did not [$t(24) = 2.01$, $p = .06$]. For Week 2, distress renewal was defined by the change in ratings from BII novel 1 to BII novel 2. Planned comparisons revealed a significant increase from BII novel 1 to BII novel 2 for the SCE group [$t(24) = 3.32$, $p = .003$], while the MCE group did not show significant distress renewal to a novel BII stimulus [$t(24) = 1.53$, $p = .14$].

Distress Retention

Given that time itself can be considered a context (see Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014), the current study also examined the effect of varying context during exposure on distress retention from Week 1 to Week 2. Distress retention was defined by the change in ratings from Week 1

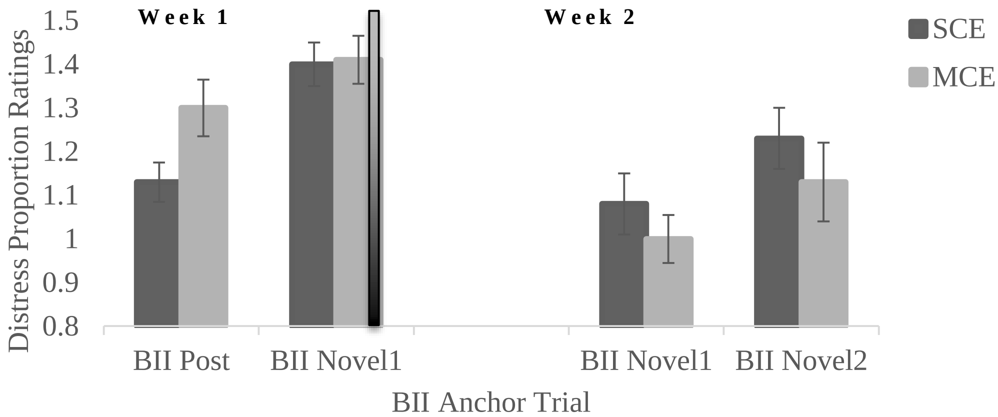


Fig. 10. Experiment 3a distress renewal at Week 1 and Week 2 for MCE and SCE conditions.

to Week 2. Distress retention was defined by the change in ratings from Week 1 to Week 2 for the same stimulus and was examined for two stimuli: BII pre/post and BII novel 1, given that both videos were presented at both Week 1 and Week 2. Paired t-tests (Fig. 11) revealed that while the MCE condition reported significantly less distress for the pre/post video at Week 2 compared to Week 1 [$t(24) = 6.05$, $p < .001$], the SCE condition did not [$t(24) = 1.86$, $p = .08$].

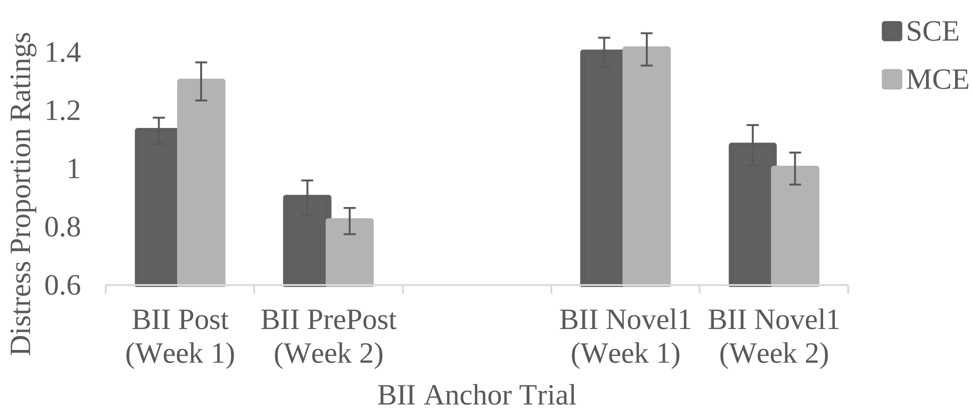


Fig. 11. Experiment 3a distress retention from Week 1 and Week 2 for MCE and SCE conditions.

Physiological Arousal

Skin conductance responses were visually inspected and corrected for artifacts before they were analyzed statistically. A baseline skin conductance (SC_0) value, collected during the first 30-sec of the exposure manipulation before video stimuli were presented, was calculated for each participant. In order to calculate phasic fluctuations of SC as a function of exposure (e.g. Galvanic Skin Conductance; GSR), the baseline (SC_0) was subtracted from the mean SC of each 30s trial (SC_1). This raw GSR was range-corrected using the largest and smallest responses observed during all video presentations (Lykken, Rose, Luther, & Maley, 1966; Lykken & Venables, 1971) by means of the formula:

$$\Delta\varphi = \frac{SC_1 - SC_0}{SC_{i(max)} - SC_{i(min)}}$$

Two participants (one from each condition) were excluded from the skin conductance analyses due to technical problems, resulting in 24 participants in both the MCE and SCE groups. Planned pairwise comparisons (see Fig. 12) were then conducted to examine the renewal of skin conductance responses (SCR) revealed that the SCE condition showed increased SCR when presented with a novel BII stimulus at Week 1 ($t(23) = -2.11$, $p = .046$, $d = .73$) and Week 2 ($t(23) = -2.89$, $p = .008$, $d = .83$) whereas the MCE group did not (Week 1: $p = .882$; Week 2: $p = .363$).

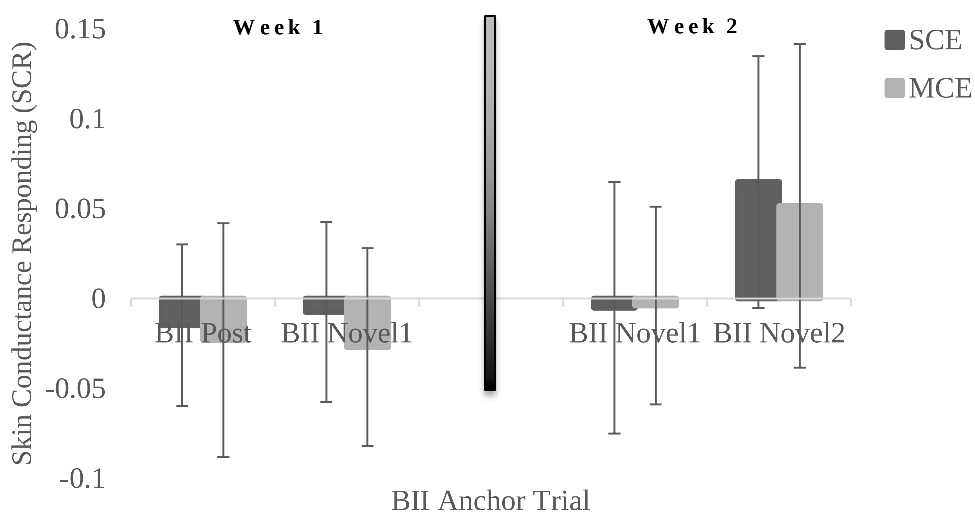


Fig. 12. Experiment 3a SCR renewal

Disgust Propensity

In order to examine potential changes in disgust propensity before exposure and at Week 2, planned comparisons were conducted using the Propensity subscale of the DPSS-R. These analyses yielded a significant decrease in disgust propensity for the MCE condition [$t(23) = 2.27$, $p = .03$], whereas the SCE condition showed no changes [$t(23) = -.97$, $p = .34$].

Behavioral Avoidance

Paired t-tests were also conducted to assess any changes in the behavioral avoidance task (BAT) before the exposure and at the Week 2 follow-up session. Contrary to predictions results showed that neither the SCE [$t(24) = 1.62$, $p = .12$] nor MCE [$t(24) = 1.94$, $p =. 07$] conditions showed any changes in behavioral avoidance from Week 1 to Week 2.

Experiment 3a Discussion

The present study found that the MCE condition demonstrated attenuated distress renewal to a novel injection stimulus at Week 1 and Week 2. However, the SCE condition reported significant renewal of distress to a novel stimulus at both Week 1 and Week 2. Similar findings were also observed physiologically such that the SCE group showed increased skin conductance responding to novel BII stimuli at Week 1 and Week 2 while the MCE condition showed no changes in physiological responding. Further beneficial effects of context variation were evidenced significantly greater retention of distress habituation among the MCE condition, with significant decreases in distress at Week 2 for both of the injection stimuli presented during Week 1. Additionally, the MCE condition reported significant reductions in trait disgust propensity while the SCE condition showed no changes. Contrary to predictions, neither condition reported any changes in behavioral avoidance from Week 1 to Week 2.

The results from Experiment 3a suggest that repeated exposure to disgusting, yet threat-irrelevant, stimuli is effective for reducing phobic symptoms among BII fearful individuals. Additionally, varying the context of exposure stimuli was yielded greater treatment benefits compared to repeated exposure to the same stimulus. These findings are consistent with previous examining the effect of context variation during fear-specific exposure (Bandarian-Balooch, Neumann, & Boschen, 2015; Shiban et al., 2013; Vansteenwegen et al., 2007). This suggests that while disgust and fear may differ in the mechanisms by which they are acquired, they may employ similar strategies for enhanced extinction.

While the results of the present research offer initial support for an adapted exposure approach among specific phobia, it remains unclear how repeated exposure to disgust-specific, but threat-irrelevant, stimuli compares to the traditional process of repeated exposure to threat-relevant stimuli. If disgust is truly causal in the development of specific phobia as the literature has proposed, then successful reduction of disgust responding should result in greater treatment effects compared to treatments which fail to successfully habituate the affective experience of disgust. Therefore, Experiment 3b sought to examine whether reduction of phobic symptoms varies as a function of emotional content presented during exposure in multiple contexts. Specifically, the effect of disgust-relevant exposure was compared to threat/fear-relevant exposure and a general negative affect exposure. Given previous research which posits that residual evaluative associations between phobic stimuli and disgust responding may account for poor long-term treatment success, it was predicted that disgust-specific exposure would reduce disgust evaluations of phobic stimuli thereby resulting in greater attenuated distress renewal and larger reductions in phobic symptoms compared to a fear-specific exposure. It was further predicted that repeated exposure to disgust-specific or fear-specific stimuli would be more beneficial in reducing phobic symptoms compared to a control condition (i.e., exposure to general negative affect stimuli).

Experiment 3b Method

Participants

Participants were identified using the same selection criteria as used in Experiment 3a. The final sample for Experiment 3.2 included 57 undergraduates (Mean Age = 18.93, SD = .98; 79% female; 75% Caucasian). Participants had a mean IPS score of 39.14 (SD = 7.70) with 86% of individuals meeting diagnostic criteria for BII phobia based on the ADIS. Participants were randomly assigned to one of three experimental conditions in which stimuli were shown in multiple context (described below): Disgust-Specific Exposure (n = 19); Fear-Specific Exposure (n = 19); or General Negative Exposure (n = 19).

Materials

Experiment 3b included three exposure conditions with stimuli that varied as a function of emotional content. All three conditions viewed the same outcome stimuli (three intravenous blood draw videos) used in Experiment 3a. As in Experiment 3.1, each video was 30 seconds long and was played full-screen, without sound, on a 17” monitor. Fig. 13 presents the study overview.

Disgust-Specific condition. The Disgust-Specific Exposure (DSE) condition included stimuli that was disgusting but threat-irrelevant (i.e., vomit). The DSE condition utilized the same video stimuli used in Experiment 3a.

Fear-Specific condition. The Fear-Specific Exposure (FSE) condition included threat-relevant stimuli that are consistent with stimuli typically used in exposure-based treatments for BII phobia. The FSE condition utilized four distinct intravenous blood draw videos that presented similar stimuli to the target/anchor BII trials.

Negative condition. The General Negative Exposure (GNE) condition included stimuli that elicit negative affect while not being considered disgusting or threat-relevant for BII phobic individuals. The GNE condition was included in order to exclude the possibility that reductions in phobic symptoms following exposure to disgust-specific or fear-specific stimuli largely reflect arousal effects rather than the intended affective target. The GNE condition utilized four videos of severe storms including hurricanes and tornados. Each video included people in order to remain consistent with the other two conditions.

Procedure

Procedure in Experiment3b was identical to Experiment 3a.

Week 1:

	BII pre	Disgust Exposure trials												BII post	BII novel
DSE	**B1/B2**	D1	D2	D1	D3	D2	D4	D3	D1	D4	D4	D3	D2	**B1/B2**	**B2/B1**
FSE	**B1/B2**	F1	F2	F1	F3	F2	F4	F3	F1	F4	F4	F3	F2	**B1/B2**	**B2/B1**
GNE	**B1/B2**	N1	N2	N1	N3	N2	N4	N3	N1	N4	N4	N3	N2	**B1/B2**	**B2/B1**

Week 2:	BII Pre/Post	BII Week 1 Novel	BII Week 2 Novel
Disgust-Specific	**B1/B2**	**B2/B1**	**B3**
Fear-Specific	**B1/B2**	**B2/B1**	**B3**
Negative	**B1/B2**	**B2/B1**	**B3**

Fig, 13. Overview of Experiment 3b exposure trials.

Results

Participant Characteristics and Preparation of Emotion Ratings

Table 12 provides descriptive statistics by condition for each of the study variables. Consistent with Experiment 3a, fear and disgust ratings were averaged to form a composite distress rating. Raw distress ratings were then normalized for each participant by creating a proportion score where each anchor trial was divided by an individual's baseline/pre-trial. All analyses below employed normalized distress ratings.

Table 12. Descriptive statistics for Experiment 3b variables

	DSE	**FSE**	**GNE**
Distress Ratings			
Week 1			
BII Pre	1.00 (.00)	1.00 (.00)	1.00 (.00)
BII Post	1.03 (.40)	.88 (.41)	1.18 (.46)
BII Novel 1	1.27 (.52)	.99 (.40)	1.35 (.40)
Week 2			
BII Pre/Post	.59 (.26)	.59 (.27)	.90 (.25
BII Novel 1	.90 (.38)	.69 (.28)	1.04 (.30)
BII Novel 2	1.06 (.54)	.77 (.30)	1.28 (.39)
Disgust Propensity			
Week 1	18.53 (4.87)	17.58 (4.55)	18.78 (5.24)
Week 2	17.95 (5.86)	17.47 (5.00)	18.94 (5.09)
Behavioral Avoidance			
Week 1	8.42 (2.46)	7.42 (3.37)	6.61 (3.85)
Week 2	8.63 (2.34)	7.79 (3a0)	7.28 (3.51)

Note. Distress ratings are normalized as proportions of each individual's baseline/BII Pre-trials.

Distress Renewal

Pairwise comparisons (see Fig. 14) revealed significant distress renewal for all three conditions during Week 1 as evidenced by significant increases in distress ratings from BII post trial to BII novel 1trial [DSE: p = .003; FSE: p = .04; GNE: p = .004]. However, at Week 2, pairwise comparisons (i.e., BII novel 1 to BII novel 2) revealed that while the G NE condition reported a significant distress renewal to a novel injection stimulus ($t(18) = -3.73$, p = .002), the DSE and FSE conditions did not (p = .10, p = .08, respectively).

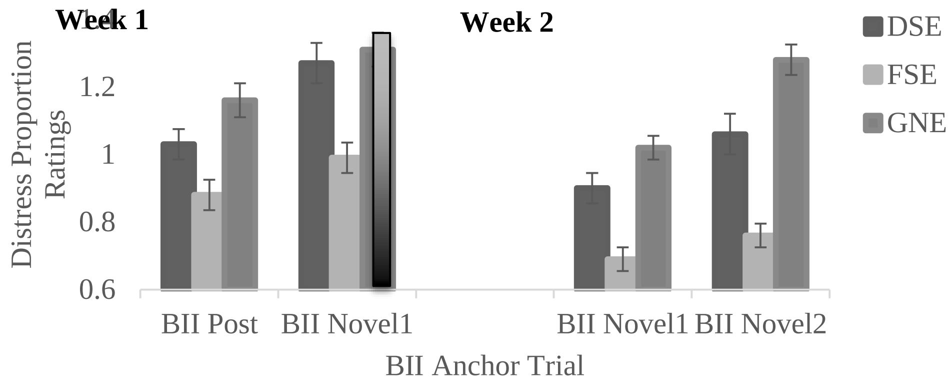


Fig. 14. Experiment 3b distress renewal at Week 1 and Week 2 for DSE, FSE, and GNE conditions.

Distress Retention

Consistent with Experiment 3a, distress retention was examined for two BII stimuli that were presented at both Week 1 and Week 2. Pairwise comparisons (see Fig.16) examining distress retention of the BII pre/post stimuli showed greater distress ratings at Week 2 for the GNE condition compared to both the DSE (p = .02) and FSE (p =.002) conditions. There were no group differences between the DSE and FSE conditions. Similar findings were observed for retention of BII novel 1 where pairwise comparisons yielded significantly less distress at Week 2 for the FSE condition compared to both the DSE (p = .03) and the GNE (p = .005) conditions. There were no differences between the DSE and GNE condition

Physiological Arousal

Skin conductance responses were visually inspected and corrected for artifacts before they were analyzed statistically. Responses were corrected using procedures described in Experiment 3a. Four participants (DSE n = 1; FSE n = 1; GNE n = 2) were excluded from skin conductance due to technical problems. Planned comparisons (see Fig. 15) examining skin conductance responses (SCR) renewal effects revealed that while both the FSE (t(18) = -3b7, p = .004, d = .20) and GNE (t(18) = -3.53, p = .002, d = .29) conditions showed increased SCR to a novel BII stimulus during Week 1 (i.e., Week 1 BII Post vs Week 1 BII Novel 1), the DSE condition showed no change in SCR (p = .74). Analysis of Week 2 renewal effects (i.e., Week 2 Novel 1 vs Week 2 Novel 2) showed no change in SCR for all three condition (p > .10).

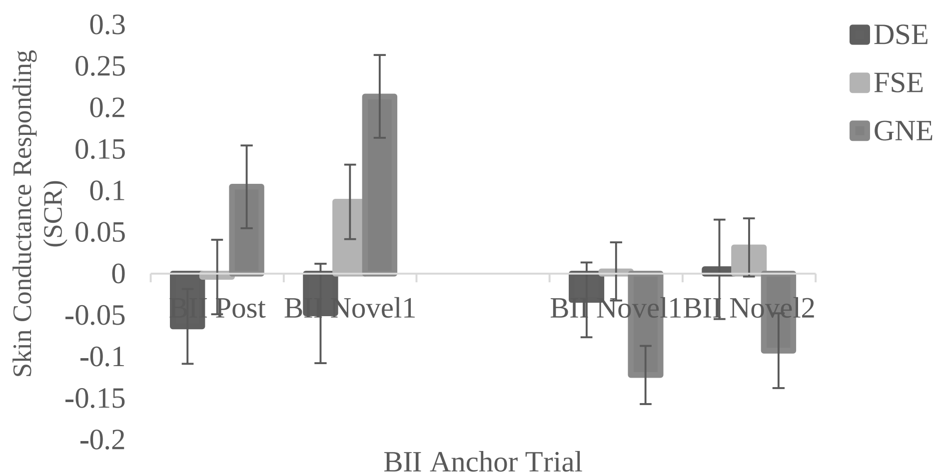


Fig. 15. Experiment 3B renewal of SCR by condition.

Disgust Propensity

Contrary to predictions and the findings from Experiment 3a, paired t-tests showed no changes in disgust propensity from Week 1 to Week 2 for all three conditions.

Effect of Context on Behavioral Avoidance

Planned comparisons also revealed that, in contrast to Experiment 3a, the DSE condition showed no changes in behavioral avoidance from Week 1 to Week 2 (p = .10). However, paired t-tests showed that both the FSE and GNE conditions showed significantly less behavioral avoidance at Week 2 (p's < .05).

Discussion

Experiment 3b examined the effect of varying emotion content during exposure on BII symptoms and behaviors. As expected, findings showed that repeated exposure to fear-specific stimuli in multiple contexts was beneficial in reducing BII phobic symptoms. However, the treatment benefits from repeated exposure to disgust-specific, but threat-irrelevant stimuli were extremely comparable. For example, consistent with Experiment 3a findings, both the DSE and FSE conditions showed attenuated distress renewal at Week2 (but not Week 1). Examination of physiological data revealed attenuated skin conductance responding among the FSE condition at Week 1 and among the DSE condition at Week 1 *and* Week 2. These findings may offer significant implications for the treatment of BII phobia. The inclusion of approximately six minutes of video clips of vomit yielded nearly identical reductions in BII phobic responding to injection stimuli compared to the gold-standard treatment for BII phobia. This might suggest that a combined fear-disgust treatment would be maximally beneficial. To date, few studies have examined combination fear-disgust treatments. Hirai and colleagues (2009) found that including disgust did yield greater symptom reductions compared to a fear-only or disgust-only exposure. However, the effect sizes were rather small. Further, other research has been inconsistent. For instance, while Choplin and Carter (2011) found beneficial effects for both disgust-specific and fear-specific exposures in the reduction of spider phobia symptoms, fear-specific exposure resulted in greater decreases. Given the limitations and inconsistencies of previous studies, the current data suggest that perhaps employing context variability during exposure would further enhance exposure effects.

Experiment 3 Conclusions

Although disgust has consistently been implicated in the development and maintenance of BII phobia, the majority of current treatments have focused solely on fear. Given that untreated disgust is likely to lead to continued avoidance and subsequent return of fear, treatments which target disgust specifically may be needed to prevent the return of distress in disorders where disgust plays a pivotal role. The present investigation is among the first to provide evidence that exposure to stimuli that is disgust-specific, yet threat-irrelevant, may be beneficial in reducing BII phobic symptoms. The findings offer some initial support for the use of a modified exposure approach for reducing disgust responding in BII phobia. Indeed, repeated exposure to disgust-specific stimuli in multiple contexts was associated with attenuated distress renewal and physiological responding (skin conductance), and significant decreases in distress towards injection stimuli from Week 1 to Week 2. Additionally, results from Experiment 3a showed decreases in disgust propensity, indicating that the effects of disgust habituation may extend to multiple modalities. However, these results were not replicated in Experiment 3b. The absence of disgust propensity reductions could be attributed to relatively low pre-treatment scores. Indeed, while the maximum score for the propensity subscale of the DPSS-R is 40, the mean pre-treatment DPSS-R Propensity score in Experiment 3b was approximately 18. A recent study found that contamination-focused exposure (akin to a disgust-specific exposure) was effective (relative to a waitlist-control condition) at reducing spider fear and perceived dangerousness in a behavioral avoidance task, but only among individuals that reported high levels of pre-treatment disgust propensity (Cougle, Summers, Harvey, Dillon, & Allan, 2016). Given previous research has shown that disgust-prone individuals report strong evaluative conditioning effects (McKay, 2006; Olatunji et al., 2013), an additional disgust-specific component may be necessary in order to reduce disgust-related symptoms. The current sample is an analogue sample and may therefore have reduced pre-treatment disgust propensity levels compared to a clinical population. Therefore, future research should examine disgust propensity as a potential moderator in the reduction of phobic symptoms following disgust-specific exposure.

As previously discussed, repeated exposure to disgust-specific yet threat-irrelevant stimuli yielded similar treatment benefits to gold-standard fear-specific exposure. While this has substantial implications on its own, there is also evidence that these effects may have been limited by several factors, which if addressed, could further improve disgust-targeted treatments. First, previous research has shown disgust to be particularly prominent in BII phobia (Sawchuk & Westendorf, 2002; Tolin et al., 1997), however, there is some evidence that this effect may vary depending on the phobic stimulus. For instance, when exposed to blood stimuli, BII phobics report more disgust than fear (Olatunji, Lohr, Sawchuk, & Patten, 2007). However, when presented with injection stimuli, phobic individuals respond with either greater fear (Page, 2003) or are no differences (Olatunji et al., 2007). This suggests that there may be differences in the emotional mechanisms which contribute to blood fears versus injection fears. The current study utilized phobic stimuli which included blood and injections (i.e., intraveneous blood draws), and while blood was present in the video, the camera's focus was primarily on the needle. Thus, the current findings may be somewhat tempered particularly when considering that the present sample was recruited using the IPS, a measure of injection fears specifically. Future research should examine if greater treatment effects are observed for individuals with more specific aversions to blood and mutilation. Additionally, the use of stimuli that is more targeted towards those aversions may also result in further treatment improvements as it will allow for a more direct assessment of disgust habituation towards phobic stimuli.

In addition to the variability of emotional responses to injection stimuli, the multidimensional nature of disgust may also influence the effectiveness of a disgust-targeted exposure treatment. Previous research has indicated that phobics report greater disgust and are more avoidant of disgust stimuli even when the elicitor is not related to their phobic concerns (Olatunji, Lohr, Smits, Sawchuk, & Patten, 2009; Olatunji, Sawchuk, Arrindell, & Lohr, 2005; Sawchuk, 2002; Tolin, Lohr, Sawchuk, & Lee, 1997). Furthermore, there is evidence that disgust responding in specific phobias may also be domain-specific. Individuals with BII phobia have been shown to have heightened animal-reminder disgust propensity compared to nonphobic samples and anxious controls (Koch, O-Neill, Sawchuk, Connolly, 2002; Sawchuk, Lohr, Tolin, & Lee, 2000; Viar-Paxton, Tomarken, Pemble, & Olatunji, 2014). Tthe current investigation chose vomit as the elicitor in the disgust habituation trials due to the finding that BII phobic individuals often respond with nausea in the presence of BII stimuli (Lumley, 1992), therefore habituation of this response was thought to result in a possible revaluation of nausea and subsequently reduce evaluative associations between disgust and BII stimuli. However, vomit may not have been a strong enough elicitor of nausea among BII phobics. Indeed, the nausea response elicited by BII stimuli may be stronger than what had been previously habituated. Therefore the habituation would have little to no effect on the evaluative association between BII stimuli and disgust. Curtis (2013) posited that in order to facilitate the treatment of pathologies that are related to specific disgust subsystems, habituation *must* include domain-congruent stimuli. Future research should therefore examine how repeated exposure to animal-reminder disgust elicitors (i.e., mutilation, body envelope violations, death) contributes to the reduction of phobic systems. Although these elicitors have substantial overlap with many threat-relevant stimuli, heightened disgust responding may be the causal factor in why those items are feared. Therefore, revaluation of the disgust response elicited by those specific items may aid in greater reduction of phobic symptoms.

CHAPTER 5

GENERAL DISCUSSION

Anxiety in childhood has been described as a "gate-way" condition as it can signal increased risk for the development of other psychopathologies (Britton et al., 2011; Zimmermann et al., 2003). Childhood anxiety diagnoses predict a 2- to 3-fold increased risk for developing an anxiety disorder or major depressive disorder in adulthood (Beesdo, Bittner, Pine, et al., 2007; Gregory, Caspi, Moffitt, et al., 2007; Pine, Cohen, Gurley, et al., 1998; Stein, Fuetsch, Muller, et al., 2001). This pattern of findings highlights the importance of identifying potential vulnerability factors associated with the development of maladaptive anxiety. Consistent and robust associations between disgust, anxiety, and fear have led many researchers to implicate disgust as playing a crucial role in the development and maintenance of anxiety disorders. However, empirical support for a causal association and a clear delineation of how disgust confers risk for anxiety remains unclear. The present research program explored the measurement, mechanisms, and modification of disgust to illuminate what role it might play in the development, maintenance, and treatment of anxiety. These findings offer novel insight into the presentation and age-appropriate assessment of trait disgust in children; the role of disgust as a causal factor in the development of fear learning; and the effect of specifically targeting disgust in reducing phobic responses.

Further support for disgust's role in anxiety

An association between disgust and psychopathology, particularly anxiety-related disorders, is well-established in the adult psychopathology literature (Cisler et al., 2009; Olatunji, Cisler, McKay, & Phillips, 2010; Olatunji & Deacon, 2008; Olatunji & Sawchuk, 2005). Despite the emergence of anxiety in childhood (Kessler et al., 2005), studies investigating the potential role of disgust in childhood anxiety are sparse, limited in part to the absence of a disgust measure that is developmentally appropriate for use with children. The present investigation found support for an association between disgust and anxiety symptoms among children using the newly developed Child Disgust Scale (CDS; Viar-Paxton et al., 2015). Importantly, this scale was developed as a measure of trait disgust designed specifically for children using age-appropriate language and elicitors. Consistent with the limited findings on disgust and childhood anxiety (Moretz, Rogove, & McKay, 2011; Muris et al., 1999), Experiment 1 found that the CDS was differentially associated with disgust-relevant anxiety disorders and fear domains (e.g., small animals, medical fears, death, contamination). Additionally, the CDS was also able to successfully differentiate children with a specific phobia diagnosis from a sample of nonclinical matched controls. These data are consistent with a recent study that examined the psychometric properties of the CDS among treatment-seeking youth with obsessive-compulsive symptoms (Nadeau et al., 2016). Indeed, Nadaeu and colleagues (2016) found the CDS and its subscales had strong reliability, and were modestly associated with measures of anxiety and obsessive-compulsive symptoms among children and, to a lesser degree, parents. Combined with the present data, these findings provide greater support for the CDS as a valid measure of individual differences in disgust among children, particularly for the study of fear and anxiety development.

The finding that an association between disgust and fear was present in children younger than the average age of onset for most anxiety disorders provides some evidence that there *could* be a causal association in the development of anxiety symptoms. Indeed, while the experience of fear is normative in children, some children go on to develop pathological levels of fear indicating a disruption to this ontogenetic process. Trait disgust may play a causal role as a moderator in the transition from normative to pathological fear. However, the mechanism by which it may operate remains unclear. Some research has suggested that one potential pathway may be through verbal transmission of disgust-related information. Experiment 2 found that verbal transmission of disgust-related information about a novel animal increased disgust beliefs and avoidance. Yet, contrary to previous research (Askew et al., 2014; Muris et al, 2008, 2009, 2010, 2013), it did not increase fear ratings among children ages 5 – 13. This suggests that receiving disgust information increases children's beliefs that the animal is indeed disgusting, but that information alone is not sufficient to increase a child's fear towards that animal. Correlational analyses revealed that trait disgust avoidance was associated with fear acquisition which suggests that disgust information alone may not be sufficient to increase fear, *unless* there are pre-existing vulnerability factors, including trait disgust avoidance, which may act to increase the threat value of the particular stimulus. This is consistent with previous research which has found that while inducing disgust does not in itself appear to directly increase levels of reported anxiety (Marzillier & Davey, 2004), it can lead to individuals choosing more threatening interpretations (Davey, Bickerstaffe, & MacDonald, 2006).

Contrary to predictions, disgust learning did not predict avoidance, the primary action tendency of disgust. However, changes in fear did predict avoidance. Specifically, only those children who were most avoidant reported an increase of fear towards the novel animal following the disgust-related information. One interpretation of these findings is that trait disgust avoidance, as assessed by the CDS, predicts fear acquisition which then predicts avoidance of disgust-related stimuli. Consistent with prominent cognitive models of anxiety (Barlow, 2002; Beck, 1995), this sequence of factors potentially creates a negative feedback loop, whereby avoidance of the animal reduces fear which validates distorted threat-related assumptions (e.g., harm potential, ability to cope).

Conditioning models posit that extinction may be achieved by repeated presentation of the CS (feared stimulus) without the US (disgust information). However, previous research has shown that this approach has little effect on reducing conditioned disgust (Olatunji et al., 2007; Olatunji et al., 2009), suggesting that the association is relational rather than probabilistic. That is, CS do not necessarily predict a disgust-relevant outcome, the CS itself becomes disgusting. Evaluative conditioning has therefore been shown to be largely resistant to traditional extinction processes. Some researchers have also suggested that residual disgust evaluations may be one factor that accounts for a renewal of fear that is common for many individuals following treatment (see Ludvik et al,2015; Mason & Richardson, 2012 for review). Therefore, it has been posited that interventions for disgust-relevant anxiety disorders may be effective if they included a specific disgust-reduction component. Results from Experiment 3 offered initial support for this hypothesis and showed that BII symptom reductions following disgust-specific, yet threat-irrelevant exposure were comparable to the gold-standard fear-specific exposure. These data might suggest that interventions which include fear-specific *and* disgust-specific treatment targets may have additive effects by extinguishing fear-related associations and habituating heightened disgust responding. Further, these data provide empirical support that modification of current interventions is likely to yield greater symptom reductions within session and at post-treatment.

Suggested modifications to disgust-targeted interventions

Among BII phobics, there is variability in emotional response to phobic stimuli where blood stimuli is more associated with disgust responding and injection stimuli elicits more fear responding. Additionally, some researchers have suggested that the greater the congruence between the vulnerability factor and exposure, the greater the treatment effects (Curtis, 2013; Foa & Kozak, 1986). These effects may be due to a greater activation of the phobic structure, which Foa and Kozak (1986) posited is necessary for symptom reduction. Consistent with this concept, greater treatment effects may be achieved if the overall affective responding during exposure is increased. Indeed, it has been suggested that relapse may occur because the habituation that is achieved in the therapy office is much below that which is experienced when the stimulus is encountered in the real world. Context variation during exposure may be one method of achieving increased responding given that the introduction of each new context creates a sort of within-session renewal thereby sustaining heightened arousal. However, findings from Experiment 3 indicate that context variation alone is not sufficient in achieving significant reductions that prevent renewal effects given that Experiment 2 showed renewal for all three conditions at Week 1. This may be due to the number of exposure trials which are not long enough to fully habituate. Experiment 3 utilized four 30-sec disgust-eliciting videos presented three times each over the course of 12 trials. Previous research (Olatunji et al., 2007; Smits et al., 2002) has shown that fear and disgust decrease during exposure, however they do so at much different rates, suggesting that disgust can be habituated, it just takes more time. Thus, increasing the number of exposure trials may result insubstantial reductions in disgust (Meunier & Tolin, 2009).

The efficacy of exposures may also be increased if they are conducted in the environments for which the stimulus is most likely to occur. For instance, for BII phobics, it may be more productive to conduct exposure-based treatments at the Red Cross rather than the therapy office where it is unlikely that an individual is going to receive a blood draw. Further, given that nausea is often experienced during exposure to disgust-eliciting stimuli, inducing nausea pharmacologically may aid in revaluation of that sensation. Clearly some of these modifications are more extreme and may not be appropriate for all treatment-seeking individuals. However, keeping in mind ethical considerations of exposure therapy in general (see Wolitzky-Taylor, Viar-Paxton, & Olatunji, 2012 for a review of the ethical issues related to exposure treatments), a more extreme approach may be necessary in order to reduce an emotion that has been refined over thousands of years to protect mankind from disease. Any attempt to overwrite what is biologically pre-programmed is bound to be met with resistance. Therefore, approaches that have been historically considered to be somewhat more radical may be warranted.

Although the evolutionary function of disgust to prevent disease makes it difficult to extinguish, it may be possible to reframe one's perception of it. First posited by Rozin and Fallon (1987), "conceptual reorientation" encourages an individual to modify their view of the actual *stimulus* rather than focusing on the probability and severity of the occurrence of the *outcome*. As Woody and Teachman (2000, p. 308) noted, "A problem related to disgust for cognitive intervention is that people seem to cling to their negative hedonic evaluation of the stimulus even if all possibility of germ contamination is removed." Thus, while we may have little success in changing one's attitude about a disgust elicitor, we may be able to aid an individual in a reappraisal of it. Consistent with this notion, Olatunji, Berg and Zhao (*in press*) found that individuals who were instructed to reappraise feelings of disgust after viewing a disgust-eliciting reported significantly less distress compared to individuals who were instructed to suppress the experience of disgust. Further, Gross (1998) found that people reported less disgust of disgust-eliciting stimuli (i.e., a video of an arm being amputated) when they were told to observe the details of the procedure as a surgeon would. Thus, in having an individual focus on the parts or the details rather than the whole, one can detach themselves enough to remove the automatic, visceral disgust reaction. These findings suggest that although it may be difficult to change some disgusting stimuli to be more positive, it may be possible to alter the context which constitute one's automatic associations. The use of conceptual reorientation may be a viable option in reducing negative associations particularly among individuals at risk due to the presence of other vulnerability factors. For instance, individuals that display information processing biases for threat may be more likely to make threat-related associations. Repeated use of reappraisal or conceptual reorientation in therapy may aid individuals in changing those biases.

Shifting the focus from the disgust reaction to secondary appraisals may also improve disgust-targeted treatments (Teachman, 2006). Indeed, the experience of disgust may not be as problematic as one's reaction to that experience. Heightened disgust sensitivity, defined as one's interpretation of the disgust experience, may be a useful target in reducing disgust among both prevention and intervention treatments. Cognitive restructuring approaches (see Beck, 1985) may be used to address distorted beliefs such as "I can't cope with being that disgusted" or "If I vomit, I'll be humiliated." After exploring and restructuring these beliefs, the use of exposure can extinguish the fear associated with the phobic stimulus while also providing an opportunity to test one's ability to cope with the affective experience of disgust.

Conclusions

The current research program suggests that fear and disgust have a complex relationship in the development, maintenance, and treatment of disgust. While many questions remain, this dissertation has shed light on the development and measurement of disgust in children, provided evidence for one possible mechanism by which disgust may confer risk for maladaptive fear learning, and examined the effectiveness of disgust-targeted treatment for BII phobia. The findings suggest the CDS is a reliable and valid measure of individual differences in disgust proneness. Further, trait disgust avoidance, as assessed by the CDS, appears to be vulnerability factor for interpreting disgust-related information about a novel animal as threatening and thus fearful, resulting in avoidance. However, only targeting acquired fear during treatment may not yield maximum effectiveness resulting a renewal of phobic symptoms at post-treatment due to residual disgust evaluations. While providing exposure to disgust-eliciting stimuli in multiple contexts in somewhat beneficial, it was not more effective that fear-specific exposure. While this dissertation provides some suggestions for further treatment modifications, future research should focus on systematically exploring these adaptations and others in order to improve treatment outcomes, prevent relapse rates, and develop preventative programs for anxiety-related disorders.

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APPENDIX 1

Child Disgust Scale

Each sentence below is a statement that might be disgusting. Choose how often you would do what the sentence says by circling: *Always*, *Sometimes*, or *Never*.

1.	If I saw my favorite toy in the garbage I would take it out and play with it.	Always	Sometimes	Never
2.	If a dog licked my popsicle I would still eat it.	Always	Sometimes	Never
3.	I would sit next to someone even if they wore the same underwear all week.	Always	Sometimes	Never
4.	I would pick up a worm with my hand.	Always	Sometimes	Never
5.	When I see blood I feel dizzy.	Always	Sometimes	Never
6.	I feel gross when I touch raw meat to help cook dinner.	Always	Sometimes	Never
7.	I would touch a sandwich with green mold on it.	Always	Sometimes	Never
8.	I would still eat my soup if I saw a hair in it.	Always	Sometimes	Never
9.	I would feel gross if I accidentally touched someone’s bloody cut.	Always	Sometimes	Never
10.	I would sit next to a sweaty kid at lunch.	Always	Sometimes	Never
11.	I would watch a TV show that showed people’s guts.	Always	Sometimes	Never
12.	I would use the toilet even if there was poop still in it.	Always	Sometimes	Never
13.	I would share markers with someone that had touched a dead bird.	Always	Sometimes	Never
14.	I won’t eat unless I can wash my hands.	Always	Sometimes	Never
15.	I feel sick if I see a dead animal on the side of the road.	Always	Sometimes	Never
16.	I don’t like seeing the blood in meat at the grocery store.	Always	Sometimes	Never
17.	I would still drink my juice box even if I saw another kid drink out of it.	Always	Sometimes	Never
18.	I feel sick if I see someone throw up.	Always	Sometimes	Never

APPENDIX 2

Video coding and inter-rater reliability statistics for Experiment 2 behavioral avoidance task.

Variable	Disgust-Paired Animal				Clean-Paired Animal			
	Rater #1	Rater #2	Cohen's κ	Average	Rater #1	Rater #2	Cohen's κ	Average
Behaviors								
1. Drawing hands or body away from stimulus	.31 (.71)	.39 (.76)	.83	.35 (.72)	.31 (.74)	.35 (.75)	.77	.33 (.73)
2. Putting hands in front of mouth	.43 (.96)	.49 (.92)	.65	.46 (.89)	.10 (.48)	.18 (53)	.57	.14 (.48)
3. Averting ones gaze from stimulus/ looking at researcher	1.08 (.95)	1.20 (1.02)	.83	1.14 (.97)	.82 (.88)	.82 (.83)	.81	.82 (.84)
4. Turning head away	.51 (.82)	.65 (.90)	.67	.58 (.84)	.43 (.68)	.47 (.62)	.84	.45 (.63)
Emotion								
Overall perceived emotional valance	.00 (.61)	-.16 (.72)	.70	-0.08 (.63)	.33 (.55)	.35 (.56)	.67	.34 (.52)
Utterances								
Count	6.12 (2.73)	6.10 (2.77)	.88	6.11 (2.75)	6.61 (2.71)	6.63 (2.78)	.88	6.62 (2.74)
Average valance	-.05 (.13)	-.14 (.26)	.69	-.11 (.23)	.02 (.10)	.04 (.13)	.70	.03 (.12)

Note. Values represent means (standard deviation) unless otherwise noted. Scale for each variable is included in Table 6. Shaded 'Average' column represents mean (sd) used in additional statistical analyses.