Looking beyond fear: the extinction of other emotions implicated in anxiety disorders

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Looking beyond fear: The extinction of other emotions implicated in anxiety disorders

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Doctor of Philosophy Thesis

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Abstract

Although anxiety disorders have traditionally been associated with maladaptive fear responses, there is growing awareness that other aversive states, in particular disgust and dislike, play an important role in anxiety. Given that the “gold standard” treatment for anxiety disorders, which involves gradual exposure to feared stimuli and situations, is explicitly based on extinction in the laboratory, extinction models have been a useful tool with which to examine anxiety disorders. A wealth of data suggests that fear responses reliably diminish in response to extinction and exposure. In contrast, research suggests that feelings of dislike towards feared stimuli remain following extinction, although the bulk of that evidence relies on self-report. Despite the central role of disgust in certain anxiety disorders, little is known about the loss of disgust reactions. Therefore, the aim of this research was to examine the extinction of evaluative responses, in particular, dislike and disgust, using both self-report and behavioural measures, in order to inform the treatment of anxiety disorders. Using a variety of assessment tools, including a promising new measure, visual avoidance, the experiments in the first experimental chapter examined residual dislike following fear conditioning and extinction. Those experiments demonstrated that feelings of dislike did not extinguish to the same extent as cognitive expectancy of threat and physiological fear responses. The next chapter examined disgust conditioning and extinction. The experiments in that chapter showed that disgust responses were also resistant to extinction and demonstrated that certain evaluative responses were retained over time whilst others were not. Finally, the last experimental chapter directly compared the extinction of learned fear and disgust within the same protocol. Although fear responses extinguished, disgust responses were again shown to be resistant to extinction, suggesting that differences in the extinction of these emotions are not due to procedural artifacts. This comprehensive examination of the extinction of evaluative responses suggests that current treatments for anxiety disorders may not adequately target disgust and dislike. This
inattention to evaluative responses may reduce the effectiveness of treatment or may leave the patient vulnerable to relapse. Potential strategies to address these affective states are explored in the General Discussion.
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Publications and Presentations

Publications


Presentations

Mason, E. C. & Richardson, R. (2009). We have something to fear beyond fear itself. Disgust is resistant to extinction: Implications for the treatment of anxiety disorders. *Australian Association for Cognitive and Behaviour Therapy, Perth, Australia*.


**Posters**


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<td>BAT</td>
<td>Behavioural avoidance task</td>
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<td>BII</td>
<td>Blood-injection-injury</td>
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<td>BLA</td>
<td>Basolateral amygdala</td>
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<td>BNST</td>
<td>Bed nucleus of the stria terminalis</td>
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<td>CBT</td>
<td>Cognitive behavioural therapy</td>
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<td>CeA</td>
<td>Central nucleus of the amygdala</td>
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<td>CS</td>
<td>Conditioned stimulus</td>
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<td>ECQ</td>
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<td>EGG</td>
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<td>EMG</td>
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<td>fMRI</td>
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<td>FNE</td>
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<td>UNSW</td>
<td>University of New South Wales</td>
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<td>US</td>
<td>Unconditioned stimulus</td>
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<td>vmPFC</td>
<td>Ventromedial prefrontal cortex</td>
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Anxiety disorders are amongst the most prevalent of all mental health disorders (Andrews, Henderson, & Hall, 2001; Somers, Goldner, Waraich, & Hsu, 2006). Anxiety is a highly aversive state that has the capacity to impact on relationships, limit educational attainments, contribute to difficulties at work, and impair one’s physical health (Mendlowicz & Stein, 2000). Exposure therapy, which involves gradual exposure to feared situations and objects, is widely accepted as the treatment of choice for anxiety disorders (Barlow, Raffa, & Cohen, 2002; Tolin, Koby, & Monteiro, 2006). However, a proportion of individuals do not respond to treatment and of those who do respond, symptom reduction is rarely complete (Brown & Barlow, 1995; Westen & Morrison, 2001). In addition, relapse is a common problem (Brown & Barlow, 1995). Medication is also effective in treating anxiety disorders but generally does not provide a cure. Once medication is terminated, relapse rates are high (Starcevic, 2006). Clearly, current treatments are by no means perfect and the development of techniques to enhance their effectiveness would be highly desirable. For these reasons, understanding the boundaries of exposure therapy would be extremely valuable in the development of improved treatments for anxiety disorders and may enhance our understanding of the factors which predict whether people are likely to respond to treatment or not. As exposure therapy is explicitly based on extinction procedures (Bouton, 1988; Mineka, 1985), one effective way to gain a better understanding of exposure therapy is to investigate extinction in the laboratory.

**Conditioning and Extinction**

During a traditional fear conditioning paradigm, an innocuous *conditioned stimulus* (CS; e.g., a tone) is paired with (i.e., presented with or closely followed by) an aversive *unconditioned stimulus* (US; e.g., an electric shock) which elicits an unconditioned response
(e.g., increased heart rate). After a number of CS-US pairings, presentation of the CS alone comes to elicit the conditioned response, which is often the same response that is elicited by the US (i.e., increased heart rate in this example). The term “CS+” is used to signify a CS that is followed by the US and the term “CS-” is used to signify a CS that is not followed by the US. Extinction refers to unreinforced presentations of the previously conditioned stimulus. That is, the CS+ is presented without the US, which results in the extinction of, or a decrease in, the response to the CS+ (for review, see Myers & Davis, 2007). In clinical terms, the CS+ is the feared stimulus (e.g., an aeroplane) and the US is the feared outcome (e.g., death by crashing; Moscovitch, Antony, & Swinson, 2009). During exposure, patients are exposed to the feared stimulus in the absence of the feared outcome. As a result, the patient lowers their expectation of the occurrence of the feared outcome (i.e., expectancy of threat is reduced) and in turn, fear is attenuated.

Conditioning and Extinction – Are they appropriate models for anxiety?

It is important to note that some theorists have argued that conditioning is not an appropriate model of how fears are acquired (e.g., Menzies & Clarke, 1995; Rachman, 1977; for a convincing counter-argument, however, see Field, 2006). If one subscribes to that point of view, it would seem questionable to use a conditioning model if one were examining the aetiology of anxiety disorders. However, in the current set of experiments, I am particularly interested in the implications of the extinction findings for the treatment of anxiety disorders. The idea that exposure therapy is based on extinction is certainly not in question. Therefore, using an extinction procedure appears to be a valid model for the study of exposure therapy and its effects on emotional responses.
Theories of extinction

Early theories suggested that extinction was due to the erasure or “unlearning” of the CS-US association (e.g., Rescorla & Wagner, 1972). There are a number of empirical findings, however, which demonstrate that extinction cannot be fully explained by unlearning. In particular, return of fear (ROF) phenomena following extinction, including renewal, reinstatement, and spontaneous recovery, indicate that the CS-US association must still be intact following extinction even if it is not expressed. That is, if participants demonstrate extinction on test (i.e., no or little fear in response to the CS following several CS-no US presentations) but then show a return of fear to the CS following certain manipulations, the CS-US link cannot have been broken. For example, renewal experiments demonstrate that subjects who acquire fear to a CS in context A and are then extinguished in context B do not demonstrate conditioned fear responses in context B but will exhibit fear responses when tested in other contexts (Bouton & Bolles, 1979a). Reinstatement experiments reveal that subjects who display extinction on test will show recovered fear responses following a reminder presentation of the US alone or following a stressful experience (Bouton & Bolles, 1979b). Moreover, spontaneous recovery of fear responses simply after a period of time has elapsed since extinction can also be observed (Robbins, 1990). Each of these reliably demonstrated phenomena clearly indicate that the CS-US association remains, at least partially, intact following extinction.

In an effort to address observations of return of fear phenomena, more recent theories suggest that extinction is due to new inhibitory learning in which the subject learns that the CS is no longer predictive of the US (e.g., Bouton, 1993). In this way, the acquisition memory (CS-US) competes with the extinction memory (CS-no US) for expression. A number of factors may influence which memory is expressed, including context and the “fragility” of the association (Myers & Davis, 2007). Context, which refers to spatial, internal, and
temporal cues, appears to be very important to extinction in that the extinction memory is only expressed in the context in which extinction training took place (Myers & Davis, 2007). It is also relevant to note that the extinction memory appears to be less stable over time than the conditioning memory (Rescorla, 2004).

Recently, some researchers have suggested that there are likely to be several mechanisms of extinction, including new inhibitory learning and erasure. For example, Myers, Ressler, and Davis (2006) investigated the effects of varying the interval between conditioning and extinction on ROF phenomena (Myers et al., 2006). Consistent with previous reports, ROF was observed when extinction training occurred the day after conditioning. However, when extinction was conducted 10 minutes or 1 hour after conditioning, there was little to no evidence of ROF on test the following day, suggesting that the original fear memory had been erased. Therefore, Myers et al. (2006) proposed that extinction may be mediated by unlearning if it occurs very soon after acquisition but may be mediated by new learning if it occurs some time after acquisition. Similarly, Rescorla (2001) and Delameter (2004) have argued that the strict inhibitory theory of extinction is too simplistic because it disregards observations of only partial recovery of conditioned responses following extinction. That is, the return of fear is generally at a level that is less than what is displayed following acquisition and by non-extinguished controls, which suggests that some degree of erasure typically occurs. However, one might also argue that incomplete recovery of conditioned responses does not necessarily imply erasure. Rather, it could be that the presence of the inhibitory CS-no US memory is “strong” enough to suppress the full expression of the excitatory CS-US memory, leading to an incomplete recovery of response.
It is clear that the processes underlying extinction are not yet fully understood (Rescorla, 2001). Certainly, extinction in humans is even more poorly understood as the bulk of research into extinction has been performed using animals other than humans (Hermans, Craske, Mineka, & Lovibond, 2006). Fortunately, however, there has been increasing interest in this field of research in recent years and it continues to expand (Hermans et al., 2006).

**Neural bases of extinction**

One area of particular growth has been research related to identifying brain structures which are implicated in the processes associated with fear extinction. Most of this research has focussed on three areas – the amygdala, hippocampus, and prefrontal cortex (Myers & Davis, 2007).

**Amygdala**

The amygdala is widely recognised as a key brain structure associated with fear and other emotional states (LeDoux, 1998). Damage to the amygdala greatly affects the way in which humans and other animals respond to danger (LeDoux, 1998). For example, when the amygdala is damaged, humans and rats are unable to learn about cues that signal danger (LeDoux, 1998). In addition, without an intact amygdala, monkeys lose their fear of snakes (LeDoux, 1998). Furthermore, evidence suggests that patients with anxiety disorders have excessive activity in the amygdala in response to fearful stimuli (Rauch, Shin, & Wright, 2003; Stein, Simmons, Feinstein, & Paulus, 2007).

The basolateral amygdala (BLA) is crucial in both the acquisition and extinction of fear, whilst the central nucleus of the amygdala (CeA) mediates the expression of fear responses (Myers & Davis, 2007). The BLA projects to both the CeA and the bed nucleus of
the stria terminalis (BNST; Davis, 2006). The BNST appears to generate defensive behaviour in much the same way as the CeA but in response to different types of stimuli (Quinn & Fanselow, 2006). Whereas the CeA is activated in response to discrete fear CSs, the BNST is activated in response to less predictable stimuli, such as prolonged bright light (an anxiogenic stimulus for rats) and fearful contexts (Davis, 2006).

**Hippocampus**

Numerous studies indicate that extinction is context specific (Bouton, 2002; Bouton & Bolles, 1979a; Corcoran & Maren, 2004). Specifically, these studies have shown that the extinction memory (i.e., CS-no US), leading to no or diminished expression of fear, is only exhibited in the same context in which the organism underwent extinction. The previously extinguished fear will return in a different context. The hippocampus is known to mediate contextual fear conditioning (Phillips & LeDoux, 1992) and it appears to play a role in the context dependence of the extinction of cued fear (Corcoran & Maren, 2001; 2004). Context dependence of extinction may confer a survival advantage. That is, an animal is more likely to survive if the CS-US relationship (signalling danger) is regarded as ubiquitous and the CS-no US association is regarded as an anomaly, specific to a particular context.

**Medial prefrontal cortex**

The ventromedial prefrontal cortex (vmPFC) plays an important role in fear extinction. Rats with vmPFC lesions demonstrate within-session extinction but fail to show retention of extinction on test one day later (i.e., they exhibit fear on test; Lebron, Milad, & Quirk, 2004). In addition, research has shown that increased activity in the vmPFC is associated with decreased fear expression during extinction recall in both rodents (Barrett, Shumake, Jones, & Gonzalez-Lima, 2003; Milad & Quirk, 2002) and people (Milad *et al.*, 2007). Furthermore, stimulation of infralimbic neurons within the vmPFC during the
presentation of the conditioned stimulus reduces fear expression, suggesting that the vmPFC “gates the response of downstream structures such as the amygdala to fear stimuli” (Milad, Vidal-Gonzalez, & Quirk, 2004, p.389). Consistent with this notion, both the lateral amygdala and the intercalated GABA (gamma-aminobutyric acid)-ergic inhibitory cells in the central amygdala receive strong excitatory input from the infralimbic neurons within the vmPFC, resulting in inhibition of the output cells of the central amygdala which are responsible for the behavioural expressions of fear (Barad & Saxena, 2005).

In humans, the thickness of the vmPFC is associated with greater extinction recall, as evidenced by skin conductance levels to an extinguished CS on test (Milad et al., 2005). Interestingly, individuals with post-traumatic stress disorder (PTSD) have been shown to have increased amygdala activation during fear acquisition and decreased activity in the anterior cingulate (a region of the prefrontal cortex), relative to healthy controls (Bremner et al., 2005). Taken together, this research has led some authors to suggest that anxiety disorders may be “mediated by hyperresponsivity of the amygdala... due to insufficient top-down regulation by the medialPFC” (Barad & Saxena, 2005, p. 49).

**Predictive and evaluative learning**

It is well established that as a result of fear conditioning, the CS comes to elicit a fear response. In addition, fear conditioning also endows the CS with a negative valence (Hermans et al., 2005). That is, not only do participants come to fear the CS, they also dislike it. The acquisition of likes and dislikes in this way is termed evaluative conditioning (De Houwer, Baeyens, & Field, 2005). Although learned fear is reduced as a result of extinction procedures, learned dislike appears to be resistant to extinction (Baeyens, Crombez, Van den Bergh, & Eelen, 1988; Diaz, Ruiz, & Baeyens, 2005). Therefore, a residual dislike of the
CS remains, even though it is no longer feared (e.g., Vansteenwegen, Francken, Vervliet, De Clercq, & Eelen, 2006).

Following from this, it has been proposed that two processes might be in operation during classical conditioning (Baeyens & De Houwer, 1995; Diaz et al., 2005; Hermans, Crombez, Vansteenwegen, Baeyens, & Eelen, 2002a; Hermans, Vansteenwegen, Crombez, Baeyens, & Eelen, 2002b). The first process, predictive or expectancy learning, occurs when one learns that the CS predicts the occurrence of the US. Under experimental conditions, this would occur, for example, when the participant learns that the tone predicts the shock. As a clinical example, a person with a fear of flying may have an expectation that flying in a plane (the CS) will lead to dying in a crash (the US). The second type of learning, evaluative learning, occurs when the participant comes to regard the CS as a negative or positive stimulus, on the basis of the valence of the event (US) with which it has been associated. Hence, in a fear conditioning experiment, participants learn to dislike the CS. To follow on from the previous clinical example, the individual may not only fear flying and expect the plane to crash, they may also dislike planes. Although extinction procedures are effective in reducing the arousal and expectancy components of fear, evidence suggests that the valence component may be more resistant to extinction treatment (Baeyens et al., 1988; De Houwer et al., 2005; Diaz et al., 2005; Vansteenwegen et al., 2006). In this way, the participant may learn that the tone no longer predicts the shock and therefore they no longer fear the tone. Nevertheless, they may continue to dislike the tone. Similarly, a person who learns through exposure therapy that the feared stimulus (e.g., a dog, planes) is not dangerous, may still harbour negative feelings towards the stimulus even though it is no longer feared. This may lead to future avoidance and in turn relapse. For this reason, it is clinically important not only to consider measures of expectancy learning but also to consider measures of evaluative learning when examining extinction.
Evaluative conditioning

Clearly, the valence that one ascribes to a stimulus is critically important. Indeed, Lang, Bradley, and Cuthbert (1990) suggested that the brain may use valence as a fundamental category to arrange information prior to generating avoidance or approach behaviours. Indeed, evaluative conditioning is pervasive and can be seen at work in a diverse range of experiences, from food preferences (Brunstrom, 2007; Rozin & Millman, 1987), to racial prejudice (Olson & Fazio, 2001; Staats & Staats, 1958), marketing (Shimp, Stuart, & Engle, 1991; Stuart, Shimp, & Engle, 1987), and clinical disorders (e.g., Lascelles, Field, & Davey, 2003).

Evaluative conditioning (EC) is generally viewed as a form of Pavlovian conditioning, in which the conditioned response is a change in the perceived valence of the CS that has been paired with the US (Rozin, Wrzesniewski, & Byrnes, 1998). The term, evaluative conditioning, was introduced by Martin and Levey in 1978, although it had been studied earlier by these same authors when they first empirically demonstrated that valence can be transferred through conditioning (Levey & Martin, 1975). Levey and Martin (1975) stated that the simplest form of evaluative response is “like” or “dislike” and aptly noted that “It is doubtful to what extent theories of conditioning and learning can be relevant to human emotions and behaviours until the phenomenon of subjective affective experience is considered in their formulations” (p. 224). Historically, theorists have understood the importance of evaluative judgements in daily life. For example, Arnold in 1960 remarked that “an object or situation is perceived, appraised, and liked or disliked” and Lazarus (1966) noted that “the process is often nearly instantaneous. . . and an individual need not be fully aware of the evaluations he [sic] is making, or of the factors that enter into them. . .” (as cited in Levey & Martin, 1975, pp. 221-222). Adding to this, Young (1967) maintained that
behaviour is regulated by the subjective experience of pleasantness/unpleasantness (i.e., a hedonic dimension). From these accounts, it appears as though evaluation is a basic process that is central to many aspects of behaviour.

The typical EC paradigm follows from Levey and Martin’s (1975) original “picture-picture” procedure in which neutral pictures were paired with a positively or negatively valenced picture. In that study, participants were first asked to categorise 50 pictures of paintings and scenic photographs as “liked”, “disliked”, or “neutral”. They were then asked to choose the two pictures they liked the most and the two pictures they most disliked. These four pictures served as the USs and four pictures that had been judged as neutral were chosen to be CSs. The experimenters then paired each CS with one US. Therefore, there were four CS-US pairings – two neutral CSs with positive USs and two neutral CSs with negative USs. A fifth control pair was created by pairing two additional neutrally rated pictures. During conditioning, each pair of pictures was presented 20 times. In the post-acquisition rating phase, participants were asked to rate each of the 10 pictures on a -100 to 100 scale, where -100 represented maximum disliking and 100 represented maximum liking. Levey and Martin (1975) showed that the CSs that were paired with liked USs were themselves subsequently more liked. Similarly, participants rated the CSs that were paired with disliked USs more negatively following conditioning. Furthermore, the evaluative shift was greater for CSs that were paired with negatively valenced USs than for CSs that were paired with positively valenced USs. This type of EC procedure has since been replicated and improved upon by several researchers, in particular by Baeyens and colleagues (e.g., Baeyens et al., 1988; Baeyens, Eelen, & Van den Bergh, 1990a; Baeyens, Eelen, Van den Bergh, & Crombez, 1992; Baeyens, Hermans, & Eelen, 1993). Furthermore, earlier criticisms related to problematic methodologies in EC research (predominantly related to the use of non-random stimulus assignment and inappropriate control conditions) have also been
rectified (Hammerl & Grabitz, 2000). In addition, others have shown that the acquired valence is resistant to extinction (e.g., Baeyens et al., 1988; Diaz et al., 2005; Vansteenwegen et al., 2006). For example, in a tightly controlled experiment, Diaz et al. (2005) demonstrated that even when participants received double the number of extinction trials (i.e., CS alone presentations) than acquisition trials (i.e., CS-US pairings), the acquired CS valences were not affected to any extent. In that study, Japanese letters were paired with positive, negative, or neutral words (e.g., love, murder, iron board, respectively). Following extinction, participants continued to rate the CS letters that had been paired with positive words as positively as they had rated them after acquisition, and continued to rate the CS letters that had been paired with negative words as negatively as they had rated them after acquisition. This result was further corroborated by the findings on the post-experimental affective priming task, a task which provides an indirect measure of participants’ stimulus evaluations that is not affected by demand characteristics (see below for details on this task).

Another way of producing EC in the laboratory involves pairing neutral odours or flavours with pleasant or unpleasant tastes (e.g., Baeyens, Eelen, Van den Bergh, & Crombez, 1990b; Zellner, Rozin, Aron, & Kulish, 1983). As a result of these pairings, participants come to evaluate the previously neutral odours and flavours as more or less pleasant in accordance with the valence of the taste with which they were paired. For example, in Zellner et al.’s (1983) study, participants received two types of flavoured tea (mandarin or apple). One flavoured tea (the CS+) was served with sugar and the other flavoured tea (the CS-) was served in plain water (i.e., without sugar). The flavours which served as the CS+ and CS- were counterbalanced across participants. That is, for some participants the mandarin flavour was served sweetened, while the apple flavour was served unsweetened and for other participants the apple flavour was served sweetened,
while the mandarin flavour was served unsweetened. On test, both teas were presented unsweetened. The researchers found that the tea that had previously been paired with sugar was preferred to the tea that had been previously served unsweetened, despite the fact that both teas were served unsweetened on test. In another study, Baeyens et al. (1990b) found that the shift in evaluations was greater for CS flavours that were paired with an unpleasant bitter taste (Tween) than for CS flavours that were paired with a pleasant taste (sugar). EC has also been demonstrated using tactile stimuli (Hammerl & Grabitz, 2000). In that experiment, participants first rated how much they liked or disliked 40 different types of materials (e.g., fur, silk, linen, wood). Throughout the experiment, participants could not see the materials (i.e., stimuli were presented in a box in which participants placed their hand into in order to touch the materials) and could not hear any sound produced from touching them as they wore headphones. On the basis of each participant’s ratings, the experimenter selected materials that were evaluated neutrally to serve as CSs and materials that were judged positively to act as USs. Stimuli that were judged as neutral were subsequently judged more positively when paired (using a trace conditioning procedure\(^1\)) with positively valenced materials. In addition, EC effects have been observed using CSs and USs from different sensory modalities. For example, EC has been demonstrated in cases where the CS was visual (pictures) and the US was olfactory (odours) or auditory (music; for review, see De Houwer, Thomas, & Baeyens, 2001). It seems therefore, that a wide variety of stimuli can be used to obtain EC.

Evaluative conditioning is also presumed to occur in animals other than humans (Rozin et al., 1998). In particular, it has been proposed that conditioned taste aversions (CTAs) in rats are examples of evaluative conditioning (Rozin et al., 1998). In a CTA

\(^1\) A trace conditioning procedure refers to a procedure in which there is a delay between the offset of the CS and the onset of the US. In the Hammerl and Grabitz (2000) experiments, the CS was presented for 2 seconds, followed by a 3-second trace interval, followed by the US.
procedure, a flavour (or taste) is paired with a substance that induces nausea. For example, Desgranges et al. (2009) exposed rats to a saccharin solution and then injected them with lithium chloride (LiCl). On test, rats exhibited a strong aversion to the saccharin solution. CTA is observed despite long intervals between the ingestion of the target stimulus (CS+) and the feelings of nausea (US). Real world cases of conditioned taste aversion are readily observed. For example, people often develop a dislike of a particular food after they become sick subsequent to eating that food (Garb & Stunkard, 1974). Such aversions appear to be highly persistent (Desgranges et al., 2009). Indeed, Campbell and Alberts (1979) showed that although young rats, who tend to show rapid forgetting, did not retain fear to a cue that had been paired with shock, they did retain aversion to a cue that had been paired with an agent that induced nausea (LiCl). Those results suggest that CTAs are long-lasting. Moreover, conditioned taste preferences, like other forms of EC, seem to be resistant to extinction. For example, Harris, Shand, Carroll, and Westbrook (2004) showed that rats exposed to an almond-sucrose drink subsequently exhibited a strong preference for almond-flavoured water over plain water. Rats exposed to almond-flavoured water alone did not exhibit a preference for that flavour. Furthermore, this preference persisted despite 20 exposures to the almond-flavoured water without the sugar, suggesting that learned food preferences are highly resistant to extinction. Although EC is a common phenomenon, Rozin et al. (1998) note that it is not always observed in the laboratory and that “there are some important and unknown factors that influence the occurrence of EC” (p. 400). They speculate that relevant factors include novelty of the CS, temporal contiguity, individual differences in the propensity to acquire EC, as well as contextual factors.

Few attempts have been made to study EC in real world contexts outside of the laboratory. Baeyens and colleagues, however, manipulated the pleasantness of a massage that physiotherapy patients received to examine whether this would influence subsequent
ratings of the neutrally fragranced oils (chosen on the basis on pilot testing) that were used during the massage (Baeyens, Wrzesniewski, de Houwer, & Eelen, 1996). One group of participants received a “negative” painful massage and another group received a “positive” relaxing massage. Half of the participants in each group were massaged using one fragrant oil and the other half were massaged using oil with a different odour. One week later, participants were asked to rate the two odours (i.e., the one that had been used in their massage and the one that was used in the other group). Participants who experienced the positive, relaxing massage rated the odour that was used in their massage as more positive than the control odour, regardless of whether they could recognise that the odour was used in their massage or not. Participants in the “negative”, painful condition did not actually rate their massage as a negative experience. Rather, they rated the experience as a generally “neutral” one. Consistent with this, no evaluative conditioning effects were seen in that group. That is, participants in the negative condition did not rate the odour of the oil used in their massage as more disliked (or liked) than the control odour. As Baeyens et al. (1996) conceded, the design did not control for non-associative mere exposure effects because the control odour was only presented in the test phase. The mere exposure effect refers to the commonly observed phenomenon that repeated exposure to a stimulus leads to enhanced liking of that stimulus (Reber, Winkielman, & Schwarz, 1998; Zajonc, 1968). Therefore, participants may have rated the target odour more positively than the control odour simply because they had been exposed to it previously rather than because it was associated with a positive massage experience. Against that, however, is that participants in the negative group did not rate the target odour more positively than the control odour, which would have been predicted if the change in valence ratings were due to mere exposure. Therefore, the increase in liking of the fragrance used in the positive massage condition appears to be a valid demonstration of EC in a real world context.
Accounts of evaluative conditioning

De Houwer et al. (2005) review three accounts of evaluative conditioning. First is the conceptual-categorical model (Davey, 1994) which is a non-associative account that holds that pairing a neutral CS with a valued US emphasises the aspects of the CS that are conceptually similar to the US. It is argued that the increase in salience of the features that are similar to those of the US results in a change in CS evaluation. This model has been criticised by Baeyens, De Houwer, Vanstevenwegen, and Eelen (1998) who reason that such an account would have difficulty explaining cross-modal EC (e.g., picture-flavour conditioning) because it seems unlikely that there would be enough similarities between the two stimuli to permit conceptual reorganisation. The second model is the holistic account (Levey & Martin, 1975; Martin & Levey, 1978) which proposes that EC is a basic component of classical conditioning. Levey and Martin suggest that as a result of the CS-US pairing, the CS and US become stored in a “stimulus complex” so that the presentation of the CS automatically evokes this complex, which includes the US valence characteristics. Finally, the referential account proposed by Baeyens et al. (1992) specifies that evaluative conditioning is a distinct form of associative learning that is procedurally similar to traditional Pavlovian conditioning but may be mediated by a different underlying process (also see, Baeyens & De Houwer, 1995; Baeyens, Eelen, & Crombez, 1995). Traditional Pavlovian conditioning is seen as a form of expectancy learning where the CS signals the US. In contrast, evaluative conditioning is viewed as referential learning where the CS merely brings the US “to mind” (unconsciously or consciously), without the expectation that the US will actually occur. This dual-process account of learning is the subject of much debate and will be discussed in greater detail below.

In a recent paper, Mitchell, De Houwer, and Lovibond (2009) argue against a dual-system approach of learning in favour of a single-system approach. That is, they make a case
for a propositional approach which holds that associative learning (including evaluative learning) requires higher-order controlled reasoning processes regarding beliefs about the world. In contrast, the dual-system approach holds that learning incorporates higher-order controlled reasoning processes regarding beliefs about the world as well as lower-order, passive unconscious processing, in which the mental representation of one stimulus (the CS) automatically forms a link with the mental representation of the other stimulus (the US). A critical difference between the higher- and lower-order processes is that the higher-order process involves propositions (e.g., the bell signals food), whereas in the lower-order process, the CS and the US are simply linked without any information regarding the nature of the relationship. Therefore, according to the latter view, the bell simply activates a representation of the food and vice versa.

In support of the propositional (single-system) approach, Mitchell et al. (2009) argue that learning does not occur in the absence of awareness of the CS-US associations, and therefore it requires propositional knowledge. They cite several reviews that indicate that skin conductance responses (a physiological measure of anxious arousal used in human fear conditioning paradigms) are only evident amongst participants who are aware of the CS-US contingency. That is, participants who are unaware of the contingencies do not show greater skin conductance responses to the CS+ than to the CS- during fear conditioning. Critics, however, contend that there are cases of evaluative learning without awareness. That is, there are instances of participants reporting dislike of a stimulus that has previously been paired with an aversive US without being aware that the CS was even paired with the US (e.g., Baeyens et al., 1990a; Dickinson & Brown, 2007; Fulcher & Hammerl, 2001). This, it is argued, suggests that a different type of learning that does not require propositional reasoning is in operation in these observations. In counter-argument to this, Mitchell et al. (2009) state that close inspection of almost all cases of purported conditioning without
awareness reveals that the measure of conditioning was more sensitive than the measure of awareness, for example because a recall rather than recognition test was used to assess contingency awareness. Therefore, it is possible that participants were actually aware of the stimulus contingencies (or at least some of them) yet the awareness test was not sensitive enough to detect it. They further maintain that aggregate awareness scores used in many studies may mask the awareness of some participants. As an illustration of the problem of aggregate awareness scores, Dickinson and Brown (2007) previously demonstrated evaluative conditioning in the absence of awareness however Wardle, Mitchell, and Lovibond (2007) reanalysed their awareness data using a more stringent test to classify participants as unaware and found that EC was actually only observed in aware participants. Specifically, Dickinson and Brown (2007) classified participants as aware if all four CS-US contingencies were recalled correctly and classified all other participants as unaware. In contrast, Wardle et al. (2007) classified participants as aware if three out of the four contingencies were recalled. Participants who recalled two or less of the associations were classified as unaware. These differences in the classification of participants as “contingency aware” or “unaware” resulted in different conclusions regarding evidence for evaluative conditioning in the absence of awareness. Based on Dickinson and Brown’s (2007) approach, participants who were aware of some but not all of the CS-US contingencies were classified as unaware. Therefore, amongst the group of unaware participants were participants who were actually aware of three of the four associations. Using Wardle et al.’s (2007) approach, fewer participants were classified as unaware. The remaining group of “truly” unaware participants did not report altered evaluative ratings of the CSs, whilst the aware group did report shifts in CS valence in accordance with the valence of the USs with which they were paired. This example highlights that closer examination of ostensible demonstrations of unaware EC may reveal that the original conclusions are unfounded.
Nevertheless, there are at least two examples of evaluative conditioning in the absence of awareness in which the lack of awareness appears to be genuine. First is the case of “flavour-flavour” conditioning in Baeyens et al.’s (1990b) widely cited paper. In that study, the CSs were either fruit flavours or colours. Sugar was used as the positively valenced US and Tween, which has a bitter taste, was used as the negatively valenced US. An interesting dissociation between the type of CS used and awareness emerged. Specifically, participants rated the flavour that had been paired with Tween as more disliked than the flavour that had been paired with sugar, however they did not report awareness of the CS-US contingencies (i.e., which flavour had been paired with the sugar or the Tween). In contrast, participants did not develop a preference or an aversion to the colours that had been paired with the USs and yet they were aware of the relevant CS-US contingencies. Baeyens et al. (1990b) proposed that the reason why EC was seen in the flavour but not in the colour condition may be because the flavour element of a food is more likely to become associated with the taste than the visual characteristics of that food. A further reason for the discrepancy between evaluative learning to colours and flavours may be due to the fact that colours aren’t as novel as flavours (i.e., we have been exposed to far more colours than flavours) and therefore people already hold pre-existing evaluations regarding colours. Pre-existing judgements may be more difficult to change than neutral evaluations to novel stimuli. Regardless of the explanation for the differences between the two conditions, the reason that the Baeyens et al. (1990b) paper has been so influential is because the awareness test was sensitive enough to detect awareness of the colour-flavour contingencies. For this reason, it is not likely that the contingency test was simply not sensitive enough to detect the flavour-flavour contingencies, therefore suggesting that the observation of unaware flavour-flavour conditioning was genuine. However, in order to optimise the sensitivity of a contingency awareness test, Lovibond and Shanks (2002) recommend that the learning and testing phases should be as similar as possible. Wardle et
al. (2007) contend that because the Baeyens et al. (1990b) contingency awareness test was conducted in a different manner to conditioning and the test of evaluative responses, sensitivity of the awareness test may have been compromised or the awareness test may have confused participants. Therefore, they sought to replicate Baeyens et al.’s (1990b) findings using an awareness test that was more similar to the conditioning procedure. In that experiment, Wardle et al. (2007) replicated the basic finding of evaluative conditioning with flavours but not colours. However, they showed that participants were aware of both the colour-US and flavour-US contingencies. Therefore, they cast doubt on the idea that EC can be seen without awareness. However, another crucial difference between those studies is that the Wardle et al. design was much simpler and used fewer CSs than the Baeyens et al. design. Because of this, the stimulus contingencies would have been fairly obvious to participants in Wardle et al.’s (2007) study. In contrast, it is possible that the complex design in Baeyens et al.’s (1990b) study disguised the CS-US contingencies for participants and therefore that experiment may still represent a valid instance of EC without awareness.

In another example of evaluative conditioning in the absence of awareness, across two tightly-controlled experiments, Stevenson, Boakes, and Prescott (1998) showed that odour-taste learning was independent of explicit contingency knowledge. In that paper, an odour (e.g., lychee) was paired with a sucrose solution whilst a control odour (e.g., water chesnut) was paired with water. Two other odours were used as distractors. During conditioning, participants drank a liquid composed of a flavourless odour and a sucrose solution or a liquid composed of a flavourless odour and water. The odour that had been paired with sucrose was subsequently judged as smelling sweeter by participants, regardless of whether they were aware of which odour had been paired with the sucrose solution or not. Importantly, the contingency awareness test in their second experiment was designed so that it would not be susceptible to criticisms regarding differences between the
conditioning and testing conditions or inadequate sensitivity (for further information on these types of criticisms, see Shanks & St. John, 1994). Mitchell et al. (2009) concede that the Stevenson et al. (1998) experiments may represent an example of unaware EC and suggest that further investigations of this finding are warranted in order to determine whether there is “a separate gustatory [taste] module isolated from cognitive processes” (p. 232). That is, acquired likes and dislikes pertaining to taste may represent a special case of learning that does not rely on higher-order cognition. This may be a particularly relevant consideration in relation to the discussion of learned disgust outlined below, given that tastes can be a key elicitor of disgust (Phillips et al., 1997; Rozin, Haidt, & McCauley, 2008).

Although the debate concerning the role of awareness in EC continues, the above examples are the exception rather than the rule. Indeed, the bulk of the evidence suggests that EC is not readily observed without awareness. Certainly, there are no convincing cases of unaware EC using visual stimuli (Dawson, Rissling, Schell, & Wilcox, 2007; Field, 2001; Lovibond & Shanks, 2002; Mitchell et al., 2009). Regardless of whether evaluative conditioning can be shown without awareness, because the studies conducted as part of this thesis employed very simple tasks with only two CSs, it could be argued that participants who did not accurately recognise the CS-US contingencies were not paying sufficient attention to provide valid and reliable data. For these reasons, unaware participants, though few in number\(^2\), were excluded from all analyses throughout the thesis. Although some of the data reported in this thesis may inform the debate regarding whether associative learning involves one or two or multiple systems, my focus is on the clinical implications of the data rather than the implications for theoretical learning models. For this reason, I have not discussed my data in relation to learning models.

\(^2\) Overall, the number of unaware participants ranged from 2.5-8.3\% across experiments and the mean number of unaware participants across experiments was 5.4\%.
The clinical relevance of residual negative valence

As noted above, the major clinical implications of EC research relate to findings of resistance to extinction. Researchers who study valence in the context of fear conditioning have found that, unlike traditional skin conductance and expectancy measures, valence is much less rapidly extinguished (Hermans et al., 2002b; Vansteenwegen et al., 2006). Specifically, these researchers have found that following extinction, although participants demonstrate a reduction in their expectancy of the US and a decrease in their level of skin conductance (a measure of autonomic arousal) to a CS that has previously been paired with shock, they continue to show a dislike of the CS+. This is highly clinically relevant. For example, consider a patient who is “successfully” treated for a fear of catching trains. Although the patient no longer fears catching trains and understands that they aren’t nearly as dangerous as initially thought, if a negative feeling towards trains remains, the patient still will not like trains or enjoy catching them. Instead, the patient may avoid trains in favour of other means of transport. In this way, there is residual negative valence which may lead to avoidance and, in turn, relapse. Blechert, Michael, Vriends, Margraf, and Wilhelm (2007) provide the following example of the clinical relevance of residual negative valence: “Imagine a PTSD [post-traumatic stress disorder] patient who has to choose between two different ways to drive to work, with one of them passing by the street where the traumatic event happened. Exposure therapy (extinction) might have reduced this patient’s fear reaction and negative expectancies with respect to this street. Yet, if subtle conditioned negative valence outlived exposure therapy, it might facilitate the avoidance of this street; thereby possibly increasing the chance of relapse” (p. 2030).

It appears that if the stimulus retains a residual negative valence, it is likely to prompt avoidant responses in the future. This, in itself, may initiate a return of fear. Indeed,
Hermans et al. (2005) observed a significant association between stimulus valence and return of fear, in that the more negatively the CS+ was rated at the end of extinction, the more return of fear was observed. It seems, therefore, that stimulus valence may be highly pertinent to the treatment of anxiety disorders.

Debate regarding resistance to extinction

Unfortunately, there is no research to date that has specifically assessed patients’ valence ratings following exposure therapy. As noted above, however, there are several studies that have been conducted in the laboratory that assess valence (for review, see De Houwer et al., 2001). Even though there is a large body of research suggesting that evaluative conditioning is resistant to extinction (De Houwer et al., 2001), this claim is somewhat contentious (Lipp & Purkis, 2005). For example, as expectancy learning and evaluative learning are typically studied independently, it has been thought that differences between expectancy learning and evaluative learning may reflect procedural differences in the way in which these two types of learning are examined (e.g., differences in the number of trials and stimulus presentation duration). In recent years, however, experimenters have studied evaluative and expectancy learning concurrently in fear conditioning procedures (e.g. Hermans et al., 2002b; Vansteenwegen et al., 2006). These authors have found that despite evidence of extinction on measures of expectancy and skin conductance, there is little to no change in valence following extinction. This suggests that the distinctions observed between the two types of learning are unlikely to be due to parametric differences.

The notion of resistance to extinction has also been challenged by Lipp and Purkis (2006) who proposed that previous failures to observe extinction of CS valence, as measured by self-report, are due to the manner in which verbal reports are measured.
Specifically, they argued that post-experimental ratings reflect an integration of the experimental valences used across the entire experiment rather than the current affective value of the conditioned stimulus. Therefore, they suggest that the post-experimental ratings of the extinguished CS+ are likely to be more negative than the current affective value of the CS+ as post-experimental ratings also take into account the value of the CS+ during conditioning. In support of this, they have shown that although post-experimental ratings show the extinguished CS+ as being rated negatively, online (i.e., trial-by-trial) ratings of valence return to neutral across extinction trials (see Lipp & Purkis, 2006). However, it is important to note that Lipp and Purkis (2006) did observe slower extinction of CS valence evaluations than US expectancy ratings on the trial-by-trial measure. Therefore, as these authors recognise, this may illustrate distinct learning mechanisms for evaluative and predictive learning. This finding of slower extinction of valence than expectancy deviates somewhat from theories which hold that evaluative learning does not extinguish at all, but it can fit with a “weaker” theory of evaluative learning which acknowledges that evaluative learning can extinguish, but at a much slower rate than expectancy learning. This weaker version is still relevant to the treatment of anxiety disorders because it suggests that exposure therapy may need to be extended in order to allow for the evaluative component of the fear (i.e., the dislike of the feared stimulus) to extinguish. Indeed, since exposure-based treatment, as the chief component of cognitive behavioural therapy (CBT) for anxiety, is billed as a short-term treatment, it is unlikely that treatment would typically proceed beyond a time at which the patient was reporting clinically significant decreases in their fear responses and expectancy of threat.

It is also important to consider the ecological validity of Lipp and Purkis’ (2006) findings. That is, simply because it can be demonstrated that online valence ratings do return to neutral in the procedure used by Lipp and Purkis does not mean that online ratings
are more meaningful than post-experiment ratings. Firstly, when participants are repeatedly asked the same question, they may feel that they are expected to change their ratings over time. But, more importantly, post-experiment ratings, which demonstrate resistance to extinction, may in fact be more reflective of real-life evaluations than online ratings. Consistent with this, valence ratings obtained two months after extinction are in line with ratings following acquisition and extinction (Baeyens et al., 1988). This suggests that post-experimental (integrative) ratings may be more consequential than online ratings.

The majority of investigations into evaluative conditioning and resistance to extinction have used self-report measures to assess stimulus evaluations. The use of additional objective, behavioural and physiological measures may shed more light on the debate.

**Measures of evaluative conditioning/residual negative valence not involving self-report**

**Affective priming**

In order to investigate resistance to extinction more thoroughly, it would be valuable to use more objective measures of stimulus valence, rather than simple self-report. Recently, Vansteenwegen et al. (2006) used affective priming as an objective measure to examine CS valence following fear conditioning and extinction. In a basic affective priming task, words appear on the screen and participants are asked to classify them as positive or negative as quickly as possible. Words are preceded by positively or negatively valenced primes such as pleasant or unpleasant pictures. For example, a picture of cute baby may be used as a pleasant prime and a picture of garbage may be used as an unpleasant prime.
Therefore, there are four trials types that can be divided into congruent and incongruent trials. Congruent trials occur when positive words are preceded by positive primes and negative words are preceded by negative primes. Incongruent trials occur when positive words are preceded by negative primes and negative words are preceded by positive primes. Research indicates that participants are faster to respond on congruent than incongruent trials (Hermans et al., 2002a; Hermans et al., 2002b). That is, there is a processing advantage for the target word when the prime is evaluatively congruent with that word. Therefore, one can infer the valence of a prime simply by observing how it affects the reaction time to the subsequently presented positive or negative word.

Vansteenwegen et al. (2006) took advantage of this effect and used the conditioned stimuli (faces) in their study as primes in an affective priming task. In a fear conditioning paradigm, following acquisition, the CS- is likely to act as a pleasant prime (because it has never been followed by shock) and the CS+ is likely to serve as an unpleasant prime (because it has been followed by shock). Vansteenwegen et al. (2006) found that following conditioning, reaction times were significantly faster on congruent trials than incongruent trials, suggesting that the CS- had acquired a positive valence and the CS+ had acquired a negative valence. In order to determine whether the CS+ retained its negative valence following extinction, participants re-did the affective priming task following extinction. If the extinguished CS+ is still disliked after extinction, its presentation as a prime should facilitate participants’ reaction time to classify negative words. If the valence of CS+ has extinguished (i.e., returned to neutral), the same processing advantage would not be observed. Following extinction, Vansteenwegen et al. (2006) reported a main effect for congruence, indicating that participants were faster on congruent than incongruent trials. In addition, they reported a nonsignificant phase-by-congruence interaction, indicating that the effect of congruence did not differ between acquisition and extinction. Importantly, participants showed clear evidence of extinction on both skin conductance and US expectancy ratings.
Taken together, this provides evidence using an objective measure that acquired valence is resistant to extinction in a fear conditioning paradigm. It is important to note that the stimulus onset times used in affective priming tasks preclude conscious processes (and hence demand effects) from influencing reaction times on this task (Hermans, Spruyt, & Eelen, 2003). A significant criticism of this study should be noted, however. As the authors did not present data for all four trial types (i.e., CS+/positive word; CS+/negative word; CS-/positive word; CS-/negative word) but rather collapsed across congruent and incongruent trials, it could be that the effects reported were driven by positive congruent trials involving the CS-, in which case, these results might not indicate resistance to extinction. In order to truly demonstrate resistance to extinction (that is, that the extinguished CS+ still retains a negative valence), it is important that the two types of congruent trials (i.e., CS+/negative word; CS-/positive word) are considered separately, as will be done in the present work.

**Behavioural forced choice (chocolate) test**

In a recent article, Blechert *et al.* (2007) used a novel measure to examine the role of avoidance following extinction. In that experiment, there were three groups of participants – PTSD patients, trauma-exposed controls, and healthy controls. Participants were conditioned to fear one of two pictures (Rorschach inkblots) which was paired with a mild electric shock. The other picture served as the CS-. Participants then underwent extinction training in which the CS+ was presented in the absence of the shock. At the end of the experiment, participants were presented with a bowl containing 20 chocolate bars. Half of the chocolates were wrapped in paper depicting the CS+ and the other half were wrapped in paper depicting the CS-. Participants were asked to pick one chocolate bar “as a small token for your participation”. Selection of the chocolate bar depicting the CS- was interpreted as avoidance of the CS+. Both the PTSD and trauma-exposed control groups chose the CS- bar significantly more frequently than the CS+ bar. There was no significant
difference in the chocolate chosen amongst the healthy controls. Although the authors interpreted this behavioural forced choice task as a measure of avoidance, it seems also to reflect residual negative valence. In support of this, individuals in the PTSD group reported the most negative valence ratings for the CS+ across all three groups and they also showed the greatest amount of behavioural avoidance of the CS+ across groups. This creative task may be a useful way in which to examine residual negative valence in a fear conditioning paradigm.

**Visual avoidance task – A novel measure**

An innovative new way to examine evaluative responses may be to investigate visual avoidance of the conditioned stimuli. Eye-tracking technology has not yet been used in the context of aversive conditioning. It has, however, been used as a measure of avoidance in the assessment of individuals with social anxiety disorder. Specifically, Horley, Williams, Gonsalvez, and Gordon (2003) presented participants with photographs of faces on a computer equipped with an eye-tracker that could monitor where participants looked and for how long. They showed that individuals with social phobia avoided looking at the eyes on the faces compared to control participants. This is in agreement with clinical observations of eye-contact avoidance amongst individuals with social anxiety as well as cognitive models of social phobia that highlight interpersonal processing biases (Horley et al., 2003). As stated earlier, avoidance is a key factor in anxiety disorders and therefore measures that examine avoidance may be particularly relevant in the investigation of anxiety.

As noted, no research has examined whether fear conditioning and extinction influences the degree to which individuals look at the conditioned stimuli, yet this may be a simple and valuable new measure of evaluative and/or fear responding. Therefore, in my
experiments, following conditioning or extinction, the CSs will be presented side-by-side on a computer that is equipped with an eye-tracker. This will allow me to measure how long participants spend viewing the CS+ and the CS-. Figure 1.1 depicts graphically the viewing times of the CSs from one participant. As can be seen, the CSs used are faces (more details below). In this example, the participant spent significantly more time viewing the face on the left-hand side of the screen (the CS-).

Figure 1.1. Image of the two CS faces side-by-side. The coloured markings on the faces represent viewing time and location for one participant on the visual avoidance task.

It is reasonable to assert that both dislike and fear may result in avoidance of the CS+. The use of concurrent measures of fear and dislike will help to disentangle whether or not avoidance of the CS+ is indexing fear or dislike or both. For example, if after extinction, participants report that they dislike the CS+ and do not exhibit fear (as indicated by skin conductance responses) yet continue to avoid looking at the CS+, it seems sensible to infer that the visual avoidance task is likely assessing dislike. As a measure of dislike/evaluative learning, it is possible that responses on this measure will be less rapidly extinguished than other standard measures such as expectancy and skin conductance.
As models of anxiety highlight both avoidance (Huppert, Roth Ledley, & Foa, 2006) and hypervigilance to threat (Koster, Crombez, Verschuere, & De Houwer, 2006), it is also possible that rather than showing avoidance of the CS+, participants may fixate on the CS+ for longer than the CS- following conditioning (i.e., exhibit hypervigilance). However, evidence suggests that although anxious individuals show an early hypervigilant response, they tend to exhibit avoidance during longer stimulus presentations. For example, using a visual probe task\(^3\) to assess attentional bias to threat, Mogg and colleagues showed that anxious individuals initially show a hypervigilant response to threat (i.e., when the stimuli are presented for 500ms) but avoid looking at the threat-related stimulus when it is presented for a longer period of time (see Mogg & Bradley, 1998; Mogg et al., 2004). Consistent with those studies in which reaction time was the dependent variable, there is general support for avoidance of threat stimuli after initial hypervigilance in studies which have used eye-tracking technology (Pflugshaupt et al., 2005; Rinck & Becker, 2006; but see Kimble, Fleming, Bandy, Kim, & Zambetti, 2010, who showed hypervigilance with no evidence of avoidance of trauma-relevant stimuli amongst Iraq war veterans). For example, Rinck and Becker (2006) demonstrated that participants highly fearful of spiders who were presented with an array of pictures (e.g., a spider, dog, butterfly, and cat) initially fixated on the spider picture but then quickly moved their gaze away from the spider and spent less time looking at it than non-anxious control participants during a 1-minute presentation. Therefore, based on these studies, one might predict avoidance of the CS+ when the CSs are displayed for longer than 500ms, as is the case in the current set of experiments. However, it should be noted that the work discussed in this section pertains to avoidance of phobic

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\(^3\) A visual probe task (also known as a dot probe task) is a task in which two stimuli, one neutral and one threatening, are presented on the computer screen for a certain length of time (e.g., 500ms). Immediately following the termination of the display of those images, a dot or another visual stimulus (as was used in the Mogg et al., 2004 task) is presented on the screen in the place of one of the two previous images and participants are asked to press a button as soon as they notice the dot. Vigilance to threat is inferred when participants are faster to locate the dot when it is placed in the position in which the threatening picture was located. In contrast, avoidance of threat is inferred when participants are faster to locate the dot when it is placed in the position in which the neutral picture was located.
stimuli by anxious individuals, whereas my experiments examine avoidance of stimuli that have acquired fear and concurrent negative valence in a student sample. For this reason, it is difficult to draw direct inferences from the cited research to the current research.

**Summary**

In summary, it seems that extinction results in a decrease in physiological arousal to the CS and a decrease in expectancy of the negative outcome but a dislike of the CS remains. This residual dislike may lead to avoidance and, in turn, relapse. Residual negative valence can be measured through self-report valence ratings, affective priming, a behavioural forced choice task, and potentially eye-gaze duration. The use of objective behavioural measures and the study of evaluative responses in the same paradigm as that used to study expectancy learning and fear responses will be highly valuable in advancing our understanding of the extinction of evaluative responses. Consequently, this research will inform exposure-based therapies for anxiety disorders.

**Disgust: An important consideration in anxiety and the next step in evaluative learning research**

Not only may the use of new, and in particular behavioural, measures be enlightening in the study of evaluative responding, but examining further evaluative responses, in addition to likes and dislikes, may be especially informative. Disgust appears to be a prime candidate for investigation given that it is a form of evaluative response that involves “gut reactions” and has been implicated in a number of anxiety disorders.
The idea that disgust is involved in anxiety is a relatively new one. Traditionally, anxiety disorders have been associated with maladaptive fear responses, however more recently there has been greater awareness that other emotions, in particular disgust, play a crucial role in the aetiology and maintenance of certain anxiety disorders (Woody & Tolin, 2002). As an example, individuals with spider phobia not only report that they fear spiders, they also report that they find them disgusting (Woody, McLean, & Klassen, 2005). That is, it appears as though excessive disgust responses may be as important as fear and possibly even more important in driving the avoidance and distress involved in certain phobias as well as obsessive compulsive disorder (OCD) contamination concerns. As Dr Richard McNally declared with the title of a 2002 paper, “Disgust has arrived”.

Most notably, disgust has been implicated in spider and other small animal phobias (e.g., de Jong & Muris, 2002; Matchett & Davey, 1991); blood-injection-injury (BII) phobia (e.g., Olatunji, Smits, Connolly, Willems, & Lohr, 2007b); obsessive compulsive disorder, specifically those with contamination concerns (e.g., Moretz & McKay, 2008); and to some extent, post-traumatic stress disorder (PTSD; e.g., Dalgleish & Power, 2004; Grey, Holmes, & Brewin, 2001), particularly amongst females (Olatunji, Babson, Smith, Feldner, & Connolly, 2009a). It has been shown that individuals with the former three disorders report higher levels of disgust sensitivity towards phobic and non-phobic stimuli than healthy controls (Sawchuk, Lohr, Tolin, Lee, & Kleinknecht, 2000; Schienle, Schafer, Walter, Stark, & Vaitl, 2005; Woody & Tolin, 2002). Not only are elevated levels of disgust reported by such individuals, but disgust is indeed primary to fear in many cases (e.g., in BII phobia – Olatunji, Lohr, Sawchuk, & Westendorf, 2005; Sawchuk, Lohr, Westendorf, Meunier, & Tolin, 2002).

It has been shown that individuals with spider phobia demonstrate both disgust-specific and fear-specific facial electromyography (EMG) responses to spiders (de Jong,
Peters, & Vanderhallen, 2002). Similarly, individuals who scored highly on a questionnaire that measures fear of blood-related stimuli showed greater disgust facial expressions\(^4\) in response to a surgery film than lower scoring participants (Lumley & Melamed, 1992). There is also evidence that the insula, a brain region implicated in disgust responses, is active when individuals with spider phobia and OCD view phobic-relevant stimuli (Dilger et al., 2003; Husted, Shapira, & Goodman, 2006, respectively). Furthermore, using structural equation modeling, Moretz and McKay (2008) demonstrated that disgust had a direct relationship with OCD contamination symptoms, independent of trait anxiety. In addition, reported level of disgust during a behavioural avoidance task (BAT) was shown to be a better predictor of spider avoidance than reported level of anxiety (Woody et al., 2005). Moreover, amongst a group of spider-phobic and non-spider-phobic girls, the degree to which spiders were viewed as disgusting was found to be the best predictor of the presence of spider phobia. In contrast, the girls’ estimates of the likelihood of spiders causing personal harm did not predict spider phobia (de Jong & Muris, 2002). Taken together, this body of research suggests that disgust is highly relevant to the maintenance of certain anxiety disorders. Yet, disgust is rarely, if ever, specifically targeted in treatment (de Jong & Muris, 2002).

The role of avoidance in both anxiety and disgust adds further support to the idea that disgust is an important emotion in the context of anxiety disorders. Avoidance is central to anxiety disorders (Huppert et al., 2006) as it prevents the patient from learning that the feared outcome will not occur, or that if it does, it will not be as aversive or dangerous as expected. Avoidance of feared stimuli and situations also prevents the patient from habituating to feelings of anxiousness (Huppert et al., 2006) and potentially to other aversive emotions, such as disgust. It is clear that disgust motivates avoidance (Rozin &

\(^4\) Measured by independent raters who coded videos of the participants’ faces.
Fallon, 1987). For example, when something is disgusting (e.g., spoiled milk), one tends to avoid it. That disgust prompts avoidance is also apparent in the experimental literature. For example, greater disgust sensitivity predicts greater avoidance on a disgust BAT (Deacon & Olatunji, 2007).

Thus, disgust is implicated in a number of anxiety disorders. In addition, the feeling of disgust prompts avoidance and avoidance is central to anxiety disorders. Given that fairly little is known about the loss of disgust reactions, it is important to examine disgust in the context of models of anxiety in order to inform and enhance treatments for anxiety disorders.

As noted by McNally, “Disgust has been the most understudied of all emotions” (McNally, 2002, p. 561). In my own experience, during discussions with other clinical psychologists on this issue, they have often made the point that on reflection about certain cases, it appears as though it was disgust, not fear, that was the key emotion driving the disorder. Yet they noted that disgust was completely neglected in the case formulation and therefore treatment approach. In a classic paper by Angyal in 1941, he defined disgust as revulsion at the prospect of oral incorporation of an offensive object. In an extension to this definition it has been noted that the offensive objects have potent contaminating properties. For example, food that comes into contact with these objects are viewed as inedible (Rozin et al., 2008; Rozin & Nemeroff, 1990). Thus, disgust is an emotion that has been implicated in the rejection of foods that may cause illness (Angyal, 1941; Ekman & Friesen, 1975; Rozin & Nemeroff, 1990), and serves a function in keeping oneself and one’s environment clean and free from disease (see Schienle, Stark, & Vaitl, 2001). Disgust may have evolved as a disease avoidance mechanism (Oaten, Stevenson, & Case, 2009), although
“disease avoidance may be nothing more than a *post hoc* rationalization of an otherwise mysterious aversion” (McNally, 2002, p. 562).

Bodily waste products are seen as the prototypical disgust stimuli (Angyal, 1941; Rozin *et al.*, 2008). Other potent elicitors of disgust include certain foods; contact with animals, death, and corpses; body envelope violations (e.g., a needle penetrating the skin and open wounds); as well as contact with undesirable people or strangers (Rozin *et al.*, 2008). There are also indications that disgust may be triggered by moral lapses (Borg, Lieberman, & Kiehl, 2008; Chapman, Kim, Susskind, & Anderson, 2009; Jones & Fitness, 2008). For example, people may describe instances of betrayal and racism as “disgusting” (Rozin *et al.*, 2008). Moreover, there is evidence that moral transgressions (e.g., unfair treatment of another player in a game) prompt disgust facial expressions that resemble the facial motor activity elicited by more traditional disgusting stimuli such as photographs of contaminants and unpleasant tasting drinks (Chapman *et al.*, 2009).

Behaviourally, disgust is characterised by distancing oneself from the object, situation, or event that is perceived to be disgusting (Rozin *et al.*, 2008). That is, disgust is manifested by avoidance. The disgust facial expression involves retraction of the lip and wrinkling of the nose, a response which parallels the rejection of unwanted food and odours (Ekman & Friesen, 1975; Schienle *et al.*, 2001). Rozin *et al.* (2008) suggest that the *qualia* (i.e., the subjective experience) of disgust is frequently described as a feeling of revulsion, that has a fairly short duration relative to other emotions⁵ (Scherer & Wallbott, 1994). Physiologically, disgust prompts feelings of nausea (Rozin *et al.*, 2008) and is associated with parasympathetic autonomic activity, in particular heart rate deceleration (Levenson, 1992). The insula, particularly the anterior portion, is the brain region that has been most

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⁵ Disgust and fear were found to be the most short-lived out of the emotions studied, lasting a few minutes to an hour in most people. In contrast, sadness and joy tend to last for hours or days.
associated with disgust (Murphy, Nimmo-Smith, & Lawrence, 2003; Wright, He, Shapira, Goodman, & Liu, 2004). This part of the brain also plays a role in taste (Rolls & Scott, 1994). Interestingly, the anterior insula also appears to be involved when people make good/bad evaluative judgements (Cunningham, Raye, & Johnson, 2004). Therefore, this may be a site related to evaluative responding in general. The basal ganglia have also been shown to be active during disgust responding across several studies (Husted et al., 2006; Murphy et al., 2003).

In the characterisation of disgust, two laws of sympathetic magic have been used to explain mechanisms by which a neutral object may acquire disgusting properties. “The laws of sympathetic magic are descriptions of a consistent pattern of beliefs, thoughts, and practices observed across a wide range of traditional cultures” (for an in depth review, see Rozin & Nemeroff, 1990, p. 206). The two relevant laws are the “law of contagion” and the “law of similarity”. The law of contagion states that when a neutral object comes in contact with a disgusting object, the disgusting properties of the latter object are permanently transferred to the previously neutral item. It is succinctly described as “once in contact, always in contact”. For example, many people would view their soup as irreparably tainted if they found a hair in it. Similarly, most people would be reluctant to eat from a container that had been used to keep stools, urine, or sputum regardless of the degree to which the container was cleaned (Angyal, 1941). The law of similarity maintains that objects that resemble each other in appearance, also share deeper properties. As an illustration of this idea, most individuals would be hesitant to eat something that is fashioned to look like a disgusting object (e.g., chocolate shaped as dog faeces; Rozin, Millman, & Nemeroff, 1986; Rozin & Nemeroff, 1990).
An interesting question regarding disgust is whether it is cognitive or not. That is, does disgust require thinking (e.g., beliefs about why something is disgusting)? This is an important clinical question because if disgust is cognitive, then it is susceptible to change by rational argument. The premise of cognitive therapy is that our thoughts influence our feelings and behaviour and that in psychopathology, irrational, unhelpful thoughts cause distress (Beck, Rush, Shaw, & Emery, 1979). For example, overestimation of the probability and severity of threat leads to feelings of fear and anxiety and is known to be a key cognitive bias amongst individuals with anxiety disorders (Foa & Kozak, 1986; Moritz & Jelinek, 2009; Wiedemann, Pauli, & Dengler, 2001). If, however, disgust is non-cognitive, then cognitive therapy will not be effective. McNally (2002, p. 564) notes that some theorists have argued that disgust is non-cognitive and as he aptly states, “it is probably a waste of time trying to convince most Americans that eating cockroaches can be a delightful dining experience”. McNally suggests that although disgust may not respond to reason, it might respond to exposure therapy. However, one of the key proposed mechanisms by which exposure works is by providing evidence that the perceived threat does not occur or if it does, it is not as bad as anticipated (Antony & Swinson, 2000). In this way, the cognitive bias of overestimation of threat is altered by exposure and fear is reduced. If there is no cognitive component of disgust, then exposure will not be able to act on disgust in this way. It is possible, however, that exposure will work via other mechanisms, such as habituation.

The only study that has examined the extinction of conditioned disgust suggests that learned disgust reactions are resistant to extinction (Olatunji, Forsyth, & Cherian, 2007a). Consistent with that finding, research conducted in clinical analogue samples⁶, comprised of individuals who report a marked fear of spiders or blood-injection-injury stimuli, or

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⁶ The term “clinical analogue sample” refers to a sample comprised of participants who report high levels of symptoms associated with the relevant disorder but have not actually received a formal diagnosis and may not meet criteria for diagnosis.
significant contamination concerns, has shown that during exposure to phobia-relevant stimuli, disgust responses do not decline to the same extent as fear responses (Olatunji et al., 2007b; Olatunji, Wolitzky-Taylor, Willems, Lohr, & Armstrong, 2009b; Smits, Telch, & Randall, 2002). However, those conclusions relied primarily on self-reported ratings of disgust and as noted by Cisler, Olatunji, and Lohr (2009), there is a need to examine the extinction of disgust reactions using measures other than self-report. Therefore, one aim of the present research was to examine whether or not learned disgust is resistant to extinction, using an objective, behavioural measure (the visual avoidance task).

Furthermore, in the one previous experiment to examine the extinction of learned disgust (Olatunji et al., 2007a), the nature of the unconditioned stimuli used (pictures of mutilated bodies) was such that it is likely that both disgust and fear were elicited (discussed further in Chapter 3). Therefore, a further aim was to replicate that experiment using unconditioned stimuli that would elicit disgust without a significant fear component.

**Summary**

Disgust is a form of evaluative response that involves “gut feelings” of aversion. Despite the central role of disgust in the aetiology and maintenance of certain anxiety disorders, very little is known about the loss of disgust reactions. A crucial question is whether disgust is reduced in the same way as fear in response to exposure-based therapies. Preliminary evidence from clinical analogue samples (Olatunji et al., 2007b; Olatunji et al., 2009b; Smits et al., 2002) as well as one study which examined the extinction of learned disgust in a non-clinical sample (Olatunji et al., 2007a) suggests that disgust, like other evaluative responses, does not decline during extinction and exposure. The majority of measures used in those studies were self-report. Furthermore, the stimuli used in the one study that has examined the extinction of learned disgust responses likely elicited a mixture
of fear and disgust. For these reasons, further examination is warranted using robust
behavioural measures as well as valid stimuli for the study of disgust. The key behavioural
measure that will be used in the current work is the visual avoidance task. This is a
particularly relevant measure given that avoidance is the chief behavioural manifestation of
disgust.

**General aims**

The overarching aim of the current experiments is to examine the extinction of
evaluative responses, in particular dislike and disgust, in order to inform the development of
treatments for anxiety disorders.

The first experimental chapter (Chapter 2) examines residual feelings of dislike
following fear conditioning and extinction and contrasts the extinction of dislike with the
extinction of cognitive expectancy of threat and the extinction of physiological fear
responses. The studies in this chapter use a variety of assessment tools, including a
promising new measure, eye-gaze avoidance, to test whether the proposal that learned
feelings of dislike are not easily extinguished can be further supported. This is particularly
informative given that the bulk of work in this area has used self-report measures.
Furthermore, the current protocol allows for a more thorough comparison of the extinction
of evaluative responses and cognitive expectancy as these constructs are studied
simultaneously within each experimental procedure. For the above reasons, these
experiments provide valuable insights into the extinction of evaluative responses which, in
turn, will inform the treatment of anxiety disorders.
The second experimental chapter (Chapter 3) examines the extinction of disgust responses, a form of evaluative response that is a particularly important maintenance factor in certain anxiety disorders. The first experiment in that chapter is only the second empirical investigation of the extinction of learned disgust and extends the previous investigation (Olatunji et al., 2007a) in several ways. The second experiment in Chapter 3 examines the retention of evaluative responses over time which provides an additional way in which to study the loss of disgust and dislike.

Finally, the last experimental chapter (Chapter 4) directly compares the extinction of fear and disgust responses within the same protocol in order to provide a greater descriptive account of the extinction of these emotions, which is not confounded by procedural artifacts.

Together, these experiments provide a comprehensive examination of the extinction of evaluative responses using multiple measures, and are discussed in terms of the clinical implications of resistance to extinction.
Chapter 2:

Fear conditioning and extinction experiments

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Experiment 1

Evaluative responses following fear conditioning

The first experiment was designed to establish whether, using the current parameters, fear conditioning would result in learning about the predictive value of the conditioned stimuli, increase fear of the CS+, and alter the valence of the CSs. It was predicted that participants would report greater expectancy of the US following the CS+ than the CS- and would exhibit greater skin conductance responses to the CS+ relative to the CS-, indicating fear of the CS+. It was further predicted that participants would report that they disliked the CS+ more than the CS- and that participants would avoid looking at the CS+ following conditioning. Finally, it was hypothesised that more participants would choose the CS- chocolate over the CS+ chocolate following conditioning, indicating an aversion to the CS+.

Method

Participants

Participants were 13 first-year psychology students at the University of New South Wales (UNSW) who participated in the experiment for course credit as well as four UNSW students who were paid for participation. Of the 17 participants, one was unaware of the CS-US contingencies (see page 48 for details) and as such, was excluded from the analyses. The data from the remaining 16 participants are reported below. Of this final sample, four were male and 12 were female.
**Design**

Participants underwent differential fear conditioning, in which one of three faces (CS+) was paired with an electric shock four times. One of the two remaining faces (CS-) was presented four times but was never followed by an electric shock. The third face served as a control face and was not presented during the conditioning procedure. Participants completed pre- and post-experiment valence ratings of the CSs and the control face. In addition, they completed the visual avoidance task and the behavioural forced choice (chocolate) task.

**Materials and apparatus**

The conditioning task was programmed and executed using MedPC on an IBM computer with Windows 98.

**Conditioned stimuli**

Three black and white photos of female faces with neutral expressions obtained from the Ekman and Friesen (1976) collection were used in this experiment. Two faces served as the conditioned stimuli and one served as the control face. The determination of which face served as the CS+, CS-, and control stimulus was randomised for each participant.

**US administration and Skin conductance recording**

The US was an electric shock to the finger combined with a 95-dB tone presented over stereo headphones, which lasted half a second. The loud tone was combined with shock to enhance the potency of the US (Guastella, Lovibond, Dadds, Mitchell, & Richardson, 2007b). The shock was administered through electrodes placed on the distal and proximal segments of the participant’s left index finger. Skin conductance responses
were measured through electrodes placed on the second and third fingers of the same hand (See Figure 2.1).

Figure 2.1. Illustration of the shock and skin conductance electrodes attached to a participant’s hand.

*US expectancy dial*

During the presentation of each CS, participants used their right hand to indicate their subjective expectancy of the shock on a semicircular, rotary dial. The left extreme of the dial was labelled “0”, “Certain no shock” and the right extreme of the dial was labelled “100”, “Certain shock”. Regularly spaced ticks labelled in increments of 10 also appeared on the dial (See Figure 2.2).
The procedures and apparatus for US administration, skin conductance recording, and US expectancy recording were based on those reported in several previous experiments (e.g., Guastella et al., 2007b; Hinchy, Lovibond, & Ter-Horst, 1995; Lovibond, Davis, & O'Flaherty, 2000).

**Eye-tracker**

The eye-tracker used in this experiment was a Tobii 1750, which samples eye saccades at 50 Hz and is accurate to 0.5 degrees of visual angle. A ClearView fixation filter was used, in which the fixation radius was set at 30 pixels and the minimum fixation duration was 100ms. A five-point calibration setting was used in order to calibrate the eye-tracker for each participant. The dependent measure for this part of the experiment was the viewing time of each CS face during the visual avoidance task.

![Figure 2.2. Illustration of the US expectancy dial.](image)
Procedure

Pre-experiment valence ratings of the faces

Participants were presented with pictures of the three faces on separate laminated pages. For each face, participants were asked, “How much do you like or dislike this picture?” with the following anchors – 0 = really dislike, 50 = neutral, 100 = really like. Presentation order of the faces was randomised.

Selection of shock intensity and Conditioning

Following the pre-experiment valence ratings, participants were seated at the computer. The skin conductance leads and shock electrodes were attached to the participants’ left hand. Using a work-up procedure, participants were asked to set the intensity of the shock to a level that was “uncomfortable, and demanding some effort to tolerate, but not painful”. After this, the experimenter\(^7\) provided verbal instructions for the task. The instructions explained that the faces that the participants had seen in the previous rating phase would appear on the screen and that some faces would be followed by shock and others would not. Participants were told that their task was to determine which face was followed by the shock. Further, participants were instructed about the use of the expectancy dial. They were told that they were required to make an expectancy rating every time a face appeared on the screen and to leave the dial in the position of their rating until instructed to turn the dial to the off position. The experimenter answered any questions and then asked the participant to put on the headphones and to try to keep their left hand as still as possible so as not to interfere with the skin conductance recording. The experimenter then dimmed the lights and left the room. Following this, written instructions for the task, reiterating the verbal instructions, appeared on the screen and the conditioning procedure began.

\(^7\) Please note that I (E. Mason) was the experimenter for all experiments presented in this thesis.
During conditioning, one face (the CS+) was immediately followed by the US four times. The other face (the CS-) was presented alone four times. Each presentation of the CS lasted 13 seconds and the US duration was half a second. Participants made their US expectancy ratings during the CS presentation. After the CS/US presentation, the following message appeared on the screen, “Please turn the dial to off”. There was a variable inter-trial interval (ITI) of 40-60 seconds, which included the 10-second period immediately prior to the CS onset in which baseline skin conductance levels were recorded. Trial order was randomised, with the exception that no one CS could be presented more than two times consecutively. At all times during this task, except when the US was presented, a white noise (70dB) was played through the headphones to minimise noise distractions from outside the testing room.

**Visual avoidance task**

Immediately following the last conditioning trial, participants were seated in another room at a computer equipped with the eye-tracker. In order to calibrate the eye-tracker, participants were instructed to “follow the dot on the screen with your eyes”. After that, the experimenter gave participants the following instructions, “In the next part of the experiment, please look at the screen. It doesn’t matter where you look, as long as you look at the screen”. The two faces used as CSs then appeared on the screen side-by-side (See Figure 2.3). The faces were shown simultaneously nine times for 2 seconds per presentation. Each presentation was preceded by a blank screen for 1 second. The side of the screen on which the images appeared was counterbalanced across participants. In cases where participants failed to look at either of the images on the screen during a presentation, data from that participant for that presentation were excluded.
Figure 2.3. Illustration of the two CSs displayed on the eye-tracker during the visual avoidance task. Please note that the eye-tracker in this photo was not the same model as was used in the current experiment. It was, however, used in the experiments described in Chapter 3.

Post-experiment valence ratings of the faces

The post-experiment valence rating of the faces was conducted in exactly the same manner as the pre-experiment rating task.

Contingency awareness check

In order to assess whether participants could recognise which face was the CS+ and which was the CS-, participants were presented with a form which had pictures of the three faces that had been shown in the experiment (i.e., the CS+, the CS-, and the control face) and were asked to cross out the face that was not presented during the computer task (i.e., the control face). Of the two remaining faces, participants were asked to indicate which face was followed by shock and which face was not followed by shock. Participants who correctly indicated the CS-US contingencies were classified as “aware”. Other participants were classified as “unaware”.
**Behavioural forced choice (chocolate) test**

Finally, participants were informed that the experiment was over and were presented with two Cadbury Freddo Frog chocolates on the desk in front of them. One chocolate had a picture of the CS+ face adhered to the front of the wrapper and the other chocolate had a picture of the CS- face adhered to the front of the wrapper (See Figure 2.4). Participants were invited to take a chocolate as thanks for their participation. The chocolate chosen was recorded by the experimenter.

![Figure 2.4. An example of the two chocolates presented in the behavioural forced choice test.](image)

**Data analysis and presentation**

Skin conductance responses were calculated for each trial as the difference between the mean skin conductance level during the last 5 seconds of the 13-second CS presentation and the mean skin conductance level during the 10-second baseline period. To normalise distributions, the data were log-transformed before differences were computed. This is consistent with the methodology used in several other differential fear conditioning studies (e.g., Guastella *et al.*, 2007b; Hinchy *et al.*, 1995; Lovibond, 1992; Lovibond *et al.*, 2000).
In the analysis of the visual avoidance task, outliers, defined as having a difference score between viewing times of the CS+ and CS- that was 2 or more standard deviations above or below the mean, were excluded from the analyses.

All statistics reported throughout this thesis were analysed using PASW Statistics, version 18 (formerly SPSS Statistics), unless otherwise stated. When reporting analyses of variance, in cases where the assumption of sphericity was violated, the nominal degrees of freedom and adjusted $p$-value using the Greenhouse-Geisser correction are reported. Adjusted $p$-values are indicated by the subscript $GG$, and appear as $p_{GG}$. When reporting independent $t$-tests, in cases where the assumption of equal variances between groups was violated (as indicated by Levine’s Test for Equality of Variances), the nominal degrees of freedom and adjusted $p$-value are reported. Adjusted $p$-values are indicated by the subscript $UV$ (i.e., Unequal Variances), and appear as $p_{UV}$. Finally, in cases where the degrees of freedom vary within an experiment, this is due to missing data.

**Results**

*Expectancy of US*

Mean US expectancy ratings on each of the four conditioning trials are presented in Figure 2.5. During conditioning, expectancy of the shock following the CS+ was significantly greater than following the CS- [$F_{(1, 10)} = 21.96, p = 0.001$]. There was also a significant trial-by-CS interaction [$F_{(3, 30)} = 10.79, p_{GG} = 0.002$], reflecting the increase in US expectancy ratings following the CS+ and the decrease in US expectancy following the CS- across trials.
Figure 2.5. Mean US expectancy ratings for the CS+ and CS- across conditioning (Experiment 1). N.B. In all figures presented, error bars represent standard error of the mean (SEM).

**Skin conductance responses**

Mean skin conductance responses (SCRs) to the CS+ and CS- faces are presented in Figure 2.6. During conditioning, participants exhibited significantly higher SCRs to the CS+ than to the CS- \( F_{1, 15} = 16.39, p = 0.001 \). There was also a significant trial-by-CS interaction \( F_{3, 45} = 5.71, p = 0.002 \), due to the development of differential skin conductance responses across trials. On trial one, there was no difference in SCRs to the CS+ and CS- \( t_{15} = -0.64, p = 0.53 \). On each of the following trials, however, SCRs were significantly greater to the CS+ than to the CS- \( \text{smallest } t_{15} = 2.81, p = 0.01 \).
Pre- and post-experiment valence ratings

Mean valence ratings of the CS+, CS-, and control faces are presented in Figure 2.7. There was a significant interaction between face type and time \( F_{(2, 30)} = 27.21, \ p_{\text{GG}} < 0.001 \). Further analyses revealed that prior to conditioning, there was no difference in the valence ratings of the CS+, CS-, and control faces \( F < 1 \). In contrast, following conditioning there was a significant difference in the valence ratings of the CS+, CS-, and control faces \( F_{(2, 30)} = 25.52, \ p < 0.001 \). Specifically, following conditioning the CS+ face was disliked significantly more than the CS- face \( t_{(15)} = -6.35, \ p < 0.001 \) and the control face \( t_{(15)} = -3.96, \ p = 0.001 \). In addition, the CS+ face was rated significantly more negatively following conditioning, compared to before conditioning \( t_{(15)} = 5.40, \ p < 0.001 \). The CS- face was rated significantly more positively following conditioning, compared to before conditioning \( t_{(15)} = -4.42, \ p < 0.001 \). There was no change in the ratings of the control face from pre- to post-experiment \( t_{(15)} = -0.36, \ p = 0.73 \).
Visual avoidance task

Mean looking times at the CSs, tested immediately after the last conditioning trial, are presented in Figure 2.8. Each block consists of the sum of three stimulus presentations. The data from two outliers were removed from block 1. One outlier had a difference score between viewing times of the CS+ and CS- that was 2 standard deviations (SD) above the mean (i.e., hypervigilant to CS+) and the other’s difference score was 2 SD below the mean (i.e., avoidant of CS+). There were no outliers in block 2. The data from one outlier, who had a difference score that was 2 SD below the mean, were removed from block 3. There was no main effect of CS type \(F < 1\) or block \(F < 1\) nor a significant interaction \(F_{(2, 20)} = 1.04, p = 0.37\). Although the interaction was not significant, each block was analysed separately due to a priori predictions. In block 1, participants spent significantly less time looking at the CS+ than the CS- \(t_{(11)} = -3.36, p = 0.006\). There was no significant difference between viewing times of the CSs in block 2 or 3 [largest \(t_{(13)} = -0.46, p = 0.67\)].
Figure 2.8. Mean looking time at the conditioned stimuli during the visual avoidance task (Experiment 1). N.B. Total possible looking time in each block was 6000ms.

*Behavioural forced choice (chocolate) test*

The number of participants who chose the chocolate with the CS+ face wrapper and the chocolate with the CS- face wrapper is presented in Figure 2.9. Significantly more participants chose the CS- chocolate than the CS+ chocolate \[ \chi^2 (1, N = 16) = 6.25, p = 0.012 \].

Figure 2.9. Number of participants who chose each chocolate type (Experiment 1).
Discussion

In this differential fear conditioning paradigm, participants learned that the shock followed the CS+ face and did not follow the CS- face. In addition, participants exhibited greater anxious arousal (as measured by SCRs) in the presence of the CS+ than in the presence of the CS- face, suggesting that participants feared the CS+ face more than the CS- face. As can be seen in Figure 2.6., despite clear distinctions between SCRs to the CS+ and the CS- on trials 2-4, SCRs to the CS+ appear to decrease slightly on the last two trials. This is consistent with many other studies that have shown a slight decline in SCRs to the CS+ after only a few pairings (e.g., Dawson & Biferno, 1973; Guastella et al., 2007b; Ohman, Fredrikson, Hugdahl, & Rimmo, 1976). There was also evidence that this procedure endowed the CS+ with a negative valence. Specifically, participants reported that they disliked the CS+ face more than the CS- and control faces following conditioning. Furthermore, an overwhelming majority of participants chose the CS- chocolate over the CS+ chocolate, suggesting an aversion to the CS+. During the visual avoidance task, participants avoided looking at the CS+ during the first block of face presentations (i.e., during the first three presentations, each lasting 2 seconds). It is not clear whether this task is measuring fear or dislike of the CS+ face, as one would predict that both affective states would result in avoidance. However it is clear that this differential fear conditioning paradigm leads to visual avoidance of the CS+, and that this response diminished fairly quickly (i.e., after approximately 9 seconds, the length of the first block including ITIs).
Experiment 2

Are evaluative responses acquired during fear conditioning resistant to extinction?

The first experiment demonstrated that differential fear conditioning leads to cognitive (measured by expectancy), physiological (measured by SCRs), and evaluative changes towards the CSs (measured by self-report and the behavioural forced choice test). The conditioning procedure in Experiment 1 also led to visual avoidance of the CS+. The aim of the current experiment was to determine whether these changes would be affected by extinction. Based on previous research, outlined in the Introduction, it was predicted that the cognitive and physiological fear responses would be reduced as a result of extinction, whereas the evaluative changes would be resistant to extinction. As it is unclear whether the visual avoidance measure is assessing fear or dislike, it is difficult to make predictions regarding the effects of extinction on performance on this measure. If the task measures fearful avoidance, then one would predict that participants would not demonstrate avoidance on this task following extinction as fear has been shown to extinguish rapidly in laboratory extinction preparations using non-clinical participants (e.g., Blechert, Michael, Williams, Purkis, & Wilhelm, 2008; Seligman, 1971). If, however, the task measures avoidance due to dislike of the CS+, one would predict that avoidance of the CS+ would be observed following extinction as previous research indicates that evaluative responses, such as dislike, are resistant to extinction (De Houwer et al., 2001).
Method

Participants

Participants were 41 UNSW first-year psychology students who participated in the experiment for course credit. Of these, one participant chose to withdraw during the experiment and one participant was unaware of the stimulus contingencies. These participants were excluded from the analyses. Data from the remaining 39 participants are reported below. Of this final sample, 10 were male and 29 were female.

Design

Participants were randomly assigned to one of two conditions – extinction (n = 20) or no extinction (n = 19). All participants underwent differential fear conditioning as in Experiment 1. Extinction involved three non-reinforced presentations of the CS+. Both groups were presented with the CS- once during this phase. Finally, the test phase involved one presentation of the CS+ and one presentation of the CS-. The experimental design is illustrated in Table 2.1. Please note that on test, the extinction group was given a non-reinforced presentation of the CS+ and the no extinction group was given a reinforced presentation of CS+ so as to maintain the stimulus contingencies from the previous phase for each group. A change in the contingency of the CS+ on test would likely have lead to confusion for the participants and would have confounded the experimental manipulation for each group. That is, a non-reinforced presentation of the CS+ during the test phase for the no extinction group would have been the equivalent of an extinction trial and therefore that group would no longer be an appropriate “conditioning only” control group. In a similar vein, a reinforced presentation of the CS+ during the test phase for the extinction group
would have been the equivalent of presenting a “reminder US” and would therefore render the extinction group more of a “reinstatement group”\(^8\).

Participants completed pre- and post-experiment valence ratings of the CSs, the visual avoidance task, and the behavioural forced choice (chocolate) test. In addition, online (i.e., trial-by-trial) valence ratings of the CSs were obtained, and a further measure of evaluative conditioning was used – affective priming (see details below).

Table 2.1. Experimental design

<table>
<thead>
<tr>
<th>Group</th>
<th>Conditioning</th>
<th>Extinction</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extinction</td>
<td>A+ (4)</td>
<td>A- (3)</td>
<td>A- (1)</td>
</tr>
<tr>
<td></td>
<td>B- (4)</td>
<td>B- (1)</td>
<td>B- (1)</td>
</tr>
<tr>
<td>No extinction</td>
<td>A+ (4)</td>
<td>B- (1)</td>
<td>A+ (1)</td>
</tr>
<tr>
<td></td>
<td>B- (4)</td>
<td></td>
<td>B- (1)</td>
</tr>
</tbody>
</table>

Note: “A” refers to the stimulus that served as the CS+ during conditioning and “B” refers to the stimulus that served as the CS- during conditioning. The “+” indicates that the stimulus was followed by the US. The “-” indicates that the stimulus was not followed by the US. Numbers in parentheses indicate the number of trials. Trial order was randomised within each phase. All phases were completed in succession, within the same session. There was a slightly longer ITI (approximately two minutes) between the last trial of each phase and the first trial of the next phase, as the experimenter switched the programs.

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\(^8\) As noted in the Introduction, reinstatement is a procedure in which following conditioning and extinction, subjects receive a US presentation (e.g., a shock). This reminder US presentation has been shown to lead to a recovery of fear responding to the extinguished CS (Bouton & Bolles, 1979b).
Materials and apparatus

Conditioned stimuli

Four black and white photographs of faces with neutral expressions (two male and two female) obtained from the Ekman and Friesen (1976) collection were used in this experiment. Two of the four faces were randomly allocated to serve as the conditioned stimuli for each participant. The other two faces served as the control faces.

Unconditioned stimulus, Skin conductance recording, and Eye-tracker

The same US used in Experiment 1 was used in the current experiment (i.e., a simultaneous shock and a loud tone). Skin conductance responses were recorded in the same manner as in Experiment 1, and the eye-tracker was the same one used in Experiment 1.

US expectancy and online CS valence dial

The dial used was the same as that used in Experiment 1. However, in addition to the labels “ Certain no shock ” and “ Certain shock ”, valence labels were added to the dial so that participants could provide online valence ratings of the CSs. The valence label at the left extreme read “ Really dislike ” and the one at right extreme read “ Really like ”.

Procedure

Pre-experiment valence ratings of the faces

The pre-experiment valence ratings were conducted in the same manner as in Experiment 1.

Selection of shock intensity

Selection of the shock intensity was done in the same manner as in Experiment 1.
As in Experiment 1, participants were told that their task was to work out which face was followed by the shock. Further, participants were informed about the use of the expectancy and valence dial. They were asked to make an expectancy rating every time a face appeared on the screen, while the face was on the screen. In addition, they were asked to make a valence rating on every trial when prompted to do so after the face was removed from the screen. Participants were told that it didn’t matter whether their valence ratings changed or stayed the same across trials and they were encouraged to “just go with your gut feeling at the time”\(^9\). The experimenter answered any questions, dimmed the lights and left the room. Following this, written instructions for the task, reiterating the verbal instructions, appeared on the screen and the conditioning (and extinction) procedure began.

During conditioning and extinction, each presentation of the CS lasted 13 seconds. The US duration was half a second. Participants made their US expectancy ratings during the CS presentation using the dial. After the CS/US presentation, the following message appeared on the screen, “Please turn the dial to off”. After 5 seconds, the following question appeared on the screen, “How much do you like or dislike the face that was just presented? 0 = Really dislike; 50 = Neutral; 100 = Really like. Please use the dial to make your response”. There was a variable ITI between 30-50 seconds\(^{10}\). Trial order was randomised, with the exception that no single CS could be presented more than two times consecutively during conditioning.

\(^9\) These instructions are consistent with those used by Vansteenwegen et al. (2006, p. 72) in which they encouraged participants “to rely on first, spontaneous reactions” when making valence ratings.

\(^{10}\) As the addition of the online CS valence question would have increased the amount of time between presentations of the CSs, the ITI was reduced from Experiment 1.
Affective priming task

This task was programmed using Runtime Revolution Studio (version 2.9.0) and ran on a Dell computer with Windows XP. During this task, participants were asked to classify words as positive or negative as quickly as possible. The CSs and the two control faces acted as the primes. Therefore, four faces were used as primes (CS+, CS-, control face 1, and control face 2). There were eight target words. Four of these were positive (caring, funny, helpful, honest) and four were negative (boring, foolish, selfish, stupid). All words were matched for frequency of general use (M. Taft, personal communication). Each word was paired with each face five times. Consequently, there were 160 trials (i.e., 4 face primes x 8 words x 5 presentations of each pair type = 160 trials). Participants also received six practice trials in which the targets and primes were chosen at random. The “A” and “L” keys on the keyboard were used to indicate that a word was positive or negative. For half the participants, the “A” key was used to indicate that the word was positive and the “L” key was used to indicate that the word was negative. For the other half, the “L” key was used to indicate that the word was positive and the “A” key was used to indicate that the word was negative. The legend indicating which key corresponded to positive and which to negative appeared on the screen on every trial. The affective priming procedure was identical to that used in Vansteenwegen et al. (2006) in terms of stimulus and inter-trial interval duration. Specifically, on each trial, a fixation cross was presented for 500ms, followed by a blank screen for 200ms, followed by a prime (i.e., face) for 200ms, followed by a blank screen for 100ms, followed by a target word. Targets were displayed until a response was made. The ITI was 2 seconds. The following written instructions were provided for participants, “In this phase of the experiment, words will appear on the screen. Your job is to classify them as positive or negative as quickly as possible. To indicate that a word is positive, please press the “A” [“L”] key on the keyboard. To indicate that the word is negative, please press the “L” [“A”] key on the keyboard. Examples: If the word that appeared on screen was “DIRT”, you
would press the “L” [“A”] key. If the word that appeared on screen was “FLOWER”, you would press the “A” [“L”] key. Each presentation of a word will be preceded by the presentation of a face that has already been shown. Please focus your attention primarily on the words”. The final instruction was also used in Vansteenwegen et al.’s (2006) study.

Post-experiment valence ratings of the faces

The post-experiment valence rating of the faces was conducted in exactly the same manner as the pre-experiment rating task.

Visual avoidance task

During this task, participants were seated in another room at the computer equipped with the eye-tracker, which was calibrated for each participant as in Experiment 1. Following this, participants were given the following verbal instructions, “In the next part of the experiment, please look at the screen. It doesn’t matter where you look, as long as you look at the screen”. The two faces used as CSs then appeared on the screen side-by-side. The faces were shown simultaneously three times for 2 seconds per presentation. Each presentation was preceded by a blank screen for 1 second. The side of the screen on which the images appeared was counterbalanced across participants. In this experiment, there was only one block of presentations during this task because significant differences between looking times at the CS+ and CS- were only observed during block one of the visual avoidance task in Experiment 1.

Contingency awareness check

In order to assess whether participants could recognise which face served as the CS+ and which face served as the CS-, participants were shown a form which had pictures of all four faces that had been shown in the experiment (i.e., the CS+, the CS-, and the two control
faces). The two faces that were not used as CSs were crossed out by the experimenter. Of the two remaining faces, participants in the no extinction group were asked to indicate which face was always followed by shock and which face was never followed by shock. Participants in the extinction group were asked to indicate which face was sometimes followed by shock and which face was never followed by shock. Participants who correctly indicated the CS-US contingencies were classified as “aware”. Other participants were classified as “unaware”.

*Behavioural forced choice (chocolate) test*

The behavioural forced choice (chocolate) test was conducted in the same manner as in Experiment 1.

See Figure 2.10 for a flow-chart of the order of tasks in this experiment.
Data analysis

Skin conductance responses were analysed in the same manner as in Experiment 1. The pre-experiment valence rating of the control face was calculated by averaging the pre-experiment valence ratings of the two control faces. Similarly, the post-experiment valence rating of the control face was calculated by averaging the post-experiment valence ratings of the two control faces.
Affective priming trials in which participants took less than 300ms or greater than 1000ms to respond were excluded from the analyses. These were the same exclusion criteria as used in Vansteenkoven et al.’s (2006) study. The mean reaction time for positive word trials involving the control prime was determined by averaging the reaction times for both control faces on positive word trials. Similarly, the mean reaction time for negative word trials involving the control prime was determined by averaging the reaction times for both control faces on negative word trials.

After the data were collected, it was discovered that the algorithm used in this experiment to transform the US expectancy and online CS valence ratings from an analogue scale (as recorded by the dial) to a digital scale (as recorded by the computer) was slightly inaccurate, resulting in incorrect recordings of expectancy and valence ratings. For example, a rating of 20 was recorded as a rating of 14.6 and a rating of 80 was recorded as a rating of 58.1. This scaling problem only affected expectancy and valence ratings during extinction and test. The problem did not affect ratings during conditioning as that phase was programmed using a different script that did not contain the error. Affected ratings were manually re-scaled. Please note that this problem also affected expectancy ratings during the extinction and test phases of the following experiment (i.e., Experiment 3). Therefore, affected ratings in that experiment were also re-scaled. No other ratings in experiments described in this thesis were affected in this way.

Results

Expectancy of US

Mean US expectancy ratings are presented in Figure 2.11. During conditioning, expectancy of the shock following the CS+ was significantly greater than following the CS- \([F(1, 32) = 277.41, p < 0.001]\). There was no difference between groups \([F(1, 32) = 2.82, p = 0.10]\)
nor any significant interactions involving group [largest $F_{(3, 96)} = 1.81, p = 0.15$]. As can be seen in Figure 2.11, both groups made comparable US expectancy ratings during the conditioning phase of the experiment. There was no main effect of trial [$F_{(3, 96)} = 2.25, p = 0.087$] but there was a CS-by-trial interaction [$F_{(3, 96)} = 94.81, p < 0.001$], reflecting an increase in US expectancy ratings across CS+ trials and a decrease in US expectancy ratings across CS- trials.

During extinction, there was a significant linear trend across CS+ trials [$F_{(1, 19)} = 11.52, p = 0.003$], indicating that participants’ expectancy of the shock following the CS+ decreased across extinction trials.

On test, expectancy of the shock following the CS+ was significantly greater than following the CS- [$F_{(1, 37)} = 344.76, p < 0.001$]. There was no main effect of group [$F < 1$] but there was a significant CS type-by-group interaction [$F_{(1, 37)} = 114.52, p < 0.001$]. Further analyses showed that participants’ expectation of the US following the CS+ was significantly lower in the extinction group than in the no extinction group [$t_{(37)} = -7.79, p_{UV} < 0.001$]. Participants in the extinction group also reported a significantly higher expectation of the US following the CS- than participants in the no extinction group [$t_{(37)} = 7.39, p_{UV} < 0.001$]. Participants in both groups reported a significantly higher expectation of the shock following the CS+ than the CS-; however the difference in expectancy ratings between the CS+ and CS- was much greater in the no extinction group ($M = 95.64$) than the extinction group ($M = 25.70$) [$t_{(37)} = 10.90, p_{UV} < 0.001$; see Figure 2.11].
Figure 2.11. Mean US expectancy ratings for the CS+ and CS- across conditioning, extinction, and test (Experiment 2).

**Skin conductance responses**

Mean skin conductance responses are presented in Figure 2.12. During conditioning, SCRs to the CS+ were significantly greater than to the CS- \(F_{(1, 37)} = 25.17, p < 0.001\). There was no main effect of trial \(F_{(3, 111)} = 1.32, p = 0.27\) but there was a CS-by-trial interaction \(F_{(3, 111)} = 7.13, p_{GG} = 0.002\), reflecting an increase in SCRs to the CS+ and a decrease in SCRs to the CS- across trials. There were no differences between groups or any interaction involving group [all \(Fs < 1\)].

During extinction, there was a significant linear trend across CS+ trials \(F_{(1, 19)} = 10.50, p = 0.004\), indicating that participants’ SCRs to the CS+ decreased across extinction trials.

On test, there was no main effect of CS type \(F_{(1, 37)} = 3.69, p = 0.063\) or group \(F_{(1, 37)} = 1.15, p = 0.29\). However, there was a significant CS-by-group interaction \(F_{(1, 37)} = 6.07, p = 0.02\). Further analyses revealed that participants in the no extinction group exhibited
significantly greater SCRs to the CS+ than participants in the extinction group \( t_{(37)} = -2.02, p_{UV} = 0.055 \). There was no difference between groups in their SCRs to the CS- on test \( t_{(37)} = 0.31, p = 0.76 \). Amongst participants in the extinction group, there was no significant difference in SCRs to the CS+ and the CS- \( t_{(19)} = -0.46, p = 0.65 \). In contrast, however, participants in the no extinction group exhibited greater SCRs to the CS+ than to the CS- \( t_{(18)} = 2.68, p = 0.015 \).

![Graph of skin conductance response across conditioning, extinction, and test trials](image)

**Figure 2.12.** Mean skin conductance responses across conditioning, extinction, and test (Experiment 2). N.B., No extinction group CS- data point on test is hidden on graph \( M = 0.035, SEM = 0.017 \).

**Online CS valence ratings**

Mean online valence ratings are presented in Figure 2.13. During conditioning, participants disliked the CS+ significantly more than the CS- \( F_{(1, 34)} = 38.88, p < 0.001 \). There was no difference between groups and no interactions involving group [all Fs < 1]. There was no main effect of trial \( F_{(3, 102)} = 1.60, p = 0.19 \) but there was a significant CS-by-trial interaction \( F_{(3, 102)} = 18.07, p < 0.001 \), reflecting an increase in liking of the CS- and a decrease in liking of the CS+ across conditioning trials.
During extinction, there was no change in valence ratings of the CS+ across trials \( F < 1 \). This is in contrast to what was observed for SCRs and US expectancy ratings during extinction.

On test, there was a significant effect of CS type \( F_{1, 37} = 59.86, p < 0.001 \), a significant effect of group \( F_{1, 37} = 9.81, p = 0.003 \), and a significant CS-by-group interaction \( F_{1, 37} = 14.73, p < 0.001 \). Further analyses revealed that both groups disliked the CS+ face more than the CS- face [no extinction group: \( t_{18} = -7.60, p < 0.001 \); extinction group: \( t_{19} = -2.98, p = 0.008 \)]. However, participants in the no extinction group disliked the CS+ significantly more than participants in the extinction group \( t_{37} = 5.95, p < 0.001 \). There was no difference between groups in their valence rating of the CS- \( t_{37} = -1.30, p = 0.21 \).

Figure 2.13. Mean online valence ratings across conditioning, extinction, and test (Experiment 2). N.B. Lower ratings indicate greater dislike.
Affective priming task

Mean reaction times on positive and negative trials for each prime type (i.e., CS+ face, CS- face, and control face) are presented in Figure 2.14. There was a main effect of target word valence $[F_{(1, 37)} = 6.44, p = 0.016]$, indicating that participants responded faster to positive target words than to negative target words. There was no main effect of prime type $[F_{(2, 74)} = 2.01, p_{GG} = 0.15]$ or group $[F < 1]$. However, there was a three-way interaction between prime type, target word valence, and group $[F_{(2, 74)} = 3.51, p = 0.035]$. Therefore, each group was analysed separately.

In the no extinction group, there was a marginally significant main effect of prime type $[F_{(2, 36)} = 3.15, p = 0.055]$. There was no main effect of target word valence $[F_{(1, 18)} = 1.62, p = 0.035]$ but there was a prime-by-word valence interaction $[F_{(2, 36)} = 3.58, p_{GG} = 0.052]$. Therefore, each prime type was considered separately. On CS- prime trials, participants in the no extinction group responded significantly faster to positively valenced (i.e., congruent) words than to negatively valenced (i.e., incongruent) words $[t_{(18)} = -3.09, p = 0.006]$. There was no significant difference between reaction times to positive and negative words on CS+ prime trials or control face prime trials [CS+: $t_{(18)} = 0.23, p = 0.82$; Control: $t_{(18)} = 0.69, p = 0.50$].

In general, participants in the extinction group were faster to respond to positive words than to negative words $[F_{(1, 19)} = 5.16, p = 0.035]$. There was no main effect of prime type $[F < 1]$ and no prime type-by-target word valence interaction $[F < 1]$. 
Figure 2.14. Mean reaction times to the target words following each prime type on the affective priming task (Experiment 2). Pos = positive word; Neg = negative word; I = incongruent trial; C = congruent trial.

Pre- and post-experiment valence ratings

Mean valence ratings of the CS+, CS-, and control face are presented in Figure 2.15. There was a significant main effect of face type \( [F(2, 74) = 21.13, p < 0.001] \) as well as a significant interaction between face type and time \( [F(2, 74) = 35.52, p_{GG} < 0.001] \). There was no difference between groups \( [F < 1] \) and no interaction involving group \( [\text{largest } F(2, 74) = 1.66, p = 0.20] \). Further analyses revealed that prior to conditioning, there was no significant difference in the valence ratings of the CS+, CS-, and control face \( [F < 1] \), and no difference between groups on this measure \( [F < 1] \). Following conditioning (and extinction), there was a significant difference in the valence ratings of the CS+, CS-, and control face \( [F(2, 74) = 37.28, p < 0.001] \), and no difference between groups on this measure \( [F < 1] \). Specifically, at the end of the experiment, the CS+ face was disliked significantly more than the CS- \( [F(1, 37) = 54.19, p < 0.001] \) and control faces \( [F(1, 37) = 24.04, p < 0.001] \) and there was no difference between groups on these measures \( [\text{largest } F(1, 37) = 1.73, p = 0.20] \). The CS+ face was rated significantly more negatively following conditioning (and extinction) than before.
conditioning \( F_{(1, 37)} = 34.76, p < 0.001 \) and there was no difference between groups on this measure \( F_{(1, 37)} = 1.21, p = 0.28 \). The CS- face was rated significantly more positively at the end of the experiment relative to the beginning of the experiment \( F_{(1, 37)} = 17.11, p < 0.001 \) and there was no difference between groups on this measure \( F < 1 \). There was no change in the ratings of the control face from pre- to post-experiment \( F < 1 \) and no difference between groups on this measure \( F_{(1, 37)} = 1.23, p = 0.27 \).

![Figure 2.15](image)

**No extinction group**

**Extinction group**

Figure 2.15. Mean pre- and post-experiment valence ratings for the CS+, CS-, and control faces (Experiment 2). N.B. Lower ratings indicate greater dislike.

**Visual avoidance task**

Looking times at each of the CSs during the three presentations were summed for each participant. The data from one outlier, who had a difference score between looking times at the CS+ and CS- that was 2 SD above the mean (i.e., hypervigilant to the CS+), were excluded. Participants looked at the CS+ for significantly less time than the CS- \( F_{(1, 33)} = 8.77, p = 0.006 \). There was no main effect of group \( F < 1 \) and no significant interaction between CS type and group \( F < 1 \). See Figure 2.16.
Figure 2.16. Mean looking time at the conditioned stimuli during the visual avoidance task (Experiment 2).

**Behavioural forced choice (chocolate) test**

The number of participants who chose the chocolate with the CS+ face wrapper and the chocolate with the CS- face wrapper is presented in Figure 2.17. In both groups, significantly more participants chose the CS- chocolate than the CS+ chocolate [no extinction group: \( \chi^2(1, N = 19) = 11.84, p = 0.001 \); extinction group: \( \chi^2(1, N = 20) = 9.80, p = 0.002 \)].

In order to test whether there was a difference between groups in terms of the proportion of CS+ and CS- chocolates chosen, a \( \chi^2 \) test for independent samples was conducted\(^\text{11}\). The \( p \) value of this test (\( \chi^2 = 0.004 \)) was > 0.9, indicating that the null hypothesis was retained. That is, there were no differences between groups on this measure.

Discussion

This experiment replicated and extended the findings of the first experiment by demonstrating that whilst traditional measures of fear conditioning were readily extinguished, certain other measures were more resistant to extinction. A summary of these findings is outlined below.

All participants learned about the stimulus contingencies during conditioning. During extinction, participants in the extinction group significantly reduced their expectancy of the US following the CS+. As can be seen in Figure 2.11, however, participants did not “fully” extinguish on this measure across the three extinction trials. That is, on the final trial, participants in the extinction group still had a higher expectation of the shock following the CS+ than the CS-. Nevertheless, given the downward linear trend across extinction trials, it is likely that US expectancy following the CS+ would have extinguished completely if more non-reinforced CS+ trials were administered. Furthermore, on test, participants in the
extinction group reported a significantly lower expectation of the US following the CS+ than participants in the no extinction group. In relation to the CS-, it can be seen that participants in the extinction group had a higher expectation of the US following the CS- than participants in the no extinction group on test. This somewhat puzzling finding is likely a result of the change in the contingency of the CS+ and the US during extinction which introduced the notion to extinguished participants that the stimulus contingencies may not be constant throughout the experiment. This ambiguity, which was not introduced in the no extinction group, likely led some participants in the extinction group to increase their US expectancy ratings for the CS-.

Participants exhibited greater skin conductance responses to the CS+ than to the CS- during conditioning. SCRs to the CS+ decreased across extinction trials. On test, participants in the no extinction group exhibited greater SCRs to the CS+ than participants in the extinction group. Furthermore, participants in the extinction group did not exhibit differential SCRs to the CSs, suggesting complete extinction of this fear response.

In addition to the changes in cognitive expectancy and physiological arousal, conditioning affected participants’ perception of the valence of the CSs. During conditioning, participants disliked the CS+ more than the CS-, replicating findings from the first experiment. In contrast to the US expectancy and SCR measures, there was no change in CS+ valence ratings across extinction trials. Although there is a slight suggestion that the valence ratings of the CS+ returned closer to neutral on the first extinction trial relative to the last conditioning trial (see Figure 2.13), this difference was not statistically significant \([t_{(19)} = 1.27, p = 0.22]\). On test, both groups disliked the CS+ more than the CS-. However, the no extinction group disliked the CS+ more than participants in the extinction group, suggesting some extinction of valence. As noted in the Introduction, findings of retarded
extinction of valence are consistent with a less extreme version of theories of evaluative learning, which proposes that acquired evaluative responses can extinguish but do so at a slower rate than expectancy learning. Online valence ratings of the CS+ did not extinguish to the same extent as both skin conductance responses and expectancy ratings. Specifically, skin conductance responses were completely abolished as a result of extinction. Expectancy ratings, although not reduced to zero as a result of extinction, did significantly decline across extinction trials. In further support of the argument that valence ratings were resistant to extinction, at the end of the experiment (in the post-experiment rating phase), participants reported that they disliked the CS+ more than the CS- and there were no differences between the extinction and no extinction groups on this measure. These latter data concerning post-experiment valence ratings support a stronger version of evaluative conditioning which holds that evaluative responses do not extinguish at all.

Replicating findings from the first experiment, participants in the no extinction group avoided looking at the CS+ during the visual avoidance task. Extending that finding, this experiment demonstrated that even participants who underwent extinction continued to avoid looking at the CS+. That is, the avoidance response was not extinguished. It remains somewhat unclear whether this task is tapping fear or dislike of the CS+ (or both). However, the fact that extinguished participants showed evidence of attenuated fear responses on the skin conductance measure supports the idea that the fear response was readily abolished and as such, any residual avoidance of the previously threatening stimulus is likely due to an affective state other than fear. As extinguished participants continued to report that they disliked the CS+, it is reasonable to postulate that the avoidance response is driven by dislike of the CS+.
Finally, participants in both groups overwhelmingly chose the CS- chocolate over the CS+ chocolate. As there was no difference between groups on this measure, this adds further support to the notion that learned dislike of the CS+ as a result of fear conditioning was not extinguished. That is, regardless of whether or not participants underwent extinction, they still preferred a chocolate that did not depict the CS+ face. Although one might argue that participants chose the CS- chocolate due to the demand characteristics of the task, anecdotally this did not appear to be the case. The majority of participants appeared unaware of the task demands and many participants made comments which seemed to reflect that their aversion to the CS+ chocolate was genuine. For example, one participant, when referring to the CS+ chocolate, stated, “I’m not choosing her, she’s evil”. There was even evidence of some degree of aversion to the CS+ amongst the few participants who did choose the CS+ chocolate in that two of these participants immediately removed the CS+ face attached to chocolate when they received it.

The affective priming task

It was predicted that responding to negative words would be facilitated by the presence of the CS+ prime and that responding to positive words would be facilitated by the presence of the CS- prime. It was further argued that the facilitation of responses to negative words in the presence of the CS+ prime amongst extinguished participants would be evidence that the CS+ had retained a negative valence. However, these hypotheses were largely unsupported. Specifically, although participants who did not undergo extinction responded more quickly to positive words than to negative words that were preceded by the CS-, these same participants did not respond any faster to negative words than to positive words that were preceded by the CS+. That is, the negative valence of the CS+ did not facilitate responding to negative words. This finding may indicate that the CS+ did not acquire a negative valence as a result of fear conditioning, however such an interpretation is
inconsistent with the rest of the data, which overwhelmingly indicate that the CS+ did acquire a negative valence. One might also argue that the reason that there was no evidence of the CS+’s negative valence in the no extinction group is because the affective priming task itself led to extinction, as the CSs were presented numerous times without reinforcement during this task. Against this, however, participants rated the CS+ as more disliked than the CS- in the post-experiment rating task and this task was completed after the affective priming task. That is, if the affective priming task resulted in the extinction of evaluative responses, the difference on the post-experiment rating task between ratings of the CS+ and CS- would not have been observed. For these reasons, the null finding regarding differences between positive and negative CS+ trials on this task in the no extinction group may simply indicate that the parameters used in this study were not suitable for achieving affective priming.

As there was no evidence from the affective priming task of the CS+’s negative valence in the no extinction group (i.e., responding to negative words on CS+ trials was not facilitated amongst non-extinguished participants), one cannot draw any inferences regarding the extinction of negative valence from this task. One final point that bears mention is that participants in the extinction group responded faster to positive words than to negative words across all trial types. This finding is consistent with the assertion that positive information is processed more quickly than negative information (Unkelbach, Fiedler, Bayer, Stegmuller, & Danner, 2008). However, it is difficult to reconcile the current results with those of Vansteenwegen et al. (2006), who demonstrated faster responding on congruent than incongruent trials (i.e., collapsed across positive word/CS- and negative word/CS+ trials to define congruent trials; and collapsed across negative word/CS- and positive word/CS+ trials to define incongruent trials). There were only very minor procedural differences between the current experiment and the Vansteenwegen et al.
(2006) experiment. In Vansteenwegen et al.’s (2006) experiment, there was one CS+ and one CS- as in this experiment. They used four control faces; in this experiment there were two. They used six positive and six negative words in their affective priming task as opposed to the four positive and four negative words used in the current experiment. Although Vansteenwegen et al. (2006) administered fewer trials during the affective priming task than were administered in the current experiment, I had previously failed to obtain an affective priming effect in a pilot study in which I used fewer trials. Indeed, on the basis of those pilot data, I was advised by Adriaan Spruyt and Dirk Hermans (two researchers very experienced in using affective priming tasks) to increase the number of trials to at least 20 per condition (i.e., 20 CS+/neg word; 20 CS+/pos word; 20 CS-/pos word; 20 CS-/neg word; plus control trials). This is the number of trials used in the current experiment. All stimulus durations were exactly the same as those used in Vansteenwegen et al. (2006). It is difficult to see how these noted minor procedural differences between the current experiment and Vansteenwegen et al.’s experiment could account for the null result in the present experiment. As affective priming effects are very subtle, it may have been useful to have used a response pad that is more accurate in measuring reaction time than a standard keyboard. It should be noted, however, that Vansteenwegen et al. (2006) also used a standard keyboard in their experiment. There is one potentially more significant difference, however, between their setup and the current setup in that in the current experiment participants were asked to use the “A” and the “L” keys to indicate a positive or negative response. In contrast, Vansteenwegen et al. labelled the keys as positive and negative. It is possible that having to first remember (or look to the legend to determine) which key was to be used to indicate positive words and which key was to be used to indicate negative words interfered with responding in the current experiment. It should be noted, however, that the use of alphabetical keys to indicate evaluative responses, as used in the current experiment, has been employed in several other studies in which reaction time was the
dependent variable (e.g., Nosek et al., 2007). Nevertheless, it may be useful to adopt the exact setup used in Vansteenwegen et al. (2006) in the future.

Summary and implications

This experiment demonstrated that several measures of evaluative learning were more resistant to extinction than measures of cognitive expectancy and physiological arousal. Specifically, although extinguished participants reported reduced expectancy of the US following the CS+ across extinction and did not exhibit differential skin conductance to the CSs on test, they continued to dislike the CS+ more than the CS-. In addition, these participants behaviourally demonstrated an aversion to the CS+ by overwhelmingly choosing a chocolate that depicted the CS- face over a chocolate that depicted the CS+ face. Finally, both participants who did and did not undergo extinction avoided looking at the CS+ face. Given that exposure-based therapies for anxiety disorders are based on extinction, these findings suggest that whilst exposure is likely to affect certain components of fear such as expectation of threat and anxious arousal, patients may continue to dislike the previously feared stimuli and situations at the end of treatment. This dislike may lead to avoidance in the future and in turn, lead to relapse. As such, it is crucial to better understand these evaluative facets of fears and anxiety in order to inform treatment strategies.
Experiment 3

Resistance to extinction: A renewal effect?

The previous experiment demonstrated that evaluative responses are resistant to extinction as measured by the valence ratings of the CSs, the visual avoidance task, and the behavioural forced choice (chocolate) test. In contrast, participants showed evidence of greater extinction of cognitive expectancy of the US and extinction of their physiological fear response (SCRs). However, as all of the measures of evaluative responding used in that study were administered in a different context (room) to conditioning and extinction, it is possible that the finding of resistance to extinction on these measures was due to renewal. As noted in the Introduction, renewal refers to the reliable observation that responding to an extinguished CS can be recovered by presenting the CS in a context that is different to the extinction context (Bouton & Bolles, 1979a). Therefore, it may have been that the evaluative responses observed in the previous experiment did extinguish but they were recovered by a context change, as the visual avoidance task and the behavioural forced choice task were administered in a different room to that of extinction. Because of this, the aim of this experiment was to determine whether resistance to extinction would still be observed on measures of evaluative conditioning when these measures were administered in the same context as conditioning and extinction. Furthermore, an additional measure of evaluative responding was administered, the Evaluative conditioning questionnaire (see details below). If it is the case that the residual evaluative responses observed amongst extinguished participants in the previous experiment were due to a renewal effect, then those same evaluative responses should not be observed amongst participants in the extinction group in the current experiment. If, however, the evaluative responding following extinction in the previous experiment was indeed a true reflection of resistance to
extinction, then the results from the previous experiment should be replicated in the current experiment.

**Method**

**Participants**

Participants were 75 first-year UNSW psychology students who participated for course credit. Of these, four participants were unaware of the stimulus contingencies and were excluded from the analyses below. Two further participants were excluded due to computer and experimenter error. Data from the remaining 69 participants are reported below (extinction group: n = 37; no extinction group: n = 32). Of this final sample, 16 were male and 53 were female.

**Design, materials, apparatus, procedures, and data analyses**

The design, materials, apparatus, procedures, and data analysis approach were the same as those used in Experiment 2, with the following exceptions – the visual avoidance task and the behavioural forced choice task were completed in the same context (i.e., room) as conditioning, extinction, and test. Furthermore, no online or pre-/post-experiment CS valence ratings were recorded due to the time constraints of the experimental session. Finally, participants were asked to complete an additional measure of evaluative conditioning – the Evaluative conditioning questionnaire.

**Evaluative conditioning questionnaire (ECQ)**

This questionnaire, adapted from Zadro, Boland, and Richardson (2006), was used to measure participants’ perceptions of the personality and attractiveness of the people whose faces served as CSs. Participants completed the ECQ for each CS face. A picture of the relevant face appeared just above the rating scale. Participants were asked to rate the CSs
on the following dimensions — friendly, helpful, boring, dishonest, caring, selfish, creative, insensitive, sincere, and attractive. All items were scored on a six-point scale ranging from 1-6. The negative trait items (boring, dishonest, selfish, insensitive) were reversed scored. Higher total scores indicate a more favourable impression of the person/CS. Cronbach’s alpha coefficients (a measure of internal consistency) for the CS+ and CS- versions of the ECQ in the present study were 0.73 and 0.87, respectively.

Results

US expectancy

Mean US expectancy ratings are presented in Figure 2.18. During conditioning, expectancy of the shock following the CS+ was significantly greater than following the CS- \( [F_{(1, 46)} = 341.54, \ p < 0.001] \) and there was no difference between groups \( [F < 1] \) nor any significant interactions involving group \( [\text{largest } F_{(1, 46)} = 1.66, \ p = 0.20] \). There was a main effect of trial \( [F_{(3, 138)} = 8.31, \ p_{GG} = 0.002] \) and a CS-by-trial interaction \( [F_{(3, 138)} = 180.17, \ p_{GG} < 0.001] \), reflecting an increase in ratings for the CS+ and a decrease in ratings for the CS- across trials.

During extinction, there was a significant linear trend across CS+ trials \( [F_{(1, 36)} = 90.34, \ p = 0.003] \), indicating that participants’ expectancy of the shock following the CS+ decreased across extinction trials.

On test, there was a significant effect of CS type \( [F_{(1, 64)} = 341.79, \ p < 0.001] \) and group \( [F_{(1, 64)} = 22.92, \ p < 0.001] \) as well as a significant CS type-by-group interaction \( [F_{(1, 64)} = 125.96, \ p < 0.001] \). Further analyses showed that participants in the extinction group reported a significantly lower expectation of the US following the CS+ than participants in the no extinction group \( [t_{(65)} = -9.52, \ p_{UV} < 0.001] \). Participants in the extinction group also
reported a significantly higher expectation of the US following the CS- than participants in the no extinction group \(t(64) = 4.06, p_{UV} < 0.001\). Participants in both groups reported a significantly higher expectation of the shock following the CS+ than the CS-; however the difference in expectancy was much greater in the no extinction group \(M = 89.79\) than in the extinction group \(M = 21.95\) \(t(64) = 11.22, p_{UV} < 0.001\).

![Figure 2.18. Mean US expectancy across conditioning, extinction, and test (Experiment 3).](image)

**Skin conductance responses**

Mean skin conductance responses are presented in Figure 2.19. During conditioning, SCRs to the CS+ were significantly greater than to the CS- \(F(1, 62) = 53.18, p < 0.001\). There was no main effect of trial \(F < 1\) but there was a CS-by-trial interaction \(F(3, 186) = 5.52, p_{GG} = 0.003\), reflecting an increase in SCRs to the CS+ and a decrease in SCRs to the CS- across trials. There were no differences between groups nor any interaction involving group \(\text{largest } F(1, 62) = 1.21, p = 0.28\).

During extinction, there was a significant linear trend across CS+ trials \(F(1, 34) = 8.11, p = 0.007\), indicating that participants’ SCRs to the CS+ decreased across extinction trials.
On test, there was a significant main effect of CS type \( F_{(1, 63)} = 8.14, p = 0.006 \) as well as a significant CS-by-group interaction \( F_{(1, 63)} = 12.52, p = 0.001 \). Further analyses revealed that participants in the no extinction group exhibited a significantly greater SCR to the CS+ than participants in the extinction group \( t_{(63)} = -2.06, p = 0.044 \). In addition, participants in the no extinction group exhibited a significantly lower SCR to the CS- than participants in the extinction group \( t_{(63)} = 2.17, p = 0.034 \). There was no significant difference in SCRs to the CS+ and the CS- amongst participants in the extinction group \( t_{(35)} = -0.56, p = 0.58 \). In contrast, participants in the no extinction group exhibited greater SCRs to the CS+ than to the CS- \( t_{(28)} = 3.89, p = 0.001 \).

Figure 2.19. Mean skin conductance responses across conditioning, extinction, and test (Experiment 3).
Evaluative conditioning questionnaire

Mean total ECQ scores are presented in Figure 2.20. Based on total scores on the ECQ, the CS+ face was rated significantly less favourably than the CS- face \( F(1, 63) = 60.39, p < 0.001 \). There was no difference between groups on this measure \( F(1, 63) = 1.78, p = 0.19 \) and no CS-by-group interaction \( F(1, 63) = 1.55, p = 0.22 \). The CS+ was rated significantly less favourably than the CS- across eight out of ten characteristics on the ECQ in both groups. Two items (creative and boring), however, did not discriminate between the CS+ and the CS- in both groups.

![Figure 2.20](image)

Figure 2.20. Mean scores on the Evaluative conditioning questionnaire for each CS (Experiment 3). N.B. Lower ratings indicate a less favourable impression of the CS.

Visual avoidance task

Looking times at each of the CSs during the three presentations were summed for each participant. The data from three outliers were excluded. One of these outliers had a difference score between looking times at the CS+ and CS- that was 2 SD above the mean (i.e., hypervigilant to the CS+) and the other two outliers had a difference score between looking times at the CS+ and CS- that was 2 SD below the mean (i.e., avoidant of the CS+).
Mean looking times at the CSs during the visual avoidance task are presented in Figure 2.21. There was no main effect of CS type or group and no significant interaction [all $F$ values < 1].

![Bar chart showing mean looking times at CSs during visual avoidance task.

Figure 2.21. Mean looking time at the CSs during the visual avoidance task (Experiment 3).

*Behavioural forced choice (chocolate) test*

The number of participants who selected each chocolate type is presented in Figure 2.22. In both groups, significantly more participants chose the CS- chocolate than the CS+ chocolate [no extinction group: $\chi^2(1, N = 32) = 8.00, p = 0.005$; extinction group: $\chi^2(1, N = 37) = 7.81, p = 0.005$]. In order to test whether there was a difference between groups in terms of the proportion of CS+ and CS- chocolates chosen, a $\chi^2$ test for independent samples was conducted in the same manner as in Experiment 2. The $p$ value of this test ($\chi^2 = 0.007$) was > 0.9, indicating that the null hypothesis was retained. That is, there were no differences between groups on this measure.
Discussion

In this experiment, as in the previous two, participants learned the stimulus contingencies during conditioning and reduced their expectation of the shock following the CS+ during extinction. Moreover, they demonstrated increased skin conductance responses to the CS+ during conditioning which were attenuated during extinction. In contrast, however, measures of evaluative conditioning were resistant to extinction. Specifically, both participants who did and did not undergo extinction training reported a less favourable impression of the CS+ than the CS- on the ECQ. In addition, the overwhelming majority of participants in both groups chose the CS- chocolate over the CS+ chocolate. It is important to note that all tasks were conducted in the same context and therefore the residual evaluative responses that were observed are reflective of resistance to extinction and cannot be attributed to a renewal effect.
Participants in both groups failed to exhibit differential looking at the conditioned stimuli during the visual avoidance task. These results were not affected by level of shock intensity, outliers, or gender (data not shown). It is unclear why the differential looking effect observed in the previous two experiments was not replicated. The major difference between the current experiment and the previous ones is that in this experiment, participants completed the visual avoidance task on the same computer as the one used for the conditioning and extinction tasks. Whilst it is conceivable that this could influence the results in the extinction group, as the extinction memory is known to be context dependent, it is unclear how context would influence the results in the no extinction group. That is, it is difficult to comprehend why participants in that group would avoid looking at the CS+ (i.e., exhibit the conditioned response) in a different context to conditioning but fail to avoid (i.e., not exhibit the conditioned response) in the same context as conditioning. It may be that the results on this task are influenced by individual differences. Indeed, individual differences in anxiety have been shown to influence attentional patterns to threatening stimuli (Mogg et al., 2004). Therefore, it is possible that discrepancies between findings on the visual avoidance task in this study and the earlier experiments are due to differential levels of anxiety (or some other state or trait) amongst the samples. For example, different levels of state anxiety may be observed at different times of the year due to varying levels of stress related to assignment and exam demands. In the future, it may be useful to assess the relationship between individual differences in anxiety and stress (as well as other relevant states/traits) and performance on the visual avoidance task.

The evaluative conditioning questionnaire appears to be a useful new measure of evaluative judgements of the CSs following conditioning. It is easy to complete and there is evidence that the findings are not likely to be due to demand characteristics. Specifically, if participants were acting in accordance with a belief that the experimenter wanted them to
rate the face that was paired with the shock less favourably than the face that was not
paired with the shock, then one would predict that participants would rate the CS+ less
favourably than the CS- on all items. Given that participants did not rate the CS+ less
favourably than the CS- face on two out of the 10 characteristics on the measure, it seems
that participants were not simply acting in accordance with the task demands but rather
that their responses reflect their genuine impression of the CSs.
Chapter 2 – Fear: General Discussion

This first set of experiments provides further support for the notion that evaluative responses are resistant to extinction. Across experiments, participants reliably demonstrated learning about the stimulus contingencies and an increase in anxious arousal (SCRs) to the CS+ during conditioning. Conditioning also endowed the CS+ with a negative valence (and the CS- with a positive valence). During extinction, expectancy of the US following the CS+ decreased as did anxious arousal. In contrast, evaluative responding was more resistant to extinction. That is, participants continued to dislike the CS+ despite extinction. Evaluative responding was assessed across a variety of measures, including self-report and behavioural indexes.

One particularly novel aspect of these experiments was the use of an eye-tracker to measure participants’ visual avoidance of the CS+. Although the results on this measure were not entirely consistent across studies, this measure appears to be a useful assessment tool in this area for a number of reasons. Firstly, because it is a behavioural measure, it is less susceptible to demand characteristics than self-report measures. Secondly, this tool is capable of measuring avoidance, which is of great benefit in the context of the study of anxiety disorders given that avoidance is a chief maintaining factor across anxiety disorders (Antony & Stein, 2009). Despite the central nature of avoidance in anxiety, it is surprising to note that there are relatively few good measures for examining avoidance in humans in a laboratory context. Behavioural avoidance tasks (also known as behavioural approach tasks; BATs) are used fairly commonly (e.g., Guastella, Dadds, Lovibond, Mitchell, & Richardson, 2007a; Olatunji & Deacon, 2008; Smits et al., 2002), however they are not suited for use in conditioning and extinction paradigms. Additional avoidance tasks include one used by Lovibond and colleagues as part of a conditioning task in which participants learned to press
a button to avoid a shock (Lovibond, Mitchell, Minard, Brady, & Menzies, 2009; Lovibond, Saunders, Weidemann, & Mitchell, 2008), as well as a virtual reality paradigm employed by Grillon, Baas, Cornwell, and Johnson (2006) in which participants were assessed on their avoidance of virtual rooms in which they had previously received shocks. Finally, several authors have used dot probe tasks as an indirect measure of attentional avoidance (e.g., Bradley, Mogg, Falla, & Hamilton, 1998; Keogh, Dillon, Georgiou, & Hunt, 2001). Apart from these tasks, I am not aware of other relevant tasks to assess avoidant responding in humans. Given the paucity of avoidance tasks and the crucial role of avoidance in anxiety, there is a need to develop and evaluate additional measures of avoidance that can be used in a laboratory setting, such as the visual avoidance task used in the current series of experiments.

An important question is whether the visual avoidance task actually measures avoidance. For example, it is possible that it is not measuring avoidance but rather that it is measuring novelty preference or preference for the CS-. It is well-known that we tend to look longer at novel stimuli (e.g., McKee & Squire, 1993; Snyder, Blank, & Marsolek, 2008), however such an account cannot be used to explain the differential looking in the no extinction group because that group actually received one less exposure to the CS+ than the CS-, rendering the CS+ the most “novel” of the two. Therefore, if looking times were due to a novelty preference, this would have led to more, not less, looking at the CS+. Given that in addition to endowing the CS+ with a negative valence, conditioning also endowed the CS- with a positive valence, an alternative explanation of the results could be that participants

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12 As noted earlier, in a dot-probe task, two stimuli, one neutral and one threatening, are presented on the computer screen. Immediately following the termination of the display of those images, a dot is presented on the screen in the place of one of the previous images and participants are asked to press a button as soon as they notice the dot. Avoidance is inferred by faster responses to the dot when it is in the position of the neutral image than when it is in the position of the threatening image, as it is assumed that response speed is facilitated if the participant was already looking at that part of the screen (i.e., away from the threatening image).
were not avoiding the CS+ but rather that they were simply looking longer at the CS which they preferred, the CS-. Against this account are the findings from Experiment 5 (below). In that experiment, which assessed visual avoidance 6 months after aversive conditioning, participants reported that the CS- retained a positive valence but that the CS+ returned to neutral. In that situation, participants did not demonstrate differential viewing times of the CSs. If the results on the visual avoidance task were due to preference for the CS-, then participants should have demonstrated avoidance of the CS+ in that experiment as well. Because participants did not avoid in that situation (i.e., in Experiment 5 below) where they reported preference for the CS- but no dislike of the CS+, it is unlikely that the avoidance of the CS+ in the current set of experiments can be explained as a preference for the CS-. That is, avoidance does not appear to be associated with preference of the CS-, although more research is warranted.

As argued above, residual evaluative responses may be particularly important in clinical contexts such as in the case of an anxious patient who has overcome their fear of a certain situation or stimulus but continues to dislike it. In order to better understand the extinction of evaluative responding, it may be valuable to examine other evaluative responses in addition to dislike. An obvious candidate is disgust, which can be considered a form of evaluative response involving “gut reactions” (Olatunji et al., 2007a). Furthermore, disgust itself has been implicated as a key maintaining factor in several anxiety disorders (reviewed in the Introduction), yet very little is known about the loss of disgust reactions. Consequently, it is critical to gain an understanding of the extinction of disgust so as to enhance our understanding of how to target disgust reactions in treatment and in order to augment our knowledge of evaluative responding in general. Therefore, the aim of the next set of experiments is to examine the loss of learned disgust responses.
Chapter 3: Disgust conditioning and extinction experiments

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Experiment 4

Are disgust responses resistant to extinction?

As reviewed extensively in the Introduction, researchers have generally focused on models of fear when studying anxiety; however, in more recent years, it has become clear that disgust is implicated in a number of anxiety disorders. In addition, the feeling of disgust prompts avoidance and avoidance is central to anxiety disorders. Given that fairly little is known about the extinction of disgust reactions, it is important to examine disgust in the context of models of anxiety. Therefore, in this experiment, I examined disgust conditioning and extinction.

The results of the one other experiment that has examined the extinction of conditioned disgust suggests that learned disgust reactions are resistant to extinction (Olatunji et al., 2007a). In that study, neutral words were used as CSs and pictures of body mutilation were used as the disgusting USs. The CS+ was paired with the disgusting USs 12 times and the CS- was paired with neutral images 12 times. During extinction, both CSs were presented alone 8 times. Participants were asked to provide their fear and disgust ratings of the CSs across trials. The researchers found that although the fear ratings of the CS+ were not significantly different to those of the CS- by the end of extinction, the CS+ continued to be rated as more disgusting than the CS-. It should be noted, however, that some decrease in disgust to the CS+ was reported across extinction. Consistent with those findings, research conducted in clinical analogue samples has shown that during exposure to phobic-relevant stimuli, disgust responses do not decline to the same extent as fear responses (Olatunji et al., 2007b; Olatunji et al., 2009b; Smits et al., 2002). However, those conclusions relied primarily on self-reported ratings of disgust and as noted by Cisler et al. (2009), there
is a need to examine the extinction of disgust reactions using measures other than self-report. Although Olatunji et al. (2007a) measured skin conductance responses to the CSs during conditioning and extinction, the data during extinction were difficult to interpret. As noted by the authors of that study, “A complex pattern of relations was observed on electrodermal responses for the CS+ and the CS during extinction blocks” (p. 830).

Therefore, one aim of the present research was to examine whether or not learned disgust is resistant to extinction using an objective, behavioural measure (the visual avoidance task). The visual avoidance task was deemed to be a useful measure of disgust as avoidance is the key behavioural manifestation of disgust (Rozin et al., 2008). In the one experiment to examine the extinction of learned disgust (Olatunji et al., 2007a), the nature of the unconditioned stimuli used (pictures of mutilated bodies) was such that it is likely that both disgust and fear were elicited. Therefore, a further aim was to replicate that experiment using unconditioned stimuli that would elicit disgust without a significant fear component.

An additional aim was to investigate whether individual differences in disgust sensitivity and state anxiety are associated with varying degrees of resistance to extinction.

It should be noted that the present conditioning procedure differed in several ways to the procedure used by Olatunji et al. (2007a). For example, Olatunji et al. (2007a) used words as conditioned stimuli, whereas the current study used pictures. In addition, Olatunji et al. (2007a) used many more different pictures as unconditioned stimuli than were used in the current study (12 vs. 2).

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13 My pilot data (N = 13) indicate that the disgusting images used in this study are significantly less fearful and more disgusting than images of mutilation (International affective picture system, IAPS, numbers 3051 and 3120; Lang, Bradley, & Cuthbert, 1997). Specifically, the mean fear rating, on a 101-point scale (0-100), of the images used in this study was 17.9, whereas the mean fear rating of the mutilation images was 53.6. Therefore, the mean difference between fear ratings of the two types of images was 35.7 ($t_{(12)} = -5.16, p < 0.001$). In contrast, the mean disgust rating of the images used in this study was 92.1 and the mean disgust rating of the mutilation images was 83.3. So, the mean difference between the disgust ratings of the two types of images was 8.7 ($t_{(12)} = 2.6, p = 0.025$).
It was predicted that learned disgust (assessed by both self-report and visual avoidance) would be resistant to extinction in comparison to expectancy ratings. That is, it was predicted that extinguished subjects would continue to avoid the CS+ and rate it as disgusting, even though they knew it no longer predicted the disgusting image. This effect is likely to be especially pronounced in participants who are highly sensitive to disgusting stimuli.

Method

Participants

Participants were 61 first-year UNSW psychology students who received course credit for participation. Of these participants, five were excluded due to lack of awareness of stimulus contingencies and one participant withdrew during the experiment due to distress caused by viewing the disgusting images. Therefore, data from 55 participants were included in the analyses. Of this final sample, 17 were male and 38 were female.

Design

Participants were randomly assigned to one of two conditions – extinction (n = 27) or no extinction (n = 28). All participants underwent differential disgust conditioning, in which one of two faces (CS+) was paired with disgusting images. The other face (CS-) was paired with neutral images. CS face allocation was counterbalanced across participants. Extinction involved non-reinforced presentations of both of the faces.
Materials and apparatus

Images

Conditioned stimuli (CSs): The same two black and white photos of male faces with neutral expressions obtained from the Ekman and Friesen (1976) collection used in the Chapter 2 experiments were used in the current experiment as the conditioned stimuli.

Unconditioned stimuli (USs): In order to minimise the possibility of habituation to the disgusting US, two disgusting images were used as USs – one depicted a man vomiting into a toilet and the other depicted faeces in a toilet bowl. Two neutral images were used to follow the CS – one was an umbrella and the other was a table with chairs. Images were obtained from Google images. A grey rectangle was presented before the CS on each trial, and all images were the same size and luminance.

Questionnaires

Disgust scale – revised (DS-r; Haidt, McCauley, & Rozin, 1994; modified by Olatunji et al., 2007d). Scale downloaded from: http://people.virginia.edu/~jdh6n/disgustscale.html

The DS-r is a self-report rating questionnaire that assesses individual differences in disgust sensitivity (i.e., the propensity to feel disgust in response to a variety of stimuli; Woody & Teachman, 2000). The DS-r is comprised of three subscales – core disgust (disgust related to food, small animals, and waste products; e.g., “I might be willing to try eating monkey meat, under some circumstances”); animal-reminder disgust (disgust related to death and body envelope violations; e.g., “It would bother me to be in a science class, and to see a human hand preserved in a jar”); and contamination disgust (disgust related to the spread of contagions; e.g., “I never let any part of my body touch the toilet seat in public restrooms”). There are 27 items on the DS-r, including two “catch” items designed to identify participants who are not paying attention or completing the task in a sincere
manner. Participants are asked to rate each item on a 5-point scale (0-4) according to the degree to which the statement applies to them or how disgusting they find the item. Scores are averaged across items. Higher scores indicate greater disgust sensitivity. The DS-r has an internal consistency of 0.87 (Olatunji et al., 2007d).

*Depression anxiety stress scales 21 (DASS21; Lovibond & Lovibond, 1995)*

The DASS21 is a 21-item self-report rating questionnaire that measures symptoms of depression, anxiety, and stress across three subscales. Participants are asked to rate each item (e.g., “I felt scared without any good reason”) on a 4-point scale (0-3) according to how much the statement applied to them over the past week. Higher scores indicate greater or more frequent experiences of the negative states. The reliabilities (Cronbach’s alpha values) for each of the scales are 0.81 (depression), 0.73 (anxiety), and 0.81 (stress) (Lovibond & Lovibond, 1995).

*Fear of negative evaluation scale (FNE; Watson & Friend, 1969)*

The FNE is a 30-item self-report rating questionnaire that measures the degree to which an individual is concerned with being evaluated negatively by others. Participants are asked to rate each item (e.g., “I rarely worry about seeming foolish to others”) on a true/false scale. Higher scores indicate a greater degree of fear of negative evaluation. The FNE has good psychometric properties, with an internal consistency of 0.94-0.96 and a test-retest reliability of 0.78-0.94 (Watson & Friend, 1969).

*Evaluative conditioning questionnaire (ECQ)*

This was the same questionnaire as used in Experiment 3 above, however the two items (creative and boring) that did not discriminate between the CS+ and the CS- in the
previous experiment were removed from the questionnaire. Cronbach’s alpha values for the CS+ and CS- versions of the ECQ in the present study were 0.83 and 0.78, respectively.

**Contingency awareness check**

As in the earlier experiments, this assessed whether participants could recognise which face was the CS+ and which was the CS-. Participants were shown pictures of both faces and asked to indicate which face was never followed by disgusting images. In addition, participants in the no extinction condition were asked to indicate which face was always followed by disgusting images and participants in the extinction condition were asked to indicate which face was sometimes followed by disgusting images. Participants who correctly indicated the CS-US contingencies were classified as “aware”. Other participants were classified as “unaware”.

**Eye-tracker**

The eye-tracker used was a Tobii T-60. This samples eye saccades at 60 Hz and is accurate to 0.5 degrees of visual angle. A Tobii fixation filter was used, in which the smallest radius for a fixation was 10 pixels. A nine-point calibration setting was used in order to calibrate the eye-tracker for each participant. The dependent measure was total observation length of each of the images. In cases where participants failed to look at either of the images on the screen during a presentation, data from that participant for that presentation were excluded.

**Procedure**

The task was programmed using E-Prime with extensions for Tobii and ran on a Dell computer using Windows XP.
**Set-up and Eye-tracker calibration**

Participants were seated in a lightly dimmed room at a computer equipped with the eye-tracker and were asked to place their chin on a chin-rest for the duration of the experiment. During the calibration, which took 15-20 seconds, participants were asked to “follow the dot on the screen”.

**Pre-experiment ratings & Conditioning and extinction**

Following calibration, instructions for the task appeared on the screen. The instructions stated that faces would appear on the computer screen and that some faces would be followed by disgusting images and others would not. Further, the instructions stated that the participants’ task was to work out which face was followed by disgusting images. Following the presentation of the instructions, pre-experiment like/dislike and disgust ratings were recorded for each of the faces used as CSs. For this, participants were presented with each of the faces on the computer one at a time (in a counterbalanced fashion) and asked to rate “How much do you like or dislike this face from 1-9? 1 = Really dislike and 9 = Really like”, and “How disgusting do you find this face from 1-9? 1 = Really disgusting and 9 = Really pleasant”. Lower ratings indicate a greater degree of dislike and disgust. Immediately following the pre-experiment rating task, participants underwent conditioning.

During conditioning, one face (CS+) was paired with disgusting images eight times. The other face (CS-) was paired with neutral images eight times. Each trial consisted of a 2-second presentation of the grey rectangle, immediately followed by a 6-second CS presentation, immediately followed by the US (either a disgusting or neutral image), which was also presented for 6 seconds. The inter-trial interval (ITI) was 10 seconds. Trial order was pseudo-randomised. At the end of trials one, four, and eight for each CS, participants
were asked to make two types of ratings. Specifically, they were asked to provide expectancy ratings of the disgusting US and like/dislike ratings of the CS. The US expectancy ratings asked participants to rate how much they expected the face that they just saw to be followed by a disgusting image the next time they saw it. Participants were asked to make these ratings on a scale from 0-100, where 0 = certainly do not expect a disgusting image to follow and 100 = certainly do expect a disgusting image to follow. That is, higher ratings indicate a greater expectation that the CS will be followed by the US. The like/dislike ratings asked participants to rate how much they liked the face they just saw from 1-9, where 1 = really dislike and 9 = really like14.

During extinction, the CSs were presented in a pseudo-randomised fashion seven times each, in the absence of any US. CSs were presented for 6 seconds, followed by a blank screen for 6 seconds. Each CS presentation was preceded by a 2-second presentation of the grey rectangle. Expectancy ratings of the disgusting US and online like/dislike ratings were obtained on every extinction trial. There was a 10-second ITI during extinction. Participants in the no extinction group did not undergo this phase.

**Visual avoidance task**

Immediately following the last experimental trial, the following instructions appeared on the screen, “In the next part of the experiment, please look at the screen. It doesn’t matter where you look, as long as you look at the screen. Please press the spacebar to begin”. When the participant pressed the spacebar, the two faces used as CSs appeared on the screen side-by-side. The faces were shown simultaneously three times for 2 seconds per presentation. Each presentation was preceded by a blank screen for 1 second, followed

14 Online (i.e., trial-by-trial) like/dislike ratings did not reveal any evidence of conditioning to the CS+, suggesting that these online ratings were not useful measures of evaluative responses in the current paradigm. For this reason, they will not be further discussed.
by a central fixation cross for 1 second. Following this, the same instructions described immediately above appeared on the screen again. Then the vomit and umbrella images were presented side-by-side in exactly the same manner as the CSs. Finally, the instructions appeared on the screen again. Following this, the CSs were again presented side-by-side but for 10 seconds immediately followed by the vomit and umbrella images side-by-side, also for 10 seconds. The side of the screen on which the images appeared was counterbalanced.

**Post-experiment rating task**

In this stage, participants were asked to provide like/dislike and disgust ratings of the CSs, in exactly the same manner as in the pre-experiment rating task.

**Questionnaires & Contingency awareness check**

In the final phase of the experiment, participants were asked to complete four questionnaires – the Evaluative conditioning questionnaire (ECQ), the Disgust scale-revised (DS-r), the Depression, stress, and anxiety scales 21 (DASS21), and the Fear of negative evaluation scale (FNE). The ECQ was always administered first. The order of the other questionnaires was counterbalanced across participants. Finally, the contingency awareness check was administered.

**Results**

**Expectancy of disgusting US**

Mean US expectancies are presented in Figure 3.1. During conditioning, expectancy of the disgusting images following the CS+ was significantly greater than following the CS- \([F(1, 47) = 183.56, p < 0.001]\). There was no difference between groups and no significant interactions involving group during conditioning (largest \(F_{(1, 47)} = 1.90, p = 0.18\)). There was a

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15 These data have been reported in Mason, E. C. & Richardson, R. (2010). Looking beyond fear: The extinction of other emotions implicated in anxiety disorders. *Journal of Anxiety Disorders*, 24, 63-70.
significant CS-by-trial interaction \( F_{(2, 94)} = 40.90, p < 0.001 \), reflecting an increase in ratings for the CS+ and a decrease in ratings for the CS- across trials.

During extinction, there was a significant CS-by-trial interaction \( F_{(6, 120)} = 11.40, p_{GG} < 0.001 \). Therefore, the CS+ and CS- were considered separately. There was a significant linear trend on CS+ extinction trials \( F_{(1, 24)} = 26.48, p < 0.001 \), indicating that participants reduced their expectancy of the US across CS+ trials. There was no change in US expectancy across CS- extinction trials, as participants’ expectancy of the US on these trials remained consistently low \( F_{(6, 120)} = 1.19, p_{GG} = 0.31 \). Participants in the no extinction group had a significantly higher expectation that the disgusting images would follow the CS+ on their final trial (i.e., after the last conditioning trial; point “a” in Figure 3.1) than participants in the extinction group on their final trial (i.e., after the last extinction trial; point “b” in Figure 3.1; mean group difference = 34.36; \( t_{(52)} = 3.72, p_{UV} = 0.001 \).

Figure 3.1. Mean US expectancy ratings for the CS+ and CS- across conditioning and extinction (Experiment 4).
**Visual avoidance task**

This task took place immediately after the last conditioning trial (no extinction group) or immediately after the last extinction trial (extinction group). Looking times at each of the images during the three initial 2-second presentations of the stimulus pairs (CS+ and CS-; vomit and umbrella) was summed and will be referred to as the “short presentation”. The 10-second presentation of the stimulus pairs during the visual task will be referred to as the “long presentation”.

**Conditioned stimuli**

Mean looking times at the CSs during the short and long presentations are presented in Figure 3.2. During the short presentation, participants looked at the CS+ for significantly less time than the CS- \([F(1,49) = 13.45, p = 0.001]\). There was no difference between groups \([F(1,49) = 1.52, p = 0.22]\) and no interaction \([F < 1]\). The same pattern of results was obtained when the data from the long presentation were analysed. Specifically, participants looked at the CS+ for significantly less time than the CS- \([F(1,52) = 15.95, p < 0.001]\). There was no difference between groups \([F < 1]\) and no interaction \([F(1,52) = 1.09, p = 0.30]\), indicating that participants continued to avoid the CS+ despite extinction.

**Unconditioned stimuli**

During the short presentation of the unconditioned stimuli, participants looked at the vomit image \((M = 1442.6\text{ms}, SEM = 186)\) for significantly less time than the image of the umbrella \((M = 3562.4\text{ms}, SEM = 219)\) \([F(1,47) = 28.63, p < 0.001]\). There was no difference between groups \([F < 1]\) and no interaction \([F(1,47) = 1.17, p = 0.29]\). The same pattern was observed when the data from the long presentation were analysed. Specifically, participants looked at the vomit image \((M = 2.46\text{s}, SEM = 0.34)\) for significantly less time than the image
of the umbrella \((M = 6.47s, SEM = 0.40)\) \([F_{(1, 52)} = 33.36, p < 0.001]\); there was no difference between groups \([F_{(1, 52)} = 1.96, p = 0.17]\) and no interaction \([F < 1]\).

Figure 3.2. Mean looking time at the CSs during the (A) short and (B) long presentations of the visual avoidance task (Experiment 4).

"Extinguishers" vs "non-extinguishers"

Although expectancy of the US did decrease across extinction trials (see Figure 3.1), at the end of extinction, participants still had a higher expectation of the disgusting US
following the CS+ than the CS- \[t_{(24)} = 5.26, p < 0.001\]. In other words, extinction was not complete. However, some participants in the extinction group demonstrated a much greater level of US expectancy extinction than other participants in this condition.

Therefore, a post-hoc analysis was conducted between participants in the extinction group who were classified as “extinguishers” or “non-extinguishers” based on their US expectancy ratings. Extinguishers were participants who demonstrated a decline in their US expectancy ratings for the CS+ across extinction trials and whose final expectancy rating on trial 7 was 50 (the median expectancy rating on that trial) or lower. Participants not meeting these criteria were classified as non-extinguishers. Of the 27 participants in the extinction group, one participant failed to make any expectancy ratings and was excluded from this post-hoc analysis. Of the remaining 26 participants, 13 were classified as extinguishers and 13 were classified as non-extinguishers. Mean US expectancy ratings for these participants are shown in Figure 3.3A. As can be seen, participants in both groups had high, and equivalent, levels of US expectancy at the start of the extinction trials. However, participants in the “non-extinguishers” group exhibited virtually no reduction in US expectancy across the 7 non-reinforced presentations of the CS+ face, whereas participants in the “extinguishers” group exhibited a marked reduction in US expectancy across the 7 non-reinforced presentations of the CS+ face.

Despite the substantial difference in US expectancy at the end of extinction, participants in both groups exhibited strong avoidance of the CS+ face (see Figure 3.3B)\(^{16}\). Statistical analysis showed that participants looked less at the CS+ face than the CS- face \[F_{(1, 23)} = 13.25, p = 0.001\]. Importantly, this analysis also showed that there was no difference

\(^{16}\) Looking times presented are taken from the long presentation on the visual avoidance task. Similar results were found when mean avoidance scores from the short presentation were considered. Specifically, during the short presentation, extinguished participants looked less at the CS+ face than the CS- face \[F_{(1, 23)} = 6.19, p = 0.02\]. There was no difference in visual avoidance of the CS+ between extinguishers and non-extinguishers and no interaction [both Fs < 1].

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between extinguishers and non-extinguishers in their visual avoidance of the CS+ and no interaction [both $F_s < 1$]. This suggests that even participants who showed substantial extinction on the US expectancy measure continued to avoid the CS+.

Figure 3.3. (A) Mean US expectancy ratings for the CS+ for “non-extinguishers” and “extinguishers”. (B) Mean looking time at the conditioned stimuli during the long presentation of the CSs in the visual avoidance task for non-extinguishers and extinguishers (Experiment 4).
Mean pre- and post-experiment disgust and dislike ratings for the CSs are presented in Figure 3.4. During the pre-experiment rating phase, there was no difference between the disgust or dislike ratings of the CS+ and the CS- [disgust: $F_{(1, 53)} = 1.77, \ p = 0.19$; dislike: $F < 1$]. There was no difference between groups in their ratings during this phase [disgust: $F_{(1, 53)} = 1.01, \ p = 0.32$; dislike: $F < 1$] and there was no interaction [disgust: $F_{(1, 53)} = 2.39, \ p = 0.13$; dislike: $F_{(1, 53)} = 1.75, \ p = 0.19$]. Following the experiment, participants rated the CS+ as significantly more disgusting than the CS- [$F_{(1, 51)} = 8.04, \ p < 0.01$]. This was true for both participants who were conditioned only and participants who were extinguished (i.e., there was no difference between groups on this measure and no interaction; both $Fs < 1$). Similarly, following the experiment, participants disliked the CS+ significantly more than the CS- [$F_{(1, 51)} = 42.39, \ p < 0.001$] and there was no difference between groups on this measure and no interaction [both $Fs < 1$].

Figure 3.4. (A) Pre- and post-experiment disgust ratings. (B) Pre- and post-experiment like/dislike ratings (Experiment 4). Lower ratings indicate greater disgust and dislike.
Are people who are more sensitive to disgust, more resistant to extinction?

In order to examine whether individuals who are more sensitive to disgust are more resistant to the extinction of disgust reactions, the correlation between DS-r scores and performance on the visual avoidance task was determined for participants in the extinction group. Avoidance scores were calculated by subtracting CS+ looking time from CS- looking time on the long presentation\textsuperscript{17}. Higher scores on the avoidance measure indicate greater avoidance of the CS+ (i.e., increased resistance to extinction). There was a significant positive correlation between avoidance and disgust sensitivity ($r_{(25)} = 0.4$, $p = 0.038$), indicating that greater avoidance is associated with higher levels of disgust sensitivity. In order to exclude the possibility that this relationship was due solely to enhanced conditioning in those subjects with high disgust sensitivity, the same correlation was examined in the no extinction group. This was non-significant ($r_{(25)} = 0.22$, $p = 0.26$). That is, disgust sensitivity does not appear to be associated with enhanced conditioning but rather seems to be more associated with resistance to extinction. There were no significant correlations between resistance to extinction and scores on the anxiety scale of the DASS\textsubscript{21} ($r_{(25)} = 0.27$, $p = 0.18$) or scores on the FNE ($r_{(25)} = 0.35$, $p = 0.08$).

Evaluative conditioning questionnaire

Mean scores on the ECQ are shown in Figure 3.5. Following reverse scoring of relevant items, all items were summed. Ratings of the CS+ were significantly lower than ratings of the CS- [$F_{(1,52)} = 61.04$, $p < 0.001$] and there was no difference between groups and no interaction [both $Fs < 1$]. This indicates that participants reported a less favourable

\textsuperscript{17} Correlations reported in this section were also determined using avoidance scores calculated by subtracting CS+ looking time from CS- looking time on the short presentation of the CSs. These correlations were in the same direction as those involving avoidance during the long presentation; however, they were of a smaller magnitude.
impression of the CS+ than the CS-, regardless of whether they had undergone extinction or not.

Figure 3.5. Mean scores on the Evaluative conditioning questionnaire (Experiment 4).

Discussion

This study demonstrated that disgust reactions are resistant to extinction, using both self-report and an objective behavioural measure. This work extends that reported by Olatunji et al. (2007a) in two key ways. First, in the present work, the US pictures elicited a more “pure” form of disgust (i.e., without a significant fear component) than the type of USs used in previous work on learned disgust. Second, this study showed that disgust conditioning also leads to visual avoidance of the CS+, a response which is not affected by extinction. As such, this is the first convincing evidence that learned disgust is resistant to extinction using a measure other than self-report.

Consistent with previous research (Olatunji et al., 2007a), following repeated pairings of a neutral CS with a disgusting US, participants rated this CS+ as more disgusting and more disliked than a CS that had been repeatedly paired with a neutral US. Further,
there was clear evidence that conditioned disgust reactions were resistant to extinction. This was observed on both self-report (disgust ratings) and behavioural (visual avoidance) measures. That is, although extinction successfully reduced participants’ expectation of the US, it did not lead to a reduction in disgust reactions. Furthermore, regardless of whether they were extinguished or not, participants rated the CS+ less favourably than the CS-. This is consistent with the Chapter 2 experiments as well as previous research involving fear conditioning which found that conditioning endowed the CS+ with a negative valence that was not eliminated by extinction (Hermans et al., 2005; Vansteenwegen et al., 2006). Finally, elevated disgust sensitivity was associated with increased resistance to extinction.

Although self-report measures provide useful information, they are susceptible to demand characteristics. Therefore, the current finding of resistance to extinction based on an objective behavioural measure (i.e., visual avoidance) adds weight to the notion that learned disgust reactions are resistant to extinction. Participants exhibited clear avoidance of the CS+, even after repeated non-reinforced presentations of the CS+ in the extinction condition. Although one may suggest that perhaps participants in the extinction group did show extinction of disgust reactions and that there simply was not enough power to detect group differences (between the extinction and no extinction groups), it should be pointed out that (1), there was sufficient power to detect other group differences (i.e., on the expectancy measure) and (2), when one examines the means, it is clear that participants in the extinction group actually demonstrated slightly more avoidance than participants in the no extinction group. Therefore, it is highly unlikely that a larger sample would result in the detection of a group difference showing that extinguished individuals demonstrate a loss of disgust reactions.
Importantly, although there was not “complete” extinction of US expectancy ratings at the end of extinction (i.e., there was still higher expectancy of the disgusting US following the CS+ than the CS-), it is unlikely that this can explain the observed resistance to extinction evident in disgust reactions. This is because a post-hoc analysis showed that when participants in the extinction condition were classified as extinguishers or non-extinguishers based on their US expectancies during extinction, there was still substantial, and comparable, avoidance of the CS+ in both sub-groups (see Figure 3.3). If participants in the extinction condition avoided the CS+ because there was still some expectation of the occurrence of the disgusting US at the end of extinction, then one would expect that non-extinguishers (who reported a high expectation of the US) would show significantly more avoidance of the CS+ than extinguishers. This was not the case. Rather, US expectancy can be dissociated from avoidant responding. This suggests that avoidance of the CS+ is motivated more by disgust or dislike of the CS+ than by expectancy of the US. These findings show that participants continue to avoid a CS that has been paired with a disgusting image, regardless of whether they have learned that the CS+ no longer predicts the occurrence of the US. It is possible that avoidance of the CS+ would eventually diminish if more extinction trials were given. In line with this, there is evidence to suggest that evaluative responses (measured online during extinction training) do extinguish, but do so at a slower rate than contingency judgments (Lipp & Purkis, 2006). Nonetheless, the critical point here is that expectancy and evaluative responding appear to be dissociated from one another. Specifically, regardless of whether expectancy of the US is reduced or not, participants exhibit equivalent levels of avoidance of the CS+.

The finding that half of the participants in the extinction group continued to rate the likelihood of the disgusting image following the CS+ as very high (at approximately 85% chance) despite seven non-reinforced presentations of the CS+ during extinction is
interesting in its own right. This finding suggests that a large subset of individuals failed to learn that the CS+ was no longer followed by the disgusting US even after numerous presentations of the CS+ on its own. This finding is highly clinically relevant as failures in extinction learning have been implicated in the aetiology and maintenance of anxiety disorders (Walker, Ressler, Lu, & Davis, 2002). Indeed, an inflated estimate of threat (in this case, regarding the presentation of a disgusting image) is a key perpetuating factor across anxiety disorders (Foa, Franklin, Perry, & Herbert, 1996). In treatment, this cognitive bias is addressed through exposure therapy. Exposure therapy is explicitly based upon the process of extinction and the clinical concept of overestimation of threat can be tied neatly to expectancy ratings of the US in the laboratory. It may be useful to consider differences between extinguishers and non-extinguishers on other measures in future research as this may yield interesting information about predictors of treatment response.

An important question addressed by this research was whether individuals who are more sensitive to disgust elicitors would be more resistant to extinction of learned disgust. The results of this study show that they are. In order to determine whether the relationship between avoidance and disgust sensitivity in the extinction group might be better explained by enhanced conditioning amongst individuals high in disgust sensitivity, rather than increased resistance to extinction, it was shown that amongst participants in the conditioning only (i.e., no extinction) group, disgust sensitivity was not associated with avoidance on the visual avoidance task. This indicates that higher levels of disgust sensitivity are not related to superior conditioning. This latter finding is somewhat surprising and there is a need to replicate this finding with a larger sample. Based on the current data, however, the relationship between disgust sensitivity and avoidance in the extinction group can be best explained as increased resistance to extinction amongst individuals who demonstrate higher levels of disgust sensitivity. There was no significant relationship between resistance
to extinction and anxiety, as measured by either the DASS21 anxiety subscale or the FNE. It should be noted, however, that the relationship between the FNE and resistance to extinction was only marginally non-significant ($p = 0.08$) and as such, with more participants, it is possible that this would have reached significance.

A potential limitation of this study is that the effects may not be specific to disgust. That is, it is possible that it is not disgust itself that is resistant to extinction but rather that it is the negative valence acquired during disgust conditioning that is driving the resistance to extinction effects observed (See the General Discussion for a more detailed discussion of this issue). Measurement of other negative emotions may permit more confident conclusions regarding the specificity of effects. Indeed, Olatunji et al. (2007a) did examine the loss of fear as well as disgust and found that although fear ratings decreased across extinction, disgust ratings remained high, supporting the conclusion that the resistance to extinction effects were specific to disgust. However, if it is the case that the effects reported in the current experiment are being driven by general negative valence as a consequence of disgust conditioning, this too is an interesting finding that is highly clinically relevant. That is, in many ways, it is irrelevant whether it is the feeling of disgust itself or a more general negative valence that is resistant to extinction. In both cases, there appears to be an affective component that does not respond to extinction. In turn, this suggests that some aspect of disgust will not respond to exposure therapy. As such, we need to thoroughly examine this resistance to extinction and investigate ways in which we can reduce disgust or its associated negative valence.

**Summary, conclusions, and implications**

This study demonstrated that learned disgust reactions are resistant to extinction, as indexed by both self-report and an objective behavioural measure. Despite numerous non-
reinforced presentations of the CS+, participants continued to avoid looking at it. Indeed, the degree of avoidance demonstrated by extinguished participants was indistinguishable from the level of avoidance observed in participants who did not undergo any extinction. This research adds novel support to the concept of the “law of contagion”, succinctly described as “once in contact, always in contact”. More specifically, this notion suggests that even brief contact between two objects can cause a permanent transfer of the properties of one object to the other, even when no substance is transmitted (Rozin et al., 1986). For example, many people state that they would not drink from a glass that once held dog faeces regardless of the number of times the glass was cleaned and sterilised (cited in Haidt et al., 1994). Similarly, residents in Toowoomba, a drought-stricken town in Queensland, Australia, voted against a scheme to use treated recycled water obtained from sewage (“Toowoomba says no to recycled water”, 2006). Po, Kaercher, and Nancarrow (2003) cite the number one reason why people can understand the sense in using recycled water but remain hesitant to drink it, as disgust or the “yuck” factor. Consistent with those examples, in the current experiment, pairing a neutral face with disgusting images resulted in the expression of disgust reactions towards that face. These responses persisted despite several viewings of the CS+ face in the absence of the disgusting images, with the knowledge that the CS+ no longer predicted the US.

Current treatments for anxiety disorders do not specifically target disgust reactions (de Jong & Muris, 2002). The results of this study suggest that the treatment of choice for anxiety disorders, namely exposure therapy, which is explicitly based on models of extinction, may not affect disgust reactions. As reviewed earlier, disgust reactions appear to be a crucial maintaining factor in a number of anxiety disorders. Therefore, if current treatments do not result in a reduction of disgust reactions towards phobic stimuli and situations, the efficacy of treatment may be compromised in cases where disgust is a
primary maintaining factor. Thus, patients are likely to remain distressed and functionally impaired. In cases where disgust is present, but perhaps secondary to fear, current treatments may lead to acute symptom reduction. However, the residual disgust is likely to lead to avoidance, which may then lead to relapse in the long-term.
Experiment 5

Retention experiment: The loss of evaluative responses (disgust & dislike) over time

Experiment 4 demonstrated that learned disgust responses do not decrease in response to extinction, a laboratory analogue of exposure therapy. That initial demonstration suggests that disgust reactions are particularly “hardy” or resistant to change. In order to further examine this important issue, participants were re-tested 4-7 (mean = 6) months after their initial conditioning episode. The aims of this experiment were to determine whether these same participants would (1) remember the faces used in the original experiment; (2) recall which of the faces was associated with the disgusting images; and (3) exhibit residual disgust and dislike reactions towards the CS+. This novel memory experiment provides useful insights into the loss of disgust reactions over time, which in turn, will assist in the conceptualisation and treatment of anxiety disorders in which disgust plays an important role.

In order to assess the recognition of the CS+ and CS- faces, participants were presented with these faces as well as four distractor faces and asked to indicate whether or not they recognised each face and whether or not each face was followed by a disgusting image in the previous experiment (see below for further details). During this task, in which each face was presented on the screen individually, skin conductance responses were recorded in an effort to assess implicit recognition of the faces. The skin conductance measure was chosen on the basis of previous work by Newcombe and Fox (1994) as well as Stormark (2004). In Stormark’s experiment, he showed preschoolers slides of other children. Some of the slides were of former classmates and others were of unfamiliar children. He
found that although the preschoolers did not generally recognise their former classmates, they exhibited increased skin conductance responses to slides depicting former classmates compared to unfamiliar children. Similar results were previously demonstrated by Newcombe and Fox (1994). In the present experiment, it was hypothesised that although participants may not report recognition of the CS+ and CS- faces, they may exhibit increased autonomic arousal to those faces. It is difficult to make predictions regarding potential differences in skin conductance responses to the CS+ and CS- faces. This is because, although one might expect that participants would show increased autonomic arousal to the CS+ as it was paired with the aversive stimulus, it has been suggested that disgust is associated with parasympathetic arousal (Levenson, 1992; Rozin et al., 2008; Woody & Teachman, 2000) and as such, it might then be predicted that viewing the CS+ would not result in an increased skin conductance response because this response (that is due to sweating) is only innervated by the sympathetic nervous system (Sherwood, 2004).

Although disgust has been associated with increased skin conductance responding in certain studies (Gross, 1998; Lang, Greenwald, Bradley, & Hamm, 1993), it should be noted that in both of the instances cited, the disgusting films/images that were used depicted mutilation. Specifically, videos of an amputation and the treatment of a burn victim were used in the Gross study, and images of mutilated faces were used in the Lang et al. study. As noted previously, mutilation images elicit both disgust and fear and therefore the increased skin conductance responses to those stimuli could have been due to fear rather than disgust.

In order to test for retained disgust and dislike reactions towards the CS+ face, participants were asked to provide self-report disgust and dislike ratings of the CS+ and CS- faces. They were also asked to complete the Evaluative conditioning questionnaire for each face, and to complete the visual avoidance task. It was hypothesised that participants would report retained disgust and dislike of the CS+ and continue to avoid looking at it. It was
unclear whether residual disgust and dislike would only be observed amongst participants who could explicitly recall the stimulus contingencies from the previous experiment.

To further examine participants’ memory retention, they underwent conditioning and extinction. For each participant, the same face that served as the CS+ in the previous experiment was used as the CS+ in the current experiment and the same face that served as the CS- in the previous experiment was used as the CS- in this experiment. Therefore, this was the second conditioning episode for all participants. It was the first extinction episode for those participants who were not extinguished in the previous experiment and the second extinction episode for participants who were previously extinguished. The aim of this task was to determine whether a savings effect would be observed. A savings effect refers to the “phenomenon whereby prior exposure to information facilitates the relearning of the material” (Monk, Gunderson, Grant, & Mechling, 1996, p. 1051). In a classical conditioning context, savings refers to faster learning of the conditioned response during the second conditioning episode, relative to the first conditioning episode (Kehoe & Macrae, 2002). It was predicted that participants would show faster conditioning in this experiment compared to their previous conditioning episode. As it has been suggested that individuals are faster to learn an association between a CS and an aversive US when the CS has a negative valence itself (Hermans et al., 2005; Williams & Rhudy, 2007), a savings effect amongst participants who could not consciously recall the CS-US association might also be taken as an indication of implicit residual dislike and disgust towards the CS+. That is, if participants cannot recall which face was the CS+ and yet demonstrate faster learning that the CS+ face is associated with the aversive outcome (i.e., the presentation of the disgusting US) than when previously trained, this might suggest that the CS+ retained a negative valence. Of course, there are a number of other possible reasons for faster reacquisition than acquisition. For example, one reason may simply be the learning to learn phenomenon,
which describes an increase in the rate of learning across a sequence of similar tasks (see Kehoe, 1988). That is, familiarity with the task demands may on its own lead to faster reacquisition, regardless of conscious recall of the stimulus contingencies or residual negative valence. Therefore, faster reacquisition may not definitively indicate preserved knowledge of the CS-US association or residual negative valence in the absence of an appropriate control group. An example of such a control group would be one who has been previously conditioned in the same manner who is then presented with different stimuli that serve as the conditioned stimuli during the second conditioning episode. If such a control group showed faster reacquisition than acquisition, this would suggest that familiarity with the task demands was contributing to faster reacquisition. However, due to the small sample size in this experiment, the inclusion of such a control group was not deemed appropriate, as it would make the groups quite small and thus minimise the statistical power to detect effects.

Finally, in an effort to replicate previous findings, following conditioning and extinction, participants were asked to re-rate the faces according to how much they disliked them and how disgusting they found them. They also completed the visual avoidance task for the second time in this experiment. It was predicted that participants would report that the CS+ face was more disgusting and disliked than the CS- face. It was also predicted that participants would avoid looking at the CS+ face.

I am only aware of three other studies that have examined evaluative responding after a delay (Askew & Field, 2007; Baeyens et al., 1988; Levey & Martin, 1975). Specifically, Levey and Martin (1975) retested seven of the 10 participants from their original study approximately 18 months after picture-picture evaluative conditioning. Although they did not present the data from the follow-up test in their article, they stated that “Only the
results for transfer of negative evaluation to the neutral stimuli remained significant for this group, though the positive evaluation was in the original direction” (p. 224). Baeyens et al. (1988) showed that participants who completed a picture-picture evaluative conditioning and extinction paradigm continued to rate faces that were paired with a negative stimulus as negative and to rate faces that were paired with a positive stimulus as positive after a 2-month delay. Finally, Askew and Field (2007) exposed children to pictures of unknown animals that were paired with faces depicting either a happy, scared, or neutral expression. They used an affective priming paradigm as an “indirect measure of fear beliefs”. However, the task, which involved classifying words following the animal primes as “nice” or “nasty”, may also be described as a measure of evaluative conditioning. The authors found that there was faster responding to congruent than incongruent trials 3 months after conditioning. This suggests that evaluative responses in that paradigm were retained up to 3 months. However, as the authors did not differentiate between congruent trials that involved the animal that was paired with the scared face and congruent trials that involved the animal that was paired with the happy face, it is not clear whether positive, negative, or both types of evaluations were retained. In the present study, therefore, evaluative responses to the CS+ and the CS- were examined separately.

Method

Participants

All aware participants from Experiment 4 (i.e., N = 55) were contacted via email in order to recruit them for this retention experiment. Of these, 24 responded and agreed to participate. Seven were male and 17 were female.
**Design**

Participants were assessed for their recognition of the CS faces. They then completed tasks that were designed to measure the extent to which evaluative responses (disgust and dislike) were retained. All participants then underwent differential conditioning, in which one of two faces (CS+) was paired with disgusting images. The other face (CS-) was paired with neutral images. CS face allocation for each participant remained the same as that used during the original conditioning episode (Experiment 4). Participants then underwent extinction in which both of the faces were presented unreinforced. Finally, participants completed further tasks to measure evaluative responses towards the CSs.

**Materials and apparatus**

The recognition task was programmed and executed using MedPC on an IBM computer with Windows 98. All other computer tasks in this experiment ran using the same setup as was used in Experiment 4.

**Images**

The same two faces used in the previous experiment served again as the conditioned stimuli. Four additional control/distractor male faces displaying a neutral affect expression, obtained from the same collection as the conditioned stimuli (Ekman & Friesen, 1976), were also used in the recognition task. The same images that were used in the previous experiment to serve as the unconditioned stimuli were used in the same capacity in the current experiment.

**Eye-tracker**

The eye-tracker was the same as that used in Experiment 4.
**Skin conductance recording**

As in the earlier fear conditioning experiments (Chapter 2), skin conductance was measured through electrodes on the second and third fingers of the left hand.

**Contingency awareness check**

The same contingency awareness check used in Experiment 4 was used in the current experiment with the exception that participants were explicitly asked to make their responses on the basis of “today’s task”.

**Debriefing interview**

At the end of the experiment, participants were asked the following questions: (1) “What do you recall was the aim of the previous study that you participated in last year?”; (2) “Specifically, do you recall what we were measuring during the phase of the experiment where the two faces were presented on the screen side-by-side?” [i.e., during the visual avoidance task]; and (3) “If so, were you aware of this when you were completing the same task in the experiment today?”. The experimenter noted participants’ responses. The aim of the debriefing interview was to allow for the assessment of whether prior knowledge of the visual avoidance task affected performance on the visual avoidance task in the current experiment.

**Data analysis**

Analysis of the skin conductance measure was based upon procedures that were used in the fear conditioning and extinction experiments presented in Chapter 2. Skin conductance responses were calculated for each face as the difference between the mean skin conductance level during the last 5 seconds of the 6-second presentation of the face and the mean skin conductance level during the 10-second baseline period immediately...
prior to the face display onset. For the purpose of normalising distributions, skin conductance level scores were log-transformed before differences were computed. The log-transformed SCR s to the four distractor/control faces were averaged to calculate a single SCR for the “control face”.

**Procedure**

Participants were informed that the experiment was a “follow-up” of the experiment that they had completed last year.

**Recognition task**

The skin conductance leads were attached to the participants’ left hand. Participants were told that during this task they would see faces on the computer screen, some of which they would have seen in the previous experiment. They were also provided with instructions regarding the questions they would be asked (see immediately below). When the participant was ready to begin, similar written instructions appeared on the screen for 2 minutes. Following this, the task began. Each trial consisted of a blank screen for 60 seconds. The baseline SCR was collected in the last 10 seconds of this period (participants were not informed about the baseline collection). One of the faces was then presented on the screen for 6 seconds. When the image was removed from the screen, the experimenter asked the participant, “Did you recognise the face that you just saw from the previous experiment?”. Participants were then asked to rate how confident they were in their response, using the scale provided, where 0 indicated that they were not at all confident in their response and 100 indicated that they were totally confident in their response. If a participant indicated that they recognised a face, they were then asked, “Was that face followed by a disgusting image in the previous experiment?”. Participants were again asked to rate how confident they were in their response, using the scale provided. The
experimenter recorded the participants’ responses. Presentation of the faces was pseudo-randomised. Participants were instructed not to speak during this phase unless they were answering the experimenter’s questions and to try to keep their left hand as still as possible. The experimenter sat behind the participant throughout the task so that the participant could not obtain any visual cues from the experimenter that might indicate whether or not a face was novel or not.

*Retention of disgust and dislike tasks*

*Visual avoidance task (time 1)*

Participants then completed the visual avoidance task. This was conducted in the same way as in Experiment 4, with the exception that the US images were not presented. Only the CS+ and CS- faces were used for this task and all tasks reported below (i.e., the distractor faces were not presented again).

*Dislike and disgust ratings of the faces*

The CS+ face and the CS- face appeared on the screen one at a time. Presentation order was counterbalanced across participants. Participants were asked to rate “How much do you like or dislike this face from 1-9? 1 = Really dislike and 9 = Really like”, and “How disgusting do you find this face from 1-9? 1 = Really disgusting and 9 = Really pleasant”. Lower ratings indicate a greater degree of dislike and disgust.

*Evaluative conditioning questionnaire (ECQ)*

This was conducted in the same manner as in Experiment 4. Cronbach’s alpha coefficients for the CS+ and CS- versions of the ECQ in the present study were 0.85 and 0.84, respectively.
Re-conditioning & (re-)extinction

All participants underwent conditioning and extinction in exactly the same manner as in Experiment 4.

Visual avoidance task (time 2)

All participants completed the visual avoidance task in exactly the same manner as in Experiment 4.

Post-experiment dislike and disgust ratings of the faces

This was conducted in exactly the same manner as the retention dislike and disgust ratings of the faces.

Contingency awareness check and Debriefing

In this phase, participants completed the contingency awareness check based on the current experiment. Finally, participants were administered the debriefing interview.

See Figure 3.6 for a flow-chart of the order experimental tasks.
Recognition task

Visual avoidance task (time 1)

Dislike and disgust ratings of the faces

Evaluative conditioning questionnaire

Re-conditioning and (re-)extinction

Visual avoidance task (time 2)

Post-experiment dislike and disgust ratings of the faces

Contingency awareness check and Debriefing

Figure 3.6. The order of the experimental tasks in Experiment 5.

Results

Recognition task

All participants reported that they recognised both the CS+ and CS- faces. Confidence in recognition of the CS+ ranged from 40 to 100 (Mean = 87.88). Confidence in recognition of the CS- ranged from 30 to 100 (Mean = 86.46). Seven participants also indicated that they recognised one or more of the distractor/control faces.
Participants were classified as “rememberers” or “non-rememberers” based on their recollection of the stimulus contingencies in the previous experiment. Rememberers (n=11) were those participants who reported recognising only the CS+ and CS- faces (i.e., reported that all other faces were not presented in the previous experiment) and identified the correct face as having been followed by disgusting images (i.e., the CS+) and the other familiar face as not having been followed by disgusting images in the previous experiment (i.e., the CS-). All other participants were classified as non-rememberers (n=13). Seven out of the 11 participants in the rememberers group and three out of the 13 in the non-rememberers group had undergone extinction in the previous experiment.

It should be noted that 12 out of the 13 non-rememberers reported that they believed that the CS- face was previously followed by the disgusting image and seven of the non-rememberers reported that they believed that the CS+ face was previously followed by the disgusting image. The one participant in this group who indicated that the CS- was not followed by the US also indicated that the CS+ was not followed by the US. Importantly therefore, there were no participants who were classified as non-rememberers on the basis of identifying a distractor face as familiar, despite correctly identifying the stimulus contingencies of the CSs. That is, all participants in the non-rememberers group incorrectly identified the stimulus contingencies.

Skin conductance responses – implicit recognition?

Mean skin conductance responses for rememberers and non-rememberers are presented in Figure 3.7. There was no main effect of face type or group, and no interaction [all Fs < 1].
Retention of disgust & dislike tasks

Dislike and disgust ratings of the faces (before re-conditioning and extinction)

Mean dislike and disgust ratings of the faces are presented in Figure 3.8. The CS+ was significantly more disliked than the CS- \( [F_{(1, 22)} = 5.64, p = 0.027] \). There was no difference between rememberers and non-rememberers \( [F < 1] \) and no significant interaction \( [F_{(1, 22)} = 1.11, p = 0.30] \), indicating that the CS+ was more disliked than the CS-, regardless of whether participants could recall the stimulus contingencies. For disgust ratings, there was no main effect of CS type \( [F_{(1, 22)} = 2.58, p = 0.12] \). There was a main effect of group \( [F_{(1, 22)} = 4.41, p = 0.047] \), indicating that participants in the rememberers group reported less overall disgust than non-rememberers. There was a marginally significant interaction \( [F_{(1, 22)} = 3.85, p = 0.063] \). Therefore, simple effects analyses were undertaken. Paired samples t-tests revealed that the CS+ was rated as more disgusting than the CS- for rememberers only \( [t_{(10)} = -2.12, p = 0.061] \). Amongst non-rememberers, there was no
significant difference in the disgust ratings of the CSs \( t_{12} = 0.31, p = 0.77 \). Independent samples t-tests revealed that there was no difference between groups in their disgust of the CS+ \( t_{22} = -0.08, p = 0.94 \). There was, however, a significant difference between groups in their disgust ratings of the CS- \( t_{22} = 3.42, p = 0.002 \). This suggests that the group difference between rememberers and non-remeberers on the disgust rating was driven by differences in their rating of the CS-, not the CS+.

![Figure 3.8. Mean dislike and disgust (retention) ratings (Experiment 5). N.B. Lower ratings indicate greater disgust and dislike.](image)

Dislike and disgust ratings: Changes over time (comparison with the previous experiment)

Differential ratings of the CS+ and CS- in the current experiment are not necessarily indicative of the retention of negative valence over time. That is, it is possible that the CS+ did not retain its negative valence but rather that the differential ratings of the CS+ and CS- in the current experiment are due to the fact that the CS- retained its positive valence. Therefore, in order to assess whether disgust and dislike ratings were retained over time, pre-experiment disgust and dislike ratings in the current experiment were compared to pre-experiment ratings from the previous experiment. This makes it possible to determine whether ratings of the CS+ and the CS- in the current experiment are different from ratings
made of the CSs before participants were ever conditioned. As such, conclusions can then be drawn regarding changes in valence over time. Only data from the subset of participants who completed both experiments were included for analyses. For illustrative purposes, mean disgust and dislike pre- and post-experiment ratings for both experiments are displayed in Figure 3.9. This graph demonstrates that this subset of participants did report valence changes in the previous experiment and shows whether or not these changes were retained over time. However, for simplicity, analyses were only conducted on the differences between the pre-experiment ratings from the previous experiment and the pre-experiment ratings from the current experiment to determine statistically whether valence changes were maintained over time. Mean disgust and dislike pre-experiment ratings from the previous experiment (prev) and the current experiment (ret) for rememberers and non-rememberers are presented in Figure 3.10.

Figure 3.9. Mean pre- and post-experiment disgust and dislike ratings from the previous experiment (prev) and the current experiment (ret) for non-rememberers and rememberers. N.B. Lower ratings indicate greater disgust and dislike.
Figure 3.10. Mean pre-experiment disgust and dislike ratings from the previous experiment (prev) and the current experiment (ret) for non-rememberers and rememberers. N.B. Lower ratings indicate greater disgust and dislike.

**CS+ over time**

Disgust: For both rememberers and non-rememberers, there were no significant differences in disgust ratings of the CS+ 6 months after conditioning relative to before participants were ever conditioned [rememberers: \( t_{(10)} = -0.30, p = 0.77 \); non-rememberers: \( t_{(12)} = 0.67, p = 0.51 \)]. That is, disgust towards the CS+ was not maintained over time.

Dislike: For both rememberers and non-rememberers, there were no significant differences in dislike ratings of the CS+ 6 months after conditioning relative to before they were ever conditioned [rememberers: \( t_{(10)} = -0.79, p = 0.45 \); non-rememberers: \( t_{(12)} = 0.13, p = 0.90 \)]. That is, dislike towards the CS+ was not maintained over time.

**CS- over time**

Disgust/Pleasantness: Non-rememberers did not report a significant difference in disgust ratings of the CS- 6 months after conditioning relative to before they were ever conditioned [\( t_{(12)} = 1.25, p = 0.24 \)]. That is, ratings of pleasantness of the CS- were not
maintained over time for those participants who could not recall the stimulus contingencies. In contrast, rememberers did report that they found the CS- significantly less disgusting/more pleasant 6 months after conditioning relative to before they were ever conditioned \( t_{(10)} = -2.35, p = 0.040 \). That is, ratings of pleasantness of the CS- were maintained over time for those participants who could recall the stimulus contingencies.

Dislike/Like: Non-rememberers did not report a significant difference in dislike ratings of the CS- 6 months after conditioning relative to before they were ever conditioned \( t_{(12)} = -1.47, p = 0.17 \). That is, liking of the CS- was not maintained over time for non-rememberers. In contrast, rememberers did report that they liked the CS- significantly more 6 months after conditioning relative to before they were ever conditioned \( t_{(10)} = -4.23, p = 0.002 \). That is, liking of the CS- was maintained over time for rememberers.

In summary, the CS+ did not retain a negative valence over time amongst both rememberers and non-rememberers. The CS- did retain a positive valence over time, but only amongst rememberers.

*Evaluative conditioning questionnaire (ECQ)*

Mean ECQ ratings of the faces are presented in Figure 3.11. The CS+ was rated significantly less favourably than the CS- \( F_{(1, 22)} = 4.77, p = 0.040 \). There was no main effect of group (rememberers vs. non-rememberers \( F < 1 \)). However, the interaction was significant \( F_{(1, 22)} = 4.55, p = 0.044 \). Paired samples \( t \)-tests revealed that the CS+ was rated significantly less favourably than the CS- for rememberers only \( t_{(10)} = -4.05, p = 0.002 \). Amongst non-rememberers, there was no significant difference in the ECQ ratings of the CSs \( t_{(12)} = -0.03, p = 0.98 \). Independent samples \( t \)-tests revealed that there was no difference between groups in their ratings of the CS+ \( t_{(22)} = 1.09, p = 0.29 \). There was, however, a
significant difference between groups in their ratings of the CS- \( t_{22} = -2.23, p = 0.036 \). This suggests that the interaction was driven by differences in ratings of the CS-, not the CS+.

![Graph](image_url)

Figure 3.11. Mean evaluative ratings on the ECQ (Experiment 5). N.B. Lower ratings indicate a less favourable impression of the CS.

As with the disgust and dislike ratings, differential ratings of the CS+ and CS- on the ECQ in the current experiment are not necessarily indicative of the maintenance of negative valence over time. Therefore, in order to assess whether ratings on the ECQ remained the same over time, ECQ ratings in the current experiment were compared to ECQ ratings from the previous experiment. Again, only data from the subset of participants who completed both experiments were included in the analyses. Mean ECQ ratings from the previous experiment (prev) and the current experiment (ret) for rememberers and non-rememberers are presented in Figure 3.12. Recall that the ECQ was administered after conditioning (and extinction) in the previous experiment.
There was a main effect of CS type \( F_{(1, 22)} = 21.79, p < 0.001 \), indicating that participants had a significantly less favourable impression of the CS+ than the CS. There was a main effect of time \( F_{(1, 22)} = 4.30, p = 0.050 \) as well as a significant CS-by-time-by-group interaction \( F_{(1, 22)} = 4.71, p = 0.041 \). Therefore, follow-up t-tests were conducted.

**CS+ over time:** Non-rememberers reported a significantly more favourable impression of the CS+ at the start of the retention experiment, relative to immediately after the original conditioning (and extinction) episode \( t_{(12)} = -2.20, p = 0.048 \). That is, negative valence was not maintained over time for non-rememberers. Rememberers did not report any significant change in their ratings of the CS+ at the start of the retention experiment, relative to immediately after the original conditioning (and extinction) episode \( t_{(10)} = -1.17, p = 0.27 \). That is, negative valence was maintained over time for rememberers.

**CS- over time:** Both non-rememberers and rememberers did not report any significant change in their ratings of the CS- at the start of the retention experiment, relative
to immediately after the original conditioning (and extinction) episode [non-rememberers: $t_{(12)} = 1.73, p = 0.11$; rememberers: $t_{(10)} = -1.97, p = 0.077$]. That is, the CS- retained a positive valence, regardless of whether participants could recall the stimulus contingencies.

In summary, on the ECQ, the CS- retained a positive valence amongst both groups of participants and the CS+ retained a negative valence amongst rememberers only.

*Visual avoidance task (time 1)*

As in Experiment 4, looking time during the three initial 2-second presentations of the conditioned stimuli was summed and will be referred to as the “short presentation”. The 10-second presentation of the conditioned stimuli during the eye-tracker task will be referred to as the “long presentation”.

During the short presentation, there was no significant effect of CS type [$F_{(1, 22)} = 1.01, p = 0.33$] or group [$F < 1$] and no significant interaction [$F < 1$]. Similarly, during the long presentation, there was no significant effect of CS type or group and no significant interaction [all $Fs < 1$]. That is, there was no difference between looking times at the CSs. For descriptive statistics and a comparison to looking times in Experiment 4, see Table 3.1.
Table 3.1. A comparison of looking time at the CSs during the visual avoidance task in the current and previous experiments.

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<th>Looking time (seconds)</th>
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<td></td>
<td>Retention experiment</td>
<td>Previous experiment</td>
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<td>(time 1)</td>
<td>(Exp. 4)</td>
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<tr>
<td></td>
<td>Mean</td>
<td>SEM</td>
<td>Mean</td>
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<tr>
<td>Rememberers</td>
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<td>Short Presentation</td>
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<td>CS+</td>
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<td>Non-rememberers</td>
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Re-conditioning and (re-)extinction

Due to a computer malfunction, the data from one participant have been excluded for this task and all tasks that took place after conditioning [i.e., the post-experiment ratings and the visual avoidance task (time 2)]. Another participant was unaware of the stimulus contingencies following re-conditioning and extinction and therefore data from this participant were similarly excluded. Therefore, there were 22 remaining participants included in the analyses below (rememberers: n = 10; non-rememberers: n = 12).

Conditioning

Mean US expectancy ratings are presented in Figure 3.13. During conditioning, there was a significant main effect of CS type [$F_{(1, 18)} = 242.19$, $p < 0.001$] and group [$F_{(1, 18)} = 6.03$, $p = 0.02$]. There was also a significant CS-by-group interaction [$F_{(1, 18)} = 7.50$, $p = 0.01$], reflecting greater overall discrimination between the CS+ and CS- amongst rememberers.
than non-remembers, due to heightened recognition of the stimulus contingencies on the very first trial amongst rememberers compared to non-rememberers. There was not a main effect of trial \([F < 1]\) but there was a CS-by-trial interaction \([F(2, 36) = 6.11, \rho_{GG} = 0.01]\), reflecting an increase in US expectancy following the CS+ and a decrease in US expectancy following the CS- across trials.

![Figure 3.13. Mean US expectancy ratings during conditioning and extinction (Experiment 5).](image)

**Extinction**

During extinction, there was a significant main effect of CS type \([F(1, 16) = 105.85, p < 0.001]\) and trial \([F(6, 96) = 3.67, \rho_{GG} = 0.041]\). There was also a significant CS-by-trial interaction \([F(6, 96) = 3.95, \rho_{GG} = 0.02]\), as ratings for the CS+ decreased across trials and ratings of the CS- remained relatively low across trials. There was not a significant main effect of group \([F < 1]\) or any interaction involving group \([\text{largest } F(1, 16) = 2.95, p = 0.11]\), indicating that there were no differences between rememberers and non-rememberers in their extinction across trials.

As in the previous experiment, participants were classified as extinguishers and non-extinguishers based on their US expectancy ratings during extinction, using the same criteria as in the previous experiment (i.e., a US expectancy of 50 or below on the last CS+ trial and a
reduction in expectancy ratings across CS+ extinction trials). Amongst rememberers, 80% (8 out of 10) were classified as non-extinguishers. Amongst non-rememberers, 42% (5 out of 12) were classified as non-extinguishers. In order to test whether there was a difference between groups in terms of the proportion of extinguishers and non-extinguishers, a $\chi^2$ test for independent samples was conducted. The $p$ value of this test ($\chi^2 = 5.09$) was < 0.05, indicating that the null hypothesis was rejected. That is, there were significantly more non-extinguishers in the rememberers group than in the non-rememberers group.

**Was there a savings effect?**

In order to determine whether there was a savings effect, conditioning data from this experiment were compared to the conditioning data in the previous experiment. The only data that were considered from the previous experiment were data from included participants on this measure in this experiment (i.e., N = 22).

Data pertaining to the CS+ and CS- were analysed separately in order to determine whether there was a savings effect for both the CS+ and CS-. In addition, because learning in this paradigm is so rapid, only the first conditioning trial was considered. Rememberers reported a significantly higher expectation of the US following the CS+ during re-acquisition (Mean expectancy = 87.2) relative to the original conditioning episode (Mean expectancy = 66.1) [$t(8) = 2.55, p = 0.03$]. Non rememberers did not report a significantly higher expectation of the US following the CS+ during re-acquisition (Mean expectancy = 76.5) relative to the original conditioning episode (Mean expectancy = 72.5) [$t(10) = 0.56, p = 0.59$]. This suggests that there was a savings effect for rememberers only.

Similarly, rememberers reported a significantly lower expectation of the US following the CS- during re-acquisition (Mean expectancy = 9.2) relative to the original conditioning
episode (Mean expectancy = 38.6) \[ t(9) = 4.45, p = 0.002 \]. Non-rememberers did not report a significantly lower (or higher) expectation of the US following the CS- during re-acquisition (Mean expectancy = 45.5) relative to the original conditioning episode (Mean expectancy = 35.5) \[ t(9) = 1.11, p = 0.30 \]. This suggests that there was a savings effect for learning regarding the “safety signal” (i.e., the CS-) for rememberers only.

**Online valence ratings**

Mean valence ratings are presented in Figure 3.14. During conditioning, there was a significant main effect of CS type \[ F_{(1, 20)} = 41.07, p < 0.001 \], indicating that the CS+ was more disliked than the CS-. There was no main effect of trial \[ F < 1 \] or group \[ F_{(1, 20)} = 1.02, p = 0.33 \]. There was, however, a significant CS-by-trial interaction, due to an increase in dislike of the CS+ and a increase in liking of the CS- over trials \[ F_{(2, 40)} = 7.55, p_{GG} = 0.004 \].

During extinction, the CS+ was more disliked than the CS- \[ F_{(1, 20)} = 48.15, p < 0.001 \]. There was no main effect of trial \[ F < 1 \] or group \[ F < 1 \] and there were no significant interactions \[ \text{largest } F_{(6, 120)} = 1.39, p = 0.23 \]

![Figure 3.14. Online valence ratings of the CSs across conditioning and extinction (Experiment 5). N.B. Lower ratings indicate greater dislike.](image-url)
Visual avoidance task (time 2)

As in Experiment 4, looking time at each of the images during the three initial 2-second presentations of the stimulus pairs (CS+ and CS--; vomit and umbrella) was summed and will be referred to as the “short presentation”. The 10-second presentation of the stimulus pairs will be referred to as the “long presentation”.

Conditioned stimuli

Mean looking times at the CSs during the second visual avoidance task are shown in Figure 3.15. During the short presentation, participants looked at the CS+ for significantly less time than the CS- \([F(1, 20) = 10.24, p = 0.005]\). There was no difference between groups \([F < 1]\) nor a significant interaction \([F(1, 20) = 2.03, p = 0.17]\). Similarly, during the long presentation, participants looked at the CS+ for significantly less time than the CS- \([F(1, 20) = 15.87, p = 0.001]\). There was no difference between groups \([F < 1]\) nor a significant interaction \([F(1, 20) = 2.22, p = 0.15]\).
Figure 3.15. Mean looking time at the CSs during the (A) short and (B) long presentations of the visual avoidance task (time 2; Experiment 5).
Unconditioned stimuli

During the short presentation, participants looked at the vomit image ($M = 1383.4ms$, $SEM = 284.7$) for significantly less time than the umbrella image ($M = 3601.1ms$, $SEM = 312.4$) [$F_{(1, 19)} = 14.75$, $p = 0.001$]. There was no difference between groups [$F_{(1, 19)} = 1.84$, $p = 0.19$] nor a significant interaction [$F < 1$]. Similarly, during the long presentation, participants looked at the vomit image ($M = 2.19s$, $SEM = 0.54$) for significantly less time than the umbrella image ($M = 7.37s$, $SEM = 0.57$) [$F_{(1, 20)} = 21.20$, $p < 0.001$]. There was no difference between groups [$F < 1$] nor a significant interaction [$F < 1$].

Post-experiment ratings

Mean post-experiment dislike and disgust ratings of the faces are presented in Figure 3.16. The CS+ was rated as significantly more disgusting than the CS- [$F_{(1, 20)} = 66.18$, $p < 0.001$] and more disliked than the CS- [$F_{(1, 20)} = 38.84$, $p < 0.001$]. On both measures, there was no difference between rememberers and non-rememberers and no significant interaction [all $Fs < 1$].

Figure 3.16. Mean post-experiment dislike and disgust ratings of the CSs (Experiment 5).
N.B. Lower ratings indicate greater disgust and dislike.
Debriefing interview

Of the 24 participants, three participants expressed explicit knowledge regarding the task demands of the visual avoidance task and specifically stated that they were aware that the experimenter was observing whether or not participants would avoid looking at the face that was associated with the disgusting image previously (i.e., the CS+). Five other participants expressed that the task examined where participants looked, without specific reference to avoidance of the CS+. All other participants either made incorrect suggestions regarding what was measured during the visual avoidance task (e.g., “pupil dilation”) or indicated that they did not know what was being measured. In order to remain conservative, all participants who expressed any awareness of the task demands (i.e., with or without explicit reference to avoidance of the CS+) were classified as “demand aware”. All other participants were classified as “demand unaware”.

Descriptive data for both subsets of participants in relation to the visual avoidance tasks are presented in Table 3.2 below. At time 1 (i.e., during the first visual avoidance at the start of this experiment), there were 8 demand aware and 16 demand unaware participants. Due to the exclusion of the two participants noted on page 138, at time 2 (i.e., after re-conditioning and extinction), there were only 14 demand unaware participants. There were no significant differences between demand aware and unaware participants on these tasks [largest $t_{(20)} = 1.75, p_{UV} = 0.10$].
Table 3.2. Time spent viewing the CSs during the visual avoidance tasks (i.e., at time 1 and time 2) for demand aware and demand unaware participants.

<table>
<thead>
<tr>
<th>Group</th>
<th>Looking time (seconds)</th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Time 1</td>
<td>Short presentation</td>
<td>CS+</td>
<td>2.63</td>
<td>.22</td>
<td>2.62</td>
</tr>
<tr>
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<td></td>
<td>CS-</td>
<td>2.33</td>
<td>.23</td>
<td>2.42</td>
</tr>
<tr>
<td></td>
<td>Long presentation</td>
<td>CS+</td>
<td>4.92</td>
<td>.98</td>
<td>4.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CS-</td>
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<td>1.25</td>
<td>4.57</td>
</tr>
<tr>
<td>Time 2</td>
<td>Short presentation</td>
<td>CS+</td>
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<td>.48</td>
<td>1.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CS-</td>
<td>3.14</td>
<td>.43</td>
<td>3.01</td>
</tr>
<tr>
<td></td>
<td>Long presentation</td>
<td>CS+</td>
<td>2.72</td>
<td>2.11</td>
<td>3.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CS-</td>
<td>7.06</td>
<td>2.09</td>
<td>5.40</td>
</tr>
</tbody>
</table>

Discussion

In my previous study on the loss of disgust reactions (Experiment 4), it was demonstrated that disgust and dislike responses were resistant to extinction. In order to further examine the loss of disgust reactions, participants’ disgust and other evaluative responses were re-examined 6 months after the original conditioning episode to determine whether these responses would decrease over time. All participants recognised the faces that served as conditioned stimuli in the previous experiment, with relatively few false positive identifications of the other distractor faces. Approximately half (46%) of the participants could also identify which of the faces served as the CS+ and which served as the CS-. Based on this, there were two subsets of participants which were termed “rememberers” (those who could recall the stimulus contingencies) and “non-rememberers” (those who could not recall the stimulus contingencies). During the recognition task, there were no statistically significant differences between physiological
arousal to the CS+, CS-, or control faces in both groups, as measured by skin conductance. The lack of statistically significant differences is possibly due to the large degree of variance observed on this measure. Based on the current data, however, it can be concluded that skin conductance responses did not track explicit recognition of the faces and did not provide any indication of implicit recognition of the faces.

Retention of negative and positive valence

In an effort to examine the loss of evaluative responses over time, participants were asked to re-rate the CS faces in terms of dislike and disgust, as well as on a number of personality traits and appearance (on the ECQ). In addition, they were administered the visual avoidance task.

Dislike and disgust ratings

All participants reported greater dislike of the CS+ face than the CS- face, regardless of whether they could consciously recall the stimulus contingencies or not. Only rememberers reported greater disgust towards the CS+ relative to the CS-. Non-rememberers reported equivalent levels of disgust towards the CS+ and the CS-. However, when the pre-experiment ratings in the current experiment were compared to the pre-experiment ratings in the previous experiment, it became clear that the CS+ did not retain a negative valence (measured by both dislike and disgust ratings) over time amongst both rememberers and non-rememberers. Similarly, the CS- did not retain a positive valence over time amongst non-rememberers, however it did retain a positive valence amongst rememberers (measured by both dislike and disgust ratings).
ECQ

Rememberers reported a less favourable impression of the CS+ than the CS- in relation to a variety of personality characteristics and appearance. In contrast, non-remeberers reported equivalent ratings of the CS+ and the CS- on the ECQ. A comparison between the ECQ ratings in the current experiment and the previous experiment revealed that the CS+ retained a negative valence amongst rememberers only. However, the CS- retained a positive valence amongst both groups of participants. This finding provides some evidence of implicit liking of the CS- because it indicates that even participants who could not consciously recall that the CS- was paired with neutral images previously (in fact, the vast majority reported that it had been followed by a disgusting image previously) still reported that their impression of that face was as favourable as immediately after the experiment 6 months earlier. However, at this stage it is unwise to draw any strong conclusions from this finding as it is inconsistent with other measures of valence in this experiment which did not provide evidence of implicit evaluative judgements.

Visual avoidance task (time 1)

Both rememberers and non-rememberers looked at the CS+ and the CS- for equal lengths of time during the first visual avoidance task. This indicates that the avoidance response was not preserved over time. Because the majority of the evidence from this experiment supports the notion that positive valence was sustained over time (at least amongst rememberers) but negative valence was not, the fact that there was no differential looking time on the initial visual avoidance task suggests that the reason why participants spent less time viewing the CS+ than the CS- in the previous experiments and at time 2 in the current experiment is due to avoidance of the CS+ rather than preference for the CS-. If it were the case that the differential looking time was driven by preference for the CS-, one would expect to have observed differential looking at time 1. Because differential looking
has only been observed on this task when there is strong evidence that participants evaluate the CS+ negatively, it seems reasonable to infer that differential looking time on this task is in fact driven by negative feelings towards the CS+, and that it is an avoidance response (of the CS+) rather than an approach response (to the CS-).

In summary, the preponderance of evidence suggests that negative valence is not retained over a 6-month period. This evidence comes from the pre-experiment disgust and dislike ratings of the CS+ as well as the visual avoidance task. The exception to this is that individuals who could recall the stimulus contingencies reported a retained negative impression of the CS+ on the ECQ, providing some evidence of preserved negative valence. In contrast to the findings regarding negative valence, there was more evidence to support the notion that positive valence (related to the CS-) is retained over time. This evidence comes from rememberers’ pre-experiment disgust and dislike ratings of the CS- as well as both groups’ ECQ ratings of the CS-. The finding that negative valence was not retained is inconsistent with Baeyens et al.’s (1988) finding. This discrepancy is possibly due to the longer retention interval in the current study (~ six months) relative to that in Baeyens et al.’s study (2 months). It is also inconsistent with Levey and Martin (1975). That disparity may be due procedural differences such as the stimuli used and the number of trials. For example, there were many more CS-US pairings (20) in Levey and Martin’s experiment than in the present experiment (seven). Nevertheless, it is also possible that the current findings represent a type II error. That is, it may be that negative valence is retained over time but that this was simply not observed in this sample.
Conditioning and extinction

*US expectancy*

There was evidence of a savings effect amongst rememberers in that they were faster to re-acquire the associations between the CS+ and the aversive US, and the CS- and the neutral image. That is, they were faster to obtain knowledge regarding both the aversive and safety signals. The same was not true for non-rememberers.

Interestingly, the vast majority of rememberers did not fully extinguish in the current experiment. Specifically, 80% of rememberers were classified as non-extinguishers. In contrast, only 42% of the non-rememberers did not extinguish on this measure. The latter statistic is consistent with the number of extinguishers found in the previous study. This suggests that individuals who recall the stimulus contingencies show enhanced resistance to extinction on this measure relative to individuals who do not recall the stimulus contingencies.

*Online valence*

In both groups, the CS+ was more disliked than the CS- during both conditioning and extinction. There was no change in valence ratings across extinction trials indicating that despite reductions in US expectancy during extinction, participants did not show increased liking of the CS+ across trials, providing further evidence that evaluative responses are resistance to extinction.

*Visual avoidance task (time 2)*

Replicating my previous finding from Experiment 4, following re-conditioning and extinction/re-extinction, participants avoided looking at the CS+ face and the vomit image.
This was true for both rememberers and non-rememberers. This finding adds further weight to the notion that disgust responses are resistant to extinction. Importantly, participants’ knowledge of the task demands did not influence the results on either of the visual avoidance tasks (i.e., at time 1 or time 2). That is, there was no difference in behaviour on the visual avoidance task between participants who reported knowledge of the task demands and those who did not. This suggests that avoidance of the CS+ is not due to demand characteristics.

Post-experiment ratings

At the end of the experiment, both groups of participants rated the CS+ face as more disgusting and more disliked than the CS- face. This replicates the findings from the previous experiment and again provides evidence that certain affective responses are not easily modifiable via an extinction procedure.

Were there any differences between rememberers’ and non-rememberers’ US expectancy ratings during their original conditioning and extinction?

An interesting question is whether there were any differences between rememberers and non-rememberers in their original learning. This is an important question as it may provide clues regarding factors that might result in the retention or forgetting of information about threatening cues (i.e., the CS+) and safety signals (i.e., the CS-). Such information is clinically relevant in that it could help to identify which patients might be more likely to relapse than others. In order to examine whether there were any differences between rememberers’ and non-rememberers’ US expectancy ratings during their original conditioning and extinction, a post-hoc analysis of US expectancy in the previous experiment was conducted comparing data from individuals who were classified as rememberers and non-rememberers in the current experiment. Data from these groups can
be seen in Figure 3.17. Please keep in mind that only half of the participants underwent extinction in the previous experiment and that conditioning data from the no extinction and extinction groups in the previous experiment have been collapsed. There were no differences between rememberers and non-rememberers during their original conditioning episode [all Fs involving group < 1]. It seems from Figure 3.17 that rememberers showed greater resistance to extinction on the expectancy measure than non-rememberers during their original extinction episode. It should be noted, however, that there are only three participants in the non-rememberers group and only seven participants in the rememberers group who underwent extinction previously. It is inappropriate to do analyses based on such a small sample size. Given that this is an important clinical question, it would be useful to consider analyses such as these on a larger sample size in the future.

Figure 3.17. Post-hoc comparison of rememberers and non-rememberers during conditioning and extinction in the previous experiment (i.e., Experiment 4).

Summary, implications, and conclusions

This experiment was a novel way of examining the loss of learned disgust and other evaluative responses. The majority of evidence suggested that participants did not retain feelings of disgust and dislike towards the CS+. In contrast, there was evidence that participants continued to like the CS- and rate it as pleasant, which may suggest that people
are particularly good at retaining knowledge regarding safety signals in the environment. These findings are somewhat counterintuitive as one might have expected greater retention of negative affect towards a cue that predicted an aversive stimulus than retention of positive affect towards a cue that predicted a neutral stimulus. Indeed, Cacioppo and Gardner (1999, pp. 205-206) state that “heightened sensitivity to negative information is a robust psychological phenomenon... because it is more difficult to reverse the consequences of an injurious or fatal assault than those of an opportunity unpursued”. Moreover, it has also been shown that shifts in evaluative learning are greater to CSs paired with negative USs than to CSs paired with positive USs (Baeyens et al., 1990b; Levey & Martin, 1975). It is possible that if the original conditioning procedure was more aversive, retention of negative valence would have been observed. It should be noted that the CS- could also be seen as a highly meaningful stimulus in that it has become a “safety signal” because the presentation of that face guarantees the absence of the disgusting US. In future research, it may be interesting to investigate whether clinically anxious populations are more likely to retain negative valence over time than non-clinical controls. Similarly, it would be worthwhile to examine whether clinically anxious individuals retain positive affect towards the CS- over time to the same extent as non-clinical controls.
Chapter 4:

Fear vs. disgust extinction

Experiment 6: A comparison of the extinction of fear and disgust ........................................155
Experiment 6

A comparison of the extinction of fear and disgust

Throughout this thesis, I have argued that disgust responses do not respond to extinction in the same way as fear responses. However, until now, I have examined the extinction of learned disgust and fear in separate experiments using different procedures. Because of this, one might argue that any distinctions observed are due to procedural artifacts rather than true differences between the extinction of these emotions. The aim of this experiment was to measure the loss of learned fear and disgust responses within the same paradigm in order to further explore whether there are differences in the way these emotions are affected by extinction. Participants were randomly assigned to receive fear or disgust conditioning. All participants underwent extinction. During conditioning and extinction, participants were asked to report US expectancy and CS valence ratings. In addition, skin conductance responses were measured. Participants completed the visual avoidance task as well as self-report measures including pre- and post-experiment fear and disgust ratings of the CSs, the Evaluative conditioning questionnaire, the Depression anxiety stress scales 21, and the Disgust sensitivity scale-revised.

Hypotheses

Based on the experiments reported in Chapter 2 and 3, it was predicted that both groups would learn about the stimulus contingencies during conditioning and reduce their expectation of the US following the CS+ during extinction. It was further hypothesised that more participants in the disgust group than in the fear group would be classified as non-extinguishers on the expectancy measure. It was predicted that both groups would report greater dislike and a less favourable impression of the CS+ than the CS- and that this would
be resistant to extinction. It was also hypothesised that participants in both groups would avoid looking at the CS+ during the visual avoidance task following extinction. Finally, it was predicted that participants in the disgust group would report continued disgust towards the CS+ following extinction and that reports of fear would be less resistant to extinction (i.e., participants in the fear group would not report more fear of the CS+ than the CS- at the end of the experiment).

Although it is well-established that fear evokes sympathetic autonomic nervous system (ANS) arousal, it has been suggested that disgust evokes parasympathetic ANS arousal (Levenson, 1992). As the skin conductance response is a reflection of sympathetic arousal, it was predicted that participants in the fear group would exhibit greater skin conductance responses to the CS+ than to the CS- during conditioning, whereas participants in the disgust group would not demonstrate differential skin conductance responses. It was further predicted that skin conductance responses in the fear group would be rapidly attenuated during extinction. Only one other study has examined SCRs in the context of disgust conditioning and extinction (Olatunji et al., 2007a). In that experiment, the authors observed greater SCRs to the CS+ than to the CS- during conditioning. However, as mentioned, the data during extinction were difficult to interpret, as SCRs to the CS+ and CS- changed in a puzzling way across blocks. Furthermore, due to the nature of the USs used in that study (mutilation images), it is probable that both disgust and fear were elicited, as reviewed earlier. As such, the increased SCR to the CS+ during conditioning may have been due to fear elicited by the CS+ rather than feelings of disgust. Because of the inconclusive nature of the data during extinction and due to the type of USs used in Olatunji et al.’s (2007a) study, it seems worthwhile to further investigate skin conductance during disgust conditioning and extinction in the context of the current experiment using disgust USs that do not also elicit fear.
Method

Participants

Participants were 66 first-year UNSW psychology students who participated for course credit. Of these, one participant was excluded due to a computer malfunction and four participants (all from the disgust group) were unaware of the stimulus contingencies and were excluded from the analyses. Data from the remaining 61 participants are reported below. Of this final sample, 14 were male and 47 were female.

Design

Participants were randomly assigned to one of two conditions – fear conditioning and extinction (n = 31) or disgust conditioning and extinction (n = 30). All participants underwent differential conditioning, in which one of two faces (CS+) was paired with an electric shock US (fear condition) or a disgusting image US (disgust condition). The other face (CS-) was never followed by the US. CS face allocation was counterbalanced across participants. Extinction involved nonreinforced presentations of both of the faces.

Materials and apparatus

The conditioning task was programmed and executed using MedPC on an IBM computer with Windows 98. The pre- and post-experiment fear and disgust ratings task was programmed and executed using E-prime and ran on a Dell computer with Windows XP. The visual avoidance task was programmed and executed using Tobii studio and ran on a Dell computer with Windows XP. Although two computers were used to run the experiment, a switch was employed so that both computers projected onto the one screen that was equipped with an eye-tracker (see below). As such, participants completed all tasks on the one computer screen.
Conditioned stimuli

The same two black and white photos of male faces used in the Chapter 2 and 3 experiments were used as the conditioned stimuli in this experiment.

Unconditioned stimuli

Fear condition: The fear-eliciting US was an electric shock, the same as that used in the fear conditioning experiments in Chapter 2, however the simultaneous loud tone was not presented in this experiment.

Disgust condition: The disgust-eliciting US was an image of a man vomiting into a toilet. This was the same vomit image that was used in the disgust conditioning experiments in Chapter 3. Please note that although two disgusting images were used in the disgust conditioning experiments in Chapter 3, only one of these images was used in the present experiment as only one fear US was used in the fear condition.

Skin conductance recording

As in the earlier fear conditioning experiments, skin conductance was measured through electrodes on the second and third fingers of the left hand.

US expectancy and CS valence dial

The same dial used in the Chapter 2 fear experiments was used in the current experiment. For the fear condition, the left extreme of the dial was labelled “0”, “Certain no shock” and the right extreme of the dial was labelled “100”, “Certain shock”. For the disgust condition, the left extreme of the dial was labelled “0”, “Certain no disgusting image” and the right extreme of the dial was labelled “100”, “Certain disgusting image”. Regularly spaced ticks labelled in increments of 10 also appeared on the dial. As the dial was also used
to make online valence ratings of the CSs, additional labels were used. Specifically, the “Really like” label was placed next to “0” and the “Really dislike” label was placed next to “100”. Therefore, zero corresponded with no expectancy of the US and liking the CS, and 100 corresponded with certain expectancy of the US and disliking the CS.

**Eye-tracker**

A Tobii 1750 eye-tracker with a Tobii fixation filter was used, in which the smallest radius for a fixation was 10 pixels. A nine-point calibration setting was used in order to calibrate the eye-tracker for each participant. The dependent measure used was total observation length of each of the CSs. In cases where participants failed to look at either of the CSs on the screen during a presentation, data from that participant for that presentation were excluded.

**Questionnaires & Contingency awareness check**

The Evaluative conditioning questionnaire (ECQ), the Depression anxiety stress scales 21 (DASS$_{21}$), and the Disgust sensitivity scale-revised (DS-r) were administered. Details of these questionnaires can be found in Experiments 3 and 4. The ECQ that was used was the same version that was used in Experiment 3. In that fear conditioning and extinction experiment, two items on the ECQ (boring and creative) did not discriminate between the CS+ and the CS- and were therefore excluded from the ECQ in Experiments 4 and 5. However, these items were re-included in the present study in order to determine whether there would be a distinction between groups in their differentiation of the CS+ and the CS- on those items.

The procedure used to measure contingency awareness was the same as used previously. Participants were shown pictures of both faces and asked to indicate which face
was never followed by the US and which face was sometimes followed by the US. In the fear condition, the word “shock” was used in place of the term “US”. Similarly, in the disgust condition, the words “disgusting image” were used in place of the term “US”. Participants who correctly indicated the CS-US contingencies were classified as “aware”. Other participants were classified as “unaware”.

Procedure

Pre-experiment ratings

Participants were seated at the computer and were told that their first task was to rate the faces that would be used in the experiment. Participants were asked to rate both of the faces on two dimensions – fear and disgust. In this task, one of the faces appeared on the screen with the question “Please rate how fearful you are of this face from 0-100. 0 = Not at all fearful and 100 = Really fearful”. Once the participant made their response, the same face remained on the screen and the next question appeared – “Please rate how disgusting you find this face from 0-100. 0 = Really pleasant and 100 = Really disgusting”. Following this, the identical procedure was conducted with the other face. The order of the presentation of the faces was counterbalanced as was the order of the fear and disgust questions.

Conditioning and extinction

Immediately following the pre-experiment rating task, the experimenter entered the room and attached the skin conductance leads. The shock pads were also attached at this point for participants in the fear group. Participants in the fear group selected a shock intensity level using the same workup procedure described in the fear conditioning.

18 Participants were also asked to rate how much they liked/disliked the CS faces during the pre- and post-experiment phases, however for the purposes of brevity, these data will not be presented. Findings on this measure were consistent with the dislike ratings presented in the fear and disgust experiments reported in Chapter 2 and 3.
experiments in Chapter 2. The experimenter then explained the nature of the conditioning task and the operation of the dial that was used to make US expectancy and CS valence ratings. Participants were told that their like/dislike (i.e., valence) ratings could change or stay the same and they were encouraged to “just go with your gut feeling at the time”. Following this, the experimenter dimmed the lights and left the room. Instructions for the conditioning and extinction task then appeared on the screen. The instructions for the fear group stated that faces would appear on the computer screen and that some faces would be followed by a shock and others would not. Further, the instructions stated that the participants’ task was to work out which face was followed by the shock. The instructions for the disgust group were identical with the exception that the words “disgusting image” were used in place of “shock”.

During conditioning, one face (CS+) was paired with the US five times. The other face (CS-) was presented alone five times. CS+ trials consisted of a 6-second CS+ presentation, immediately followed by the US. The shock US was presented for half a second and the disgusting image US was presented for 6 seconds. CS- trials consisted of a 6-second CS-presentation. Trial order was pseudo-randomised. At the end of every trial, participants were asked to make two types of ratings. Specifically, they were asked to provide expectancy ratings of the US and like/dislike ratings of the CS.

During extinction, both CSs were presented seven times for 6 seconds each, in the absence of any US. Expectancy ratings of the US and online like/dislike ratings were obtained on every extinction trial. During both conditioning and extinction, the variable

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19 I previously conducted a very similar study to this one in which US expectancy ratings were obtained during the presentation of the CS. The results of that study (which are not reported in this thesis) were not significantly different to the results of the current study, suggesting that the time at which participants are asked to rate US expectancy does not have a meaningful influence on predictive or affective/evaluative learning.
inter-trial interval was between 30-40 seconds, including a 10-second period immediately prior to CS onset in which the baseline SCR was recorded.

**Visual avoidance task**

Immediately following the last extinction trial, the experimenter entered the room and told the participant that they were now going to do a task in which their pupil dilation would be measured. The pupil dilation cover story was used to minimise any demand characteristics that may be perceived to be associated with the task. The eye-tracker was then calibrated for each participant. During the calibration, which took 15-20 seconds, participants were asked to “follow the dot on the screen”. Immediately following calibration, participants were told, “In the next part of the experiment, please look at the screen. It doesn’t matter where you look, as long as you look at the screen”. Following this, the two faces used as CSs appeared on the screen side-by-side. The faces were shown simultaneously three times for 2 seconds per presentation. Each presentation was preceded by a blank screen for 1 second, followed by a central fixation cross for 1 second. Following this, the same instructions described immediately above appeared on the screen again. Then the CSs were again presented side-by-side but for 10 seconds. The side of the screen on which the images appeared was counterbalanced across participants.

**Post-experiment rating task**

In this stage, participants were asked to provide fear and disgust ratings of the CSs, in exactly the same manner as in the pre-experiment rating task.
Questionnaires & contingency awareness check

In the last phase of the experiment, participants were asked to complete the ECQ, the DS-r, the DASS21, and the contingency awareness check. The ECQ was always administered first, with CS order counterbalanced across participants. The order of the DS-r and the DASS21 was counterbalanced across participants. The contingency awareness check was always administered last.

Data analysis

Skin conductance responses were calculated for each trial as the difference between the mean skin conductance level during the last 2 seconds of the 6-second CS presentation and the mean skin conductance level during the 10-second baseline period immediately prior to CS onset. To normalise distributions, the data were log-transformed before differences were computed.

Results

US expectancy

Mean US expectancies during conditioning and extinction are presented in Figure 4.1. During conditioning, participants had a higher expectation of the US following the CS+ than the CS- \( F(1, 34) = 138.55, \ p < 0.001 \). There were no differences between groups \( F(1, 34) = 1.93, \ p = 0.17 \) and no CS-by-group interaction \( F < 1 \). There was a significant main effect of trial \( F(4, 136) = 3.99, \ \rho_{GG} = 0.021 \) but no trial-by-group interaction \( F < 1 \), indicating that there was no difference between groups in their learning about the CSs across trials during conditioning. There was a significant trial-by-CS interaction \( F(4, 136) = 50.35, \ \rho_{GG} < 0.001 \), reflecting an increase in US expectancy following the CS+ and a decrease in US expectancy following the CS- across conditioning trials.
During extinction, participants had a higher expectation of the US following the CS+ than the CS- \( [F_{(1, 49)} = 93.14, p < 0.001] \). There were no differences between groups \( [F < 1] \) and no CS-by-group interaction \( [F < 1] \). There was a significant main effect of trial \( [F_{(6, 294)} = 39.44, p_{GG} < 0.001] \) but no trial-by-group interaction \( [F_{(6, 294)} = 2.04, p = 0.106] \), indicating that there was no difference between groups in their learning about the CSs across trials during extinction. There was a significant trial-by-CS interaction \( [F_{(6, 294)} = 14.94, p_{GG} < 0.001] \), reflecting a decrease in US expectancy following the CS+ and fairly constant US expectancy ratings following the CS- across extinction trials.

![Figure 4.1. Mean US expectancy ratings of the CSs across conditioning and extinction for the fear and disgust conditioning groups (Experiment 6).](image)

**Extinguishers vs. non-extinguishers**

In the previous disgust extinction experiments, a large percentage of participants (approximately half in Experiment 4 and between 42-80% in Experiment 5) failed to show significant extinction on the US expectancy measure. Based on this, I sought to determine whether there would be a difference between the fear and disgust groups in the number of “extinguishers” and “non-extinguishers”. Extinguishers and non-extinguishers were defined in the same way as in Experiments 4 and 5. One participant in the disgust group was difficult
to classify due to erratic and missing data and was therefore excluded from this analysis. Of the 31 participants in the fear group, eight (25.8%) were classified as non-extinguishers. Of the 29 eligible participants in the disgust group, six (20.7%) were classified as non-extinguishers (group difference not significant).

Non-extinguishers in the disgust group had significantly higher mean levels of disgust sensitivity on the DS-r than extinguishers [Mean difference = 0.5420; $t_{(27)} = 3.60, p_{UV} = 0.001$]. In contrast, in the fear group, there was no difference between extinguishers’ and non-extinguishers’ levels of disgust sensitivity measured by the DS-r [Mean difference = 0.16; $t_{(29)} = 0.70, p = 0.49$]. There were no significant differences between extinguishers and non-extinguishers on the DASS21 in either group [largest $t_{(27)} = 0.52, p = 0.61$].

**Skin conductance responses**

Mean skin conductance responses during conditioning and extinction are presented in Figure 4.2. During conditioning, there was a main effect of CS type [$F_{(1, 59)} = 15.14, p_{GG} < 0.001$] but no CS-by-group interaction [$F_{(1, 59)} = 1.91, p = 0.17$]. There was no main effect of trial [$F_{(4, 236)} = 1.52, p_{GG} = 0.21$] and no trial-by-group interaction [$F_{(4, 236)} = 1.90, p = 0.11$]. There was, however, a CS-by-trial interaction [$F_{(4, 236)} = 2.67, p_{GG} = 0.049$], reflecting differential change of SCRs to the CSs over trials. There was no main effect of group [$F < 1$]. To provide further information regarding skin conductance responses during conditioning, each group was analysed individually. This analysis revealed that there was a main effect of CS type in the fear group [$F_{(1, 30)} = 19.19, p < 0.001$] but not in the disgust group [$F_{(1, 29)} = 2.43, p = 0.13$]. That is, during conditioning, participants exhibited greater SCRs to the CS+ than to the CS- in the fear group only.

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20 Note that the scale ranges from 0-4.
During extinction, there was no main effect of CS type \([F(1, 52) = 3.28, p = 0.076]\) and no CS-by-group interaction \([F < 1]\). There was no main effect of trial \([F(6, 312) = 1.54, p_{GG} = 0.18]\), nor a trial-by-group interaction \([F(6, 312) = 1.29, p = 0.26]\), nor a CS-by-trial interaction \([F < 1]\). There were no differences between groups \([F < 1]\). However, because extinction in the fear group appears to be very rapid (see Figure 4.2), a post-hoc test on the first extinction trial was conducted in each group. On the first extinction trial, participants in the fear group exhibited greater SCRs to the CS+ than to the CS- \([t(30) = 2.05, p = 0.049]\). In contrast, participants in the disgust group did not display differences in SCRs to the CSs on the first extinction trial \([t(29) = 0.02, p = 0.99]\).

![Figure 4.2. Mean skin conductance responses across conditioning and extinction for the fear and disgust groups (Experiment 6).](image)

**Online CS valence**

Mean CS valence ratings during conditioning and extinction are presented in Figure 4.3. During conditioning, the CS+ was significantly more disliked than the CS- \([F(1, 43) = 33.15, p < 0.001]\). However, there was a significant CS-by-group interaction \([F(1, 43) = 4.58, p = 0.038]\), reflecting greater discrimination between the CS+ and the CS- amongst participants.
in the fear group than participants in the disgust group. There was no main effect of trial \( F < 1 \) but there was a CS-by-trial interaction \( F_{(4, 172)} = 23.74, \rho_{GG} < 0.001 \), as participants increased their ratings of the CS+ (reflecting greater dislike) and decreased their ratings of the CS- (reflecting greater liking) across trials. There was no trial-by-group interaction \( F_{(4, 172)} = 1.77, p = 0.14 \) and no main effect of group \( F < 1 \).

During extinction, the CS+ was significantly more disliked than the CS- \( F_{(1, 46)} = 34.81, p < 0.001 \). There was no main effect of group \( F_{(1, 46)} = 2.92, p = 0.09 \) and no CS-by-group interaction \( F_{(1, 46)} = 1.26, p = 0.27 \). There was a main effect of trial \( F_{(6, 276)} = 8.15, \rho_{GG} < 0.001 \) and a significant trial-by-CS interaction \( F_{(6, 276)} = 11.45, \rho_{GG} < 0.001 \), reflecting a decline in the ratings of the CS+ across extinction trials while ratings of the CS- remained fairly constant. There was also a significant trial-by-group interaction \( F_{(6, 276)} = 2.49, p = 0.02 \), reflecting a greater rate of decline in CS+ valence ratings in the fear group than in the disgust group.

Figure 4.3. Mean online valence ratings of the CSs across conditioning and extinction for both groups (Experiment 6). N.B. Higher ratings indicate greater dislike.
Pre- and post-experiment fear and disgust ratings

Pre- and post-experiment fear and disgust ratings of the CSs are presented in Figure 4.4. Significant changes from pre- to post-experiment are indicated by a solid red line and differences that were not statistically significant are indicated by a broken black line. Due to a computer error, pre-experiment ratings were not saved for one participant. Therefore, that participant was excluded from these analyses.

Fear ratings: In both groups, the CS+ was significantly more feared than the CS- at the end of the experiment [fear group: $t_{(30)} = 4.54, p < 0.001$; disgust group: $t_{(29)} = 3.58, p = 0.001$]. However, only participants in the fear group reported greater fear of the CS+ at the end of the experiment relative to before conditioning [fear group: $t_{(30)} = -2.77, p = 0.01$; disgust group: $t_{(29)} = -0.79, p = 0.44$]. Both groups reported less fear of the CS- at the end of the experiment relative to before conditioning [fear group: $t_{(29)} = 2.93, p = 0.007$; disgust group: $t_{(28)} = 2.35, p = 0.026$]. Therefore, the post-experiment difference in fear ratings of the CS+ and the CS- appear to be driven by an increase in fear to the CS+ and a decrease in fear to the CS- in the fear group but only a decrease in fear to the CS- in the disgust group.

Disgust ratings: In both groups, the CS+ was deemed to be significantly more disgusting than the CS- at the end of the experiment [disgust group: $t_{(29)} = 3.16, p = 0.004$; fear group: $t_{(29)} = 4.07, p < 0.001$]. Participants in the disgust group reported that the CS+ was more disgusting and the CS- was less disgusting at the end of the experiment compared to before conditioning [CS+: $t_{(29)} = -2.45, p = 0.021$; CS-: $t_{(29)} = 2.35, p = 0.026$]. In contrast, participants in the fear group reported that the CS+ was more disgusting at the end of the experiment compared to before conditioning but did not report significantly different disgust ratings of the CS- from pre- to post-experiment [CS+: $t_{(28)} = -3.35, p = 0.002$; CS-: $t_{(28)} = 1.77, p = 0.09$]. Therefore, the post-experiment difference in disgust ratings of the CS+ and
the CS- appear to be driven by an increase in disgust of the CS+ and a decrease in disgust of the CS- in the disgust group but only an increase in disgust of the CS+ in the fear group.

Figure 4.4. Pre- and post-experiment fear and disgust ratings of the CSs (Experiment 6). N.B. Solid red lines indicate a statistically significant difference from pre- to post-experiment. Dotted lines indicate that the difference from pre- to post-experiment was not significant.

**ECQ**

Mean ECQ ratings are presented in Figure 4.5. The CS+ was rated significantly less favourably than the CS- \[F_{(1, 57)} = 62.15, p < 0.001\]. There was a main effect of group \[F_{(1, 57)} = 4.93, p = 0.03\], reflecting overall higher (i.e., more favourable) ratings of the CSs in the disgust group. Nevertheless, both groups rated the CS+ as significantly less favourable than the CS- \[Fear: t_{(28)} = 5.50, p < 0.001; Disgust: t_{(29)} = 5.78, p < 0.001\]. There was no significant interaction between CS and group \[F_{(1, 57)} = 1.15, p = 0.29\].

In a previous fear conditioning experiment (Experiment 3), although participants rated the CS+ more negatively than the CS- on all other items on the ECQ, the CS+ and the CS- were not discriminated by two items (boring and creative). That is, participants did not report that the CS+ was more boring or less creative than the CS-. In this experiment, two
items did not differentiate the CS+ and the CS- in the fear group (creative and attractive) and one item did not differentiate the CSs in the disgust group (boring).

![Graph showing mean ratings on the ECQ for both groups (Experiment 6).](image)

Figure 4.5. Mean ratings on the ECQ for both groups (Experiment 6). N.B. Lower ratings indicate a less favourable impression of the CS.

**Visual avoidance task**

Looking times at each of the CSs during the three initial 2-second presentations were summed and will be referred to as the “short presentation”. The 10-second presentation of the CSs will be referred to as the “long presentation”. Mean looking times at the CSs during the short and long presentations are presented in Figure 4.6. During the short presentation, there was no main effect of CS type \( F_{1, 52} = 1.13, p = 0.29 \) or group \( F_{1, 52} = 3.33, p = 0.07 \). However, there was a marginally significant CS-by-group interaction \( F_{1, 52} = 3.57, p = 0.064 \). Therefore, simple effects analyses were undertaken. These showed that participants in the disgust group spent significantly less time looking at the CS+ than the CS- during the short presentation \( t_{25} = -2.59, p = 0.016 \). In contrast, there was no difference in looking time at the CSs amongst participants in the fear group \( t_{27} = 0.51, p = 0.61 \). During the long
presentation, there was no difference in looking time at the CSs, no effect of group, and no significant interaction [all $F$s < 1].

![Graph A: Short presentation](image)

![Graph B: Long presentation](image)

Figure 4.6. Mean looking time at the CSs during the (A) short and (B) long presentations of the visual avoidance task (Experiment 6).

**The relationship between individual differences (DS-r and DASS$21$) and visual avoidance**

In the disgust group, higher scores on the animal reminder subscale of the disgust scale were associated with greater avoidance on the short presentation [$r_{(24)} = 0.53, p = 0.006$] and the long presentation [$r_{(28)} = 0.37, p = 0.045$] of the visual avoidance task. Mean total DS-r scores were also correlated with avoidance on the short presentation in the
disgust group \(r_{(24)} = 0.43, p = 0.03\). However, the correlation between mean total DS-r scores and avoidance on the long presentation failed to reach statistical significance \(r_{(28)} = 0.23, p = 0.23\). In the fear group, there were no significant correlations between avoidance (on both the short and long presentations) and scores on the DS-r (both the animal reminder subscale and the overall mean) \(r_{(28)} = 0.23, p = 0.23\). There were no significant correlations between avoidance and scores on DASS\(_{21}\) in either group \(r_{(26)} = 0.28, p = 0.15\).

**Discussion**

This experiment was designed to directly compare the acquisition and extinction of fear and disgust responses. During acquisition, both groups learned that the CS+ predicted the US and that the CS- did not. During extinction, participants in both groups reduced their expectancy of the US following the CS+. There were no differences between groups in terms of their cognitive expectancy during conditioning and extinction. This is somewhat surprising given that partial resistance to extinction was observed on this measure in earlier disgust extinction experiments. That is, in previous experiments, between 42-80% of the participants who underwent extinction following disgust conditioning did not significantly reduce their expectancy of the US following the CS+. In this experiment, however, only about 21% of participants in the disgust group were classified as non-extinguishers, which was comparable to the number in the fear conditioning group (26%). A possible reason for the discrepancy between findings from the disgust group in the current experiment and my previous findings related to disgust extinction may be due to the less aversive nature of the disgust conditioning preparation in the current experiment relative to previous experiments (discussed in greater detail below).
During conditioning, participants in the fear group exhibited increased skin conductance to the CS+ relative to the CS-. However, this differential skin conductance was not of the same magnitude as was exhibited in previous fear experiments. In addition, there was greater variance in the data relative to earlier experiments. It is possible that these differences are due to the shorter CS duration in the current experiment (6 seconds) relative to earlier fear conditioning protocols (13 seconds). After the first extinction trial, participants in the fear group did not exhibit differential skin conductance responses. This is evidence of the rapid extinction of fear reactions. During disgust conditioning and extinction, differential responding to the CSs was not observed on this measure. Therefore, it appears as though skin conductance responses may not be a useful measure to assess disgust. It is quite likely that this is due to the fact that skin conductance responses reflect sympathetic ANS arousal and as suggested above, it may be that disgust does not elicit sympathetic ANS activation. It is possible that the differential skin conductance responses observed during conditioning in Olatunji et al.’s (2007a) study of learned disgust were due to the fear component of the stimuli (mutilated bodies) used as USs.

In the present experiment, both fear and disgust conditioning resulted in evaluative changes towards the CSs. Specifically, during conditioning, the CS+ was more disliked than the CS-. This was also the case during extinction, despite some reduction in dislike of the CS+. After extinction, participants in both groups reported that they had a less favourable impression of the CS+ than the CS-, as measured by the ECQ. These findings provide additional support for the idea that evaluative responses are not abolished by extinction.

The post-experiment ratings revealed that the CS+ was more feared and deemed to be more disgusting than the CS- in both groups. As was evident in Experiment 5, it is important to consider that differential conditioning procedures not only influence the
valence of the CS+ as it becomes a predictor of an aversive outcome, but they also influence the valence of the CS- as it becomes a safety signal. In this experiment, fear conditioning resulted in increased fear and disgust of the CS+ and decreased fear of the CS-. In contrast, disgust conditioning resulted in increased disgust towards the CS+ and decreased disgust and fear of the CS-. Because there was not a conditioning-only control group (i.e., a group that did not undergo extinction), it is difficult to know whether any changes in valence of the CSs were altered as a result of extinction. Nevertheless, the overriding conclusion is that both aversive conditioning preparations resulted in differential feelings of fear and disgust towards the CSs and this was not abolished by extinction.

One might ask, however, why fear conditioning would affect feelings of disgust towards the CSs and conversely, why disgust conditioning would influence feelings of fear? Although one approach views emotion as a system of discrete categories, focusing on individual emotional states such as fear, sadness, anger, and happiness, there is another approach to the classification of emotion which postulates that emotion is generated from just two motivational systems – the appetitive and aversive systems – which are responsible for producing positive (or pleasant) and negative (or unpleasant) emotional experiences (Cacioppo & Gardner, 1999). From the latter perspective, both fear and disgust would be viewed as stemming from the aversive system. As such, one could view both fear and disgust conditioning simply as conditioning that activates the aversive system and as therefore capable of influencing not just the discrete emotion but also other aversive affective states. Furthermore, as discussed by Woody and Teachman (2000, p. 291), although emotions are often examined individually, “in natural life emotions coexist and blend”. They also note that many cognitive appraisals of threat may evoke both disgust and fear. Moreover, it has been suggested that not only do aversive emotions often occur simultaneously but that the experience of an aversive affective response is likely to be
augmented if it occurs in the context of another ongoing aversive emotion (Lang et al., 1990). Finally, it has also been suggested that research participants and lay people in general may be confused about the labelling of emotional states (Woody & Teachman, 2000). From these perspectives, it is easier to see how fear conditioning might lead to changes in (or reports of) feelings of disgust and how disgust conditioning might lead to changes in (or reports of) feelings of fear.

Consistent with research reported in Chapter 3, following disgust conditioning and extinction, participants avoided looking at the CS+ face. It should be noted, however, that this effect was only observed during the short, but not the long, presentation of the visual avoidance task. It is possible that this is due to the “weaker” or less aversive nature of the disgust conditioning preparation in the current experiment relative to previous experiments. Specifically, there were fewer conditioning trials in this experiment relative to the disgust experiments in Chapter 3; and only one disgusting image was used as a US in this experiment, whereas two disgusting images were used in the previous experiments. Although it seems likely that these parametric differences can account for the finding that participants in the disgust group did not avoid looking at CS+ during the long presentation of the CSs in the visual avoidance task in this experiment, there is one difference between the visual avoidance task used in the current experiment and earlier experiments which may have also influenced the results. Specifically, in previous experiments, in addition to the CSs, the disgusting image US (along with the neutral image) was also presented during the visual avoidance task. The short presentation of the US images occurred prior to the long presentation of the CSs in those experiments. In the current experiment, in an effort to maintain consistency between the procedures of the fear and disgust groups, the disgusting US was not presented in the visual avoidance task because the fear group would not have seen that image previously. Therefore, it is possible that the avoidance observed during the
Replicating my previous findings, it was found that increased disgust sensitivity (primarily on the animal reminder subscale) was associated with increased avoidance of the CS+ in the disgust group.
Participants in the fear group looked at the CSs for equal lengths of time during both the short and long presentations of the visual avoidance task. That is, no avoidance or hypervigilance of the CS+ was observed. The findings from the fear group in the current experiment are inconsistent with the results reported in Experiment 2 but are consistent with those reported in Experiment 3. Therefore, it seems as though the avoidance response following fear conditioning and extinction is somewhat “fragile” and not reliably obtained. It was suggested earlier that individual differences in anxiety may mediate responding on this task. Although there was no evidence of a relationship between avoidance (or hypervigilance) and anxiety levels as measured by the DASS21 in the current experiment, it may be that future studies will be able to determine individual difference factors which influence responding on this task. At this stage, however, the lack of differential looking time in the fear group in this experiment is in contrast to findings in the disgust group and suggests that there may be differences in responding to the CSs as a result of the type of emotion elicited by the aversive US. One additional distinction between the USs used for each group is their sensory modality. Specifically, the disgusting US was visual and the fear US was tactile. It is possible that the pairing of a CS with an aversive visual US lends itself to a visual avoidance response towards the CS more readily than the pairing of a CS with an aversive tactile US. It would be useful to use a scary picture as the US for the fear conditioning procedure or a disgusting US that is not visual (e.g., an offensive smell) in order to draw clearer conclusions regarding the impact of the sensory modality of the US on performance on the visual avoidance task.

Conclusions

The major aim of this experiment was to directly compare the extinction of learned fear and disgust. The same protocol was used for both groups in order to minimise the possibility that differences between the two groups were due to parametric variations. Both
groups learned about the stimulus contingencies to the same extent and both preparations resulted in differential affective responses to the CSs. Despite some decline in ratings, both groups reported more dislike of the CS+ than the CS- during extinction. Participants in both groups also reported a less favourable impression of the CS+ than the CS- at the end of the experiment, suggesting that acquired negative valence as a result of aversive conditioning is resistant to extinction, regardless of the nature of the aversive US. The key differences between the fear and disgust groups appeared in the two measures that were not self-report (skin conductance and visual avoidance). Specifically, participants in the fear group exhibited greater sympathetic arousal to the CS+ than to the CS- during conditioning, as measured by skin conductance levels. This response was quickly abolished during extinction. In contrast, the disgust group did not demonstrate differential skin conductance responses during conditioning or extinction, suggesting that sympathetic ANS arousal is less (if at all) involved in disgust. Participants in the disgust group avoided looking at the CS+ in the visual avoidance task whereas participants in the fear group did not demonstrate differential looking at the CSs. One of the chief reasons for directly comparing the extinction of fear and disgust responses was to provide further evidence that disgust responses are more resistant to extinction than fear responses. In support of this, skin conductance responses in the fear group quickly attenuated during extinction, suggesting rapid extinction of fear responses. In contrast, individuals in the disgust group avoided looking at the CS+ following extinction, suggesting sustained disgust responses. Whilst these results are consistent with the notion that disgust does not extinguish as rapidly as fear, and add further weight to the argument given that the same conditioning and extinction procedures were used for both groups, it is not entirely reasonable to directly compare these findings from the two groups. This is because evidence for the attenuation of fear responses came from a different measure (skin conductance) to that which evidenced sustained disgust responses (the visual avoidance task). In the future, greater credibility to the argument would come from evidence of
extinguished fear responses and maintained disgust responses on the same measure, as discussed further in the General Discussion. There was also some evidence from the current experiment that could be inconsistent with the idea that disgust responses are more resistant to extinction than fear responses. Specifically, participants in the fear group reported fear of the CS+ following extinction. Without a no-extinction control group, however, it is difficult to know whether or not this reported degree of fear would be at the same level as ratings by participants who did not undergo extinction. It should be noted that although the procedures for both groups were identical, it is difficult to equate the degree of “aversiveness” of the USs. In future experiments, it may be beneficial to use a within-subjects design in which one CS is paired with a fear-eliciting US and another CS is paired with a disgust-eliciting US. In such a paradigm, one could ask the participants to rate the USs in order to evaluate their subjective aversiveness. In addition, such a paradigm would allow the direct comparison of responses to the two CSs (one a fear predictor and one a disgust predictor) on a visual avoidance task.
Chapter 5:

General Discussion

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Despite great success in understanding certain emotions such as fear, there are other aversive affective states that have been largely neglected by clinical and experimental psychology. In particular, it is becoming increasingly clear that disgust may play a more important role than fear in certain anxiety disorders. Moreover, residual dislike of previously feared objects and situations may contribute to relapse. The research in this thesis is a step towards characterising the residual disgust and dislike that may be present after exposure therapy. It provides further evidence that these affective states do persist despite extinction, and demonstrates certain behavioural sequelae that arise as a result of these residual negative feelings, most notably avoidance, a key precipitating factor in relapse. The next steps are to detail the nature of these states in clinical populations and to develop and evaluate treatment strategies to target maladaptive disgust and dislike.

**Summary of main findings**

The fear conditioning studies in this thesis corroborated earlier studies which demonstrated that like and dislike evaluative responses do not decline to the same extent as cognitive expectancy of threat or physiological fear responses. The present research provided particularly clear evidence in support of that proposal, given that the residual evaluative conditioning (EC) effects were demonstrated at the same time at which other responses (i.e., cognitive expectancy and skin conductance responses) were shown to extinguish. Moreover, the use of two behavioural measures, the visual avoidance task and the behavioural forced choice (chocolate) task, lends further credence to the suggestion that evaluative responses are not affected by extinction in the same way as fear or expectancy of threat.
In line with the one other study (Olatunji et al., 2007a) that has examined the extinction of learned disgust\textsuperscript{21}, disgust responses were shown to be resistant to extinction in the present series of experiments. The current work extends previous work in several ways. Specifically, the stimuli used in these studies appear to elicit a more “pure” form of disgust than images of mutilation, which were used in Olatunji et al. (2007a). For this reason, the present results reflect participants’ feelings of disgust without being confounded by feelings of fear. In addition, the current studies provide evidence of resistance to extinction obtained from an objective behavioural measure. Although Olatunji et al. (2007a) attempted to study disgust using an objective, physiological measure (i.e., SCRs), their data on that measure were difficult to interpret. Moreover, the current studies add to previous work by demonstrating that greater disgust sensitivity is associated with greater resistance to extinction, a finding with considerable clinical implications. Finally, the current work further broadens our understanding of the loss of disgust and dislike responses by examining the persistence of these learned evaluative responses over time. Six months following the original disgust conditioning episode, participants returned to the laboratory. Approximately half of the participants could recall which face previously served as the CS+ and which one served as the CS-. Unexpectedly, however, although the negative valence of the CS+ did not appear to be preserved over that time interval, the CS- retained a positive valence amongst participants who could recall the CS-US contingencies (“rememberers”). This is surprising because of the well-documented finding of a “positive-negative asymmetry” which suggests that negative events have a greater influence on one’s affect than positive events of equivalent intensity (see Peeters & Czapinski, 1990; Rozin, 1986). This bias is generally thought to exist because it is more costly to disregard a negative event than a positive one in terms of survival. That is, the consequences of an injurious or fatal assault are greater

\textsuperscript{21} In addition to Olatunji et al. (2007a), Rozin et al. (Experiment 6; 1998) attempted to examine the extinction of disgust EC. However, as they were unable to clearly establish disgust conditioning in that experiment, they could not draw conclusions regarding the extinction of disgust.
than those of a missed opportunity (Cacioppo & Gardner, 1999). Related to this, it has been suggested that when individuals make evaluations, negatively valenced information is given more weight than positively valenced information (Kanouse & Hanson, 1987). From this perspective, one would expect that if any evaluative information were to be retained over time, it would be negative evaluations of the CS+ rather than positive evaluations of the CS-.

Therefore, it is difficult to explain my apparently anomalous finding and it would be interesting to determine whether these effects could be replicated in the future and whether they would be observed in a clinical population. Perhaps one explanation of this finding relates to the fact that, because a large proportion of rememberers underwent extinction previously, the CS- was a more reliable predictor of the absence of the US than the CS+ was for the presence of the US. That is, the ambiguity of the CS+ as a predictor of the US may have weakened the valence associated with that CS over time. If participants who could recall the stimulus contingencies had only undergone conditioning, without extinction, they may have retained greater negative affect to the CS+. Nevertheless, from a clinical perspective, it is encouraging that the negative valence of a stimulus may be reduced over time following exposure therapy, even if it is not immediately reduced.

In the last experiment in this thesis, I attempted to directly compare the extinction of disgust and fear responses. This was an important experiment in order to further strengthen the case that the way in which disgust responds to extinction is different to the way in which fear responds. As hypothesised, there were elements of conditioning and extinction that were similar between the two groups. In particular, during conditioning, participants in both groups learned that the CS+ predicted the aversive US at comparable rates. Similarly, during extinction, both groups reduced their expectation of the US following the CS+ to a similar extent. Furthermore, both conditioning preparations resulted in a dislike of the CS+ that was not abolished by extinction. There were also several aspects of conditioning and extinction,
however, that were different between the groups. In particular, fear conditioning resulted in physiological arousal to the CS+, which was quickly eliminated after only one extinction trial. In contrast, disgust conditioning did not lead to physiological arousal to the CS+, at least as measured in this experiment. As noted, this is likely because disgust does not activate sympathetic arousal, which is indexed by measures of skin conductance. Nevertheless, the findings from the skin conductance measure indicate that fear responses are readily extinguished, in keeping with observations made by other researchers such as “Standard extinction procedures are efficient in reducing specific fear” (Fonteyne, Vervliet, Hermans, Baeyens, & Vansteenwegen, 2009, p. 830) and “In the standard Pavlovian conditioning preparation, a few unreinforced presentations of the CS are generally sufficient to cause abolishment or at least a strong diminution of the conditioned response” (Baeyens et al., 1988, p. 191); see also Dawson and Schell (1985). In contrast, evidence from the visual avoidance task indicates that disgust responses were preserved following extinction. Participants in the fear group did not demonstrate differential looking on this task. Based on the rapid extinction of fear observed on the skin conductance measure and the preserved disgust responses observed on the visual avoidance task, Experiment 6 appears to support the notion that disgust responses are less affected by extinction than fear responses. Together, the experiments in this thesis show that certain affective states, in particular disgust and dislike, are not influenced by extinction in the same way as fear.

It should be noted, however, that across experiments, it is possible that if more extinction trials were administered, evaluative responses may have diminished further or may have even been eradicated. However, it is clear that evaluative responses are not mediated by cognitive expectancy of the US. This suggests that even if more trials were administered, and therefore the perception that the CS+ was not going to be followed by the US was even more apparent to participants, it would not necessarily affect evaluative
responding. Specifically, evidence that evaluative responses are unrelated to US expectancy comes from the fact that participants who underwent extinction had a significantly lower expectation of the US than non-extinguished participants and yet both groups of participants demonstrated equivalent levels of dislike and disgust to the CS+. Even stronger evidence for the proposal that disgust responses are unrelated to cognitive expectancy can be drawn from the findings of Experiment 4. In that experiment, avoidant disgust responses were shown to be unrelated to expectancy of the US in the extinction group. That is, even participants who were extinguished and expressed very clear knowledge that the US was not going to follow the CS+ still showed an equivalent level of avoidance of the CS+ as extinguished individuals who continued to expect the US to occur (see Figure 3.3, in Chapter 3). This suggests that the extinction of evaluative responses does not follow the extinction of expectancy in a direct manner and is consistent with Baeyens and colleagues’ finding that different levels of contingency between the CS and the US did not correlate with the degree of learned evaluative shifts observed (Baeyens et al., 1993). Based on these lines of evidence, it is clear that disgust and dislike responses are driven by processes other than cognitive expectancy of the aversive outcome (US). This is in contrast to what is observed with fear responses, which appear to be closely related to cognitive expectancy in the laboratory and in clinical settings, where fear is strongly tied to an overestimation of the likelihood of the occurrence of threat. Although the mechanism by which disgust and dislike responses are reduced is not related to cognitive expectancy of the aversive outcome, these responses may be reduced in response to exposure via a different, currently unknown mechanism, which may be engaged after further extinction/exposure trials.

Indeed, as mentioned earlier, Lipp and Purkis (2006) did show that online ratings of stimulus valence returned to neutral after many extinction trials. However, it is crucial to note that the change in valence ratings occurred at a slower rate than the change in
expectancy ratings. It is possible that the evaluative responses in that study weren’t conditioned to the same extent as in traditional EC paradigms due to the nature of the CSs used. Specifically, geometric shapes were used as CSs in Lipp and Purkis’ experiment and it may be that the evaluative responses that develop to such abstract stimuli require less elaborate encoding and are therefore less stable (and therefore more susceptible to extinction) than acquired evaluative responses to more complex stimuli. In support of this, it has been proposed that face stimuli may promote more sophisticated sensory encoding than other, more simple stimuli and that this disparity in stimulus complexity may account for the differences observed between certain EC experiments which have used different types of stimuli (reviewed in De Houwer et al., 2001). However, even if one were to concede that evaluative responses do extinguish, regardless of the nature of the stimuli used, but do so at a slower rate than expectancy ratings and fear responses, this is still highly clinically relevant. This is because it is unlikely that treatment would continue for an anxious patient once expectancy of the threat and fear responses were significantly diminished. In such a case, the residual dislike and/or disgust would likely remain following treatment and this might precipitate relapse in the future.

Limitations

A few limitations of the current research should be mentioned. Firstly, the majority of participants in these studies were female, which reflects the gender ratio of students in first-year psychology at the University of New South Wales, and indeed the gender ratio of psychology undergraduate students in both Western and developing countries (Nair, Ardila, & Stevens, 2007). This potentially limits the generalisation of the results to males and to the wider community at large. However, there is reason to believe that the findings from the current sample may be representative of males because preliminary examination of gender
effects in the current data did not reveal any significant differences between males and females (data not shown). In addition, the use of a predominately female sample may actually be more appropriate in the context of research related to anxiety given that there are more females than males with anxiety disorders (Craske, 2003).

Another possible limitation relates to the timing of the conditioning and extinction sessions. In the current set of experiments, the extinction sessions were conducted immediately after conditioning. Although this is the standard protocol in almost all conditioning studies with humans (e.g., LaBar & Phelps, 2005; Lovibond et al., 2000) and some conducted in animals (e.g., Anglada-Figueroa & Quirk, 2005), it may be better to perform the conditioning and extinction sessions on separate days. This is because there is some evidence, though not shown in all studies, to suggest that immediate extinction may lead to erasure of the conditioning memory, whereas delayed extinction does not have this effect, or leads to significantly less erasure (Myers et al., 2006; but see, Kim & Richardson, 2009 and Schiller et al., 2008 for failures to replicate). Conducting sessions on separate days may be a more ecologically valid model of exposure than successive conditioning and extinction because extinction learning in the real world is unlikely to occur immediately after a conditioning episode. Related to this, it also may have been useful to conduct a test session the day after extinction training in order to examine retention of the extinction memory rather than simply the effects of within-session extinction. Nevertheless, consecutive training, extinction, and testing sessions on the same day is likely to only be a major problem if one wishes to examine the effects of pharmacological manipulations on conditioning or extinction. In that case, it would be necessary to conduct the sessions with delays between them so that the effect of the drug would not influence performance in the other phases. This, clearly, was not a concern in the current work.
A further limitation of the present studies relates to the inconsistency of the findings of avoidance following fear conditioning and extinction. Although evidence for avoidance following disgust conditioning and extinction was strong (shown in Experiments 4, 5, and the short presentation of Experiment 6), evidence of avoidance following fear conditioning and extinction was less conclusive. Specifically, avoidance of the CS+ was observed following fear conditioning in Experiments 1 and 2 but not in Experiment 3. In terms of avoidance following fear extinction, there was evidence of this from Experiment 2 but not from Experiments 3 and 6. In the instances when avoidance was not observed following fear extinction, it was also not observed following fear conditioning. This suggests that it is not necessarily the case that the avoidance response was extinguished. Rather, it appears as though the avoidance effect is not robust following fear conditioning and extinction. The reasons for these inconsistencies across the fear experiments are unclear. Although participants reliably reported dislike of the CS+ following fear conditioning and extinction, it is possible that the level of dislike was not always sufficient to produce an avoidance response. Alternatively, individual differences may play a large role in determining avoidance on this task following fear conditioning and extinction. Future research may be able to identify characteristics that influence responding on this task.

Finally, as discussed throughout this thesis, because avoidance may be precipitated by fear, disgust, and dislike, it was not always clear what affective state was being measured by the visual avoidance task. In fear experiments where there is clear evidence that fear is attenuated as a result of extinction (as measured by skin conductance responses), it is likely that any avoidance of the CS+ by participants who have undergone extinction is driven by residual dislike of the CS+. It is more difficult, however, to distinguish between disgust and dislike in the disgust extinction experiments as participants in those experiments reported both dislike and disgust following extinction. Nevertheless, perhaps some inferences can be
drawn from the observation that avoidance following disgust extinction was far more reliable than avoidance following fear extinction, yet there appeared to be equivalent levels of reported dislike of the CS+ following fear and disgust extinction. If avoidance of the CS+ was driven by dislike more than disgust, then one would predict similar observations of avoidance following both fear and disgust extinction. Because avoidance was observed more frequently following disgust extinction than fear extinction, this suggests that it was perhaps not driven by dislike and one could therefore argue that perhaps the avoidance in the disgust experiments was driven more by disgust than dislike. It could also be that there was a cumulative effect of dislike and disgust driving the avoidance in the disgust experiments. It is possible that the dislike that was present in the fear experiments was not sufficient to prompt a reliable avoidance response on its own. As discussed in detail below, it will be useful to employ additional measures that are more specific to disgust in the future. As suggested earlier, however, the documentation of residual negative valence following extinction is highly clinically relevant, regardless of the specific source (i.e., disgust or dislike). It may also be the case that distinguishing between these two affective states is not pertinent to the treatment of those states as interventions aimed at targeting disgust may be effective in targeting dislike and interventions aimed at targeting dislike may be effective in targeting disgust.
Clinical implications

The clinical implications of this research are substantial. These data suggest that evaluative responses, such as dislike and disgust, may not respond to exposure therapy as efficiently as fear. In the short-term therefore, a client whose primary maintaining emotion is disgust may not respond to treatment. Even clients who have only some degree of disgust driving their disorder are likely to encounter problems. Although it would be expected that their primary fear responses would be attenuated as a result of exposure, their residual feelings of disgust may lead to avoidance which may result in relapse later on. In the same way, enduring dislike of a previously feared stimulus or situation may also lead to relapse via a parallel mechanism.

The observation of sustained dislike of a previously feared CS is supported by clinical observations such as “after exposure therapy... spiders remain nasty little animals” (Baeyens, Eelen, Van den Bergh, & Crombez, 1989, p. 286). Similarly, the finding that disgust responses are resistant to extinction is consistent with studies conducted using clinical analogue samples (comprised of people who reported marked fear of spiders or blood-injection-injury stimuli, or OCD contamination concerns, but had not been diagnosed with the relevant disorder). For example, Smits et al. (2002) asked participants with a marked fear of spiders to rate their levels of fear and disgust during exposure to a tarantula. They found that both fear and disgust declined during exposure but that the decay slope observed for fear was significantly greater than that for disgust (see Figure 5.1A on page 192). Similarly, Olatunji et al. (2007b) examined disgust and fear ratings amongst individuals with a marked fear of blood-injection-injury (BII) stimuli during exposure to BII phobia-relevant stimuli (e.g., a hypodermic needle and syringe). They found that although both fear and disgust declined across exposure, disgust declined to a lesser extent than fear (see
Figure 5.1B on the following page). That research suggests that the rate at which disgust extinguishes lags behind the rate at which fear extinguishes amongst individuals with spider and BII phobia concerns. A parallel result was found amongst a clinical analogue OCD sample with contamination concerns (Olatunji et al., 2009b). The authors of that study found that participants reported significant declines in fear ratings from pre- to post-exposure but did not show significant declines in disgust ratings (see Figure 5.2 on the following page). In another study that examined the effect of exposure on the treatment of spider phobia in girls (de Jong, Andrea, & Muris, 1997), the authors reported that “there was a parallel decline of spider fear and the spiders' disgust-evoking status as a result of treatment” (p.559). However, that claim was based on the correlation between pre- to post-treatment difference scores of spider fear and pre- to post-treatment difference scores of disgust towards spiders. This indicates that individuals who experienced greater reductions of fear also experienced greater reductions of disgust and those who experienced lesser reductions of fear also experienced lesser reductions of disgust towards spiders. This does not indicate that the loss of disgust was as great as the loss of fear. Indeed, when one examines the t-scores on the pre- to post-treatment measures of fear and disgust of spiders in that study, it is clear that the difference was greater on the fear measure (t = 11.5) than on the disgust measure (t = 3.5). Thus, that study is consistent with the ones reported above in that while there was some degree of loss of disgust following treatment, this was not as great as the degree of loss of fear. Therefore, the picture that appears to be emerging is that disgust will generally decline to some extent in response to exposure but not to the same extent as fear. Because of this, individuals with prominent disgust responses may require more exposure sessions which may need to be longer in duration than sessions for other anxious patients. Indeed, this is already the recommendation for the treatment of individuals with OCD (Abramowitz, 1996; McKay, 2006).
Figure 5.1. Mean decline slopes for fear and disgust ratings across exposure. Adapted from (A) Smits et al. (2002; spider phobia); (B) Olatunji et al. (2007b; BII phobia). BAT = behavioural avoidance task.

Figure 5.2. Mean pre- and post-exposure fear and disgust ratings, reproduced from Olatunji et al. (2009b; OCD contamination concerns).

There may also be individual differences in the response of disgust reactions to exposure. For example, McKay (2006) examined the differences between the decline of anxiety and disgust amongst two groups of participants with OCD. One group primarily had contamination-based obsessions and the other group primarily reported obsessions related
to factors other than contamination (e.g., checking or symmetry obsessions). Participants were exposed to anxiety-evoking stimuli specific to their OCD symptoms as well as disgust-evoking stimuli that did not elicit anxiety. Participants in both groups showed an equivalent level of decline in anxiety to the anxiety-provoking stimuli. However, although both groups showed a decline in disgust ratings to the disgust-evoking stimuli, the contamination group showed less of a decline than the “other-symptom” OCD group. McKay (2006) concluded that disgust does not respond as quickly to intervention among individuals with contamination-based OCD as it does among individuals with other sub-types of OCD. More broadly, those results may suggest that individuals with excessive disgust responses may benefit less from disgust exposure than individuals with lower disgust sensitivity.

**Future directions: Research regarding how to reduce maladaptive evaluative responses**

There are numerous studies which could stem from the current research. In particular, it will be valuable to develop and determine the efficacy of strategies aimed at targeting disgust and dislike.

It is important to note that I am not making the case that all disgust and negative affectivity should be eradicated. Certainly, as with fear and sadness, all emotions serve a purpose. However, it is when these emotions are excessive, cause distress, and disrupt one’s occupational or social functioning, that they are considered maladaptive. As psychologists, we then have a role in assisting patients to reduce these negative emotions or to enhance their management of the distress and disruption to functioning caused by these pathological affective states. From a different perspective, it is also relevant to note that
although there may be an initial tendency to dismiss specific phobias (such as spider and BII phobia) as relatively innocuous, these phobias cause a great deal of distress and the avoidance associated with such disorders can greatly impact on one’s daily functioning. For example, individuals with spider phobia do not just avoid having a spider crawl on their arm but go to extreme lengths to avoid any contact with spiders such as refusing to go outside altogether (McNally, 2002). Clearly, such avoidance can have a major influence on a person’s quality of life. Correspondingly, in the case of individuals with BII phobia, they may avoid going for necessary medical tests which may lead to major medical problems. Similarly, an individual with BII phobia who develops diabetes may fail to comply with their insulin regimen, which may lead to serious consequences including death (Antony & Watling, 2006). Therefore, it is important that these discrete phobias are not dismissed and that research continues to investigate ways to improve treatments for these and related disorders.

**Counterconditioning**

One suggested strategy that might be useful in reducing evaluative responses is counterconditioning (e.g., Baeyens et al., 1989). Counterconditioning refers to the procedure in which following standard conditioning, the CS+ is then paired with a different US that has the opposite valence to the US with which it was originally paired. For example, a neutral face (CS+) may first be paired with a disgusting image (US1). After a number of pairings, the same CS+ may then be paired with a pleasant or appetising image (US2). Rather than extinguishing the old conditioned response by presenting the CS+ alone, the response is reduced by pairing the CS with a conflicting-valenced US. In support of the idea that counterconditioning may be more useful than extinction in reducing disgust responses and dislike, Baeyens and collegues (1989) showed that counterconditioning, but not extinction, was effective in altering learned evaluative responses. In that study, neutral pictures were
paired with other neutral, liked, or disliked pictures during acquisition. In the counterconditioning manipulation, one of the neutral pictures that had been previously paired with a liked picture was paired with a new disliked picture and one of the neutral pictures that had been previously paired with a disliked picture was paired with a new liked picture. In the extinction manipulation, one neutral picture that had been paired with a liked picture and one neutral picture that had been paired with a disliked picture were presented without reinforcement (i.e., without any picture following). The authors found that although extinction did not alter evaluative ratings, counterconditioning produced a shift in the acquired evaluative ratings of both the liked and disliked CSs. That is, as a result of counterconditioning, the previously liked CS became more disliked and the previously disliked CS became more liked. They therefore concluded that evaluative learning is amenable to change provided that the stimulus is subsequently presented with new information that contradicts the original learning.

In another study that examined the effects of counterconditioning on stimulus valence, Eifert, Craill, Carey, and O'Connor (1988) used exposure to treat six women with animal phobias. Music that the women liked was played every second session. The researchers observed greater improvement in the evaluations of the phobic animals on sessions in which music was played compared to sessions in which music was not played, suggesting that counterconditioning was effective in changing the evaluations of the phobic animals’ valence. In contrast, however, in a separate study that examined whether disgust may be amenable to change via counterconditioning (de Jong, Vorage, & van den Hout, 2000), counterconditioning did not confer any additional benefits over standard exposure treatment. In that study, individuals with spider phobia received one session of exposure with or without concurrent counterconditioning. Participants in the counterconditioning group ate their favourite foods and listened to their favourite music during the exposure
exercises. The counterconditioning exercises were only performed during the last 30 minutes of the 3-hour session so as to prevent counterconditioning in the opposite direction (i.e., to prevent the intense fear and disgust at the start of the session from causing the foods and music to be viewed less positively). In that study, both standard exposure and counterconditioning were effective in altering perceptions of disgust towards the spiders as well as in diminishing behavioural avoidance on the contaminated cookie task. The contaminated cookie task (Mulkens, de Jong, & Merckelbach, 1996) is a task in which participants are asked to rate how much they would like to eat a cookie before and after a spider has crawled on it. Participants are also then asked to eat the cookie. Although both groups showed progress on the outcome measures, the authors conceded that there was still room for improvement, particularly in relation to the valence and disgusting properties of spiders. Therefore, it is possible that if the counterconditioning treatment was more intensive, there may have been an additional benefit of counterconditioning over standard exposure.

**Habituation and US revaluation**

Studies which examine US habituation may be helpful in determining a way in which learned disgust and dislike responses may be attenuated. As noted in the Introduction, extinction is largely thought to involve new inhibitory learning in which a new memory, “CS-no US”, is created. However, another way to inhibit a learned response is via US habituation (or devaluation), a procedure in which the US (rather than the CS) is presented alone repeatedly following conditioning (Rescorla, 1973; Storsve, McNally, & Richardson, 2010). As the US becomes devalued, responding to the CS is also reduced, presumably because the aversiveness of the US which it signals has been attenuated. In clinical terms, this might be similar to reducing the “cost” or severity of the aversive outcome. For example, a person with social phobia may be afraid of giving a speech (CS) because they are concerned that
other people will judge them negatively or laugh at them (US). Part of treatment is aimed at reducing overestimation of the probability of threat; that is, reducing the inflated expectation that giving a speech will result in being negatively evaluated. This is achieved through exposure tasks that involve giving speeches, generally in the absence of signs of negative evaluation by others (akin to CS presentations in the absence of the US). However, another part of treatment is aimed at reducing overestimation of the cost of the negative outcome; that is, reducing the client’s perception of the severity of the outcome. This is typically achieved through exposure to the negative outcome (i.e., negative evaluation from others) by exposure tasks that are specifically designed to elicit negative evaluation (e.g., wearing unattractive, attention-seeking clothes or makeup in public). This latter type of exposure task is analogous to US habituation, as long as the negative outcome does occur in these tasks.

Hammerl, Bloch, and Silverthorne (1997) showed that US presentations following conditioning reduced the magnitude of the evaluative response to the CS. In that experiment, participants rated pictures of outdoor sculptures and fountains. Pictures rated as neutral served as the CSs and pictures rated as liked served as the USs. During conditioning, one CS was paired with one US five times, a second CS was paired with another US five times, and a third CS was paired with a neutral US. Following this, one of the liked USs was presented alone five times. On test, participants were asked to rate how much they liked the three CSs. The CS that had been paired with the neutral US was rated as neutral, the CS that had been paired with the non-habituated liked US was rated as liked, and the CS that had been paired with the habituated US was rated as neutral. That is, US exposure after conditioning led to shifts in participants’ ratings of the CS that had been paired with the habituated US.
Baeyens et al. (1992) also showed that US revaluation was effective in changing acquired evaluative responses towards the CS. In that experiment, neutral CS faces were paired with other positively or negatively valenced US faces. Following conditioning, the USs were presented with five negative or positive words to describe the personalities of the people whose faces served as the USs. Half of the USs were revalued by pairing negatively valenced faces with positively valenced words and pairing positively valenced faces with negatively valenced words. The other half of the USs were not revalued and were paired with congruent words (i.e., negative faces were paired with negative words and positive faces were paired with positive words). The USs that were paired with incongruently valenced words were subsequently revalued and rated as neutral. Evaluations of the USs that were paired with congruently valenced words did not change. Following revaluation, participants were asked to then rate the CSs again. Participants’ ratings of the CSs that had been paired with the USs that subsequently underwent revaluation shifted in line with the revaluation. That is, CSs that acquired a negative valence were subsequently rated less negatively if the US with which they had been previously paired was then paired with positive words. Similarly, CSs that had acquired a positive valence were rated less positively if the US with which they were associated was subsequently revalued.

These findings on the effects of US habituation and US revaluation on judgements of CS valence are particularly noteworthy given that CS alone presentations do not seem to be particularly effective in reducing evaluative responses to the CS. These findings suggest that a possible way in which individuals may be able to reduce their disgust reactions is via a habituation mechanism. That is, people may simply “get used to” the stimulus and their own disgust reaction following repeated exposure to the disgusting stimulus or situation. There are of course many real world examples of individuals who overcome disgust responses and are able to reduce them. For example, parents must contain their disgust
responses in order to change nappies/diapers; cleaners clean other people’s toilets; surgeons cut open bodies; and vegetarians who once found eating meat disgusting are able to again eat meat for health purposes. Unlike extinction, habituation does not suppose that new learning occurs (reviewed in Moscovitch et al., 2009). Although habituation has been discredited as a mechanism by which fear is reduced during exposure (Moscovitch et al., 2009), it remains to be seen whether the same holds true for disgust responses.

The influence of cognitions on disgust (and dislike)

One might expect that cognitive therapy could be effective in targeting maladaptive disgust responses as well as feelings of dislike. However, as articulated by Woody and Teachman (2000, p. 308), “A problem related to disgust for cognitive interventions is that people seem to cling to their negative hedonic evaluation of the stimulus even if all possibility of germ contamination is removed”. As Rozin and colleagues have shown, despite reassurances that a cockroach has been sterilised, people still don’t want it floating in their drink. In my research, even when participants did not expect the US to occur, they still exhibited disgust responses towards the CS+. Both of these examples illustrate a similar concept. That is, rational understanding that a stimulus is no longer associated with something disgusting or contaminating is unrelated to feelings of disgust towards that stimulus. Likewise, understanding that a stimulus no longer predicts a fearful or painful stimulus does not eliminate feelings of dislike towards the former stimulus. Therefore, it seems that attempts to alter cognitions are unlikely to alter disgust and dislike responses. This asynchrony between cognition and affect would seem to be a major problem for cognitive-behavioural interventions aimed at targeting these maladaptive affective states as it violates the basic tenet of cognitive therapy which holds that appraisals influence emotions (Beck et al., 1979). In the case of disgust and dislike, it appears that this may not be the case. To further illustrate this distinction between fear and disgust beliefs, consider
the example of someone with a phobia of lifts, a phobia where disgust does not play a role. The person may be afraid that they will get stuck in the lift, run out of air, and suffocate. As part of treatment, the psychologist could present information to the patient in order to reduce their estimates of threat, and in turn, fear. For example, information could be provided that demonstrates that the way in which lifts are built is such that there is sufficient airflow and therefore it is impossible to suffocate in one. In contrast, there is less evidence that one can present to convince someone that they shouldn’t find something disgusting. For example, it would be hard to convince someone that they should eat cockroaches for lunch. Disgust appears to be more of a “gut” or visceral reaction that is devoid of rational reasoning. Despite this apparent disconnect between reasoning and disgust, as detailed below there may be cognitive strategies that could influence evaluative responses. Rather than focussing on the reason why a stimulus is not disgusting, these strategies (discussed in detail below) focus on what the stimulus is through “conceptual reorientation” and “deconstruction”. A further cognitive strategy that may be useful in reducing disgust focuses on altering secondary appraisals of one’s reactions to the disgusting stimulus.

Rozin and Fallon (1987) suggested that “conceptual reorientation” may be effective in reducing disgust. Conceptual reorientation refers to changing the way one views a stimulus. As an example, they suggest that if one thought that a substance was rotten milk and then discovers that it is yoghurt, they are likely to feel less disgusted. Similarly, if a person is offered a meat that they deem to be disgusting (e.g., horse) and then discover that it is actually a meat that they like (e.g., beef), their disgust is likely to lessen (Rozin & Fallon, 1987). In this way, it is not about convincing someone why they shouldn’t find a particular substance disgusting. Rather, it is helping them to reframe the way in which they view a particular stimulus. Instead of focussing on the probability and severity of the outcome,
conceptual reorientation encourages individuals to view the actual stimulus in a slightly different manner. For example, individuals with BII phobia might be encouraged to view blood as simply a substance comprised of mostly red and white blood cells, platelets, and plasma. In addition, they might be prompted to consider the positive functional aspects of blood, such as its life-sustaining properties. Part of conceptual reorientation entails “deconstructing” the offensive substance and there is some evidence that this may be effective in targeting disgust. Specifically, Gross (1998) has shown that people report less disgust when they view stimuli that usually elicit disgust and fear (a video of an arm being amputated) from a more clinical, detached way by observing the details of the procedure as a surgeon would. This suggests that the same approach may be useful in a clinical setting. In theory, not only does conceptual reorientation help patients to view disgusting stimuli in a different light, it also encourages them to move away from global, gut reactions such as “blood is gross”. Conceptual reorientation and deconstruction may also be useful in changing perceptions of dislike of feared stimuli and situations. To date, there is no empirical evidence regarding the effectiveness of conceptual reorientation in reducing disgust, however, I am currently running a clinical program which involves examining conceptual reorientation in the context of a group treatment for BII phobia.

Another cognitive strategy that may be effective in reducing disgust is to focus on secondary appraisals. Specifically, it has been suggested that addressing secondary appraisals regarding one’s perception of their ability to cope with disgust (or their reaction to being disgusted) may be a more effective strategy for targeting disgust than focusing on primary appraisals of the stimuli themselves (Teachman, 2006). Examples of secondary appraisals include “If it gets all over me, I'll never feel clean again”; “I can't cope with being that disgusted”; and “If I vomit, I'll be humiliated” (Teachman, 2006, p. 337). This contrasts with the primary appraisal that the stimulus is disgusting, which, as already mentioned, may
be difficult to challenge. This idea of challenging secondary beliefs stems from the OCD literature and is similar to the idea of targeting beliefs about the meaning of obsessions rather than the obsessions themselves. In practical terms, secondary appraisals may be addressed in treatment by cognitive restructuring (see Beck, 1995). In addition, patients can be encouraged to view exposure exercises as a way to “test out” their ability to cope with feeling disgusted.

**Pharmacotherapy adjuncts**

To date, pharmacotherapy interventions for disgust and residual dislike have not been explored (Berle & Phillips, 2006). One possible candidate in this area may be D-cycloserine (DCS), a partial N-methyl-D-aspartate (NMDA) receptor agonist. Previous research has demonstrated that DCS facilitates extinction of learned fear in rats and exposure therapy for anxiety disorders in people (Hofmann et al., 2006; Ledgerwood, Richardson, & Cranney, 2003; Ressler et al., 2004; Richardson, Ledgerwood, & Cranney, 2004; Walker et al., 2002). However, it has also been shown that DCS does not facilitate the extinction of learned fear in people in the laboratory (Guastella et al., 2007b). One possible interpretation of that finding has to do with floor effects. Specifically, because extinction of learned fear in the lab is very rapid with non-clinical populations, it may be difficult to observe any additional facilitative effects of DCS (see Grillon, 2009). However, in the case where there is resistance to extinction or slower extinction (as with disgust and dislike responses), it may be easier to observe an effect of DCS. Research that examines the effect of DCS on the extinction of disgust and other evaluative responses may provide a novel way to target disgust and dislike in the context of anxiety disorders.

In summary, there are several strategies, both psychological and pharmacological that may be effective in reducing maladaptive disgust and dislike. These strategies include
counterconditioning, US habituation and devaluation, as well as cognitive strategies such as conceptual reorientation, deconstruction, and addressing secondary appraisals regarding one’s ability to cope. Furthermore, it may be necessary to extend standard exposure treatment sessions for patients with prominent disgust or dislike responses. In addition, DCS may be useful as a pharmacological treatment adjunct.

**Future directions: Basic and translational research**

In addition to research examining the efficacy of treatments aimed at targeting evaluative responses like disgust and dislike, there is more fundamental research required in this area.

**The study of evaluative responses in clinical populations**

Firstly, it is necessary to gather more evidence regarding the characterisation of evaluative responding in clinical populations. It may be the case that individuals with anxiety disorders in which disgust is implicated experience even greater resistance to the extinction of evaluative responses (as suggested by the results of McKay, 2006) or, as postulated in Chapter 4, respond differently to safety signals. For example, individuals with spider phobia or BII phobia may demonstrate less differentiation in their evaluative responses to danger (CS+) and safety (CS-) signals. It would also be valuable to document residual dislike of previously feared stimuli in patients who have been treated for an anxiety disorder. This could easily be achieved through the use of self-report measures as well as eye-tracking technology and possibly affective priming.
Additional measures for the study of evaluative responses

It would also be useful to further examine evaluative responses through the use of additional measures of disgust and dislike. In the current experiments, a range of self-report measures as well as the visual avoidance and the chocolate tasks were used. However, as already mentioned, self-report measures can be susceptible to demand characteristics and may not always accurately reflect participants’ emotions, particularly amongst those individuals who are less adept at recognising and labelling their own affective states. Although the eye-gaze measure is largely free of these biases, as mentioned, it is not specific to disgust, fear, or dislike. That is, all three affective states are likely to prompt avoidant responses. In many ways, however, as noted, it is not relevant whether the residual affective state is disgust or dislike or a combination of the two. Clearly, both states may be problematic if they induce avoidance, a key factor in precipitating relapse. Nevertheless, other more specific measures, such as facial expressions, may provide supplementary information regarding evaluative responding. For example, Schienle et al. (2001) attempted to examine facial responses to CS pictures paired with disgusting, neutral, and liked US pictures using electromyography (EMG). Although they observed greater disgust responses to the disgusting US pictures, they did not observe greater disgust responses to the CS pictures that had been paired with the disgusting US pictures (i.e., they did not obtain evaluative conditioning on this measure). Indeed, EC effects were also not observed on the self-report measures in that study. The absence of an EC effect in that study may have been due to a lack of awareness of the stimulus contingencies amongst the majority of participants (Schienle et al., 2001). For these reasons, it may be worthwhile to re-examine facial expressions using EMG in the context of a disgust conditioning and extinction paradigm in which participants are aware.
There are also biological symptoms of disgust, such as nausea, which, if accurately measured and sufficiently intense, may be able to provide another indication of disgust. At present, nausea is typically assessed via self-report, using visual analogue scales or other validated measures (McDaniel & Rhodes, 2004). In addition, gastric myoelectrical activity, a rarely used measure of gastrointestinal system changes in wall tonus and contraction rate that tracks “gut feelings”, may also be a useful measure of disgust (Vianna & Tranel, 2006). Vianna and Tranel (2006) note that it is surprising that the gastrointestinal system has been largely neglected in the study of emotion. Those authors used electrogastrogram (EGG) to non-invasively measure gastric myoelectrical activity while participants viewed emotionally salient films. Participants exhibited stronger EGG responses to the disgusting film clip (as well as to the fearful and sad clips) than to the neutral clip, suggesting that EGG may be a useful tool to measure disgust and other emotional states in conditioning and extinction procedures. Although this tool lacks specificity in the measurement of fear and disgust responses, it may be selectively activated by disgust relative to dislike. In addition, the lack of specificity regarding fear and disgust may make this task especially useful for the direct comparison of the extinction of fear and disgust responses. As discussed in Chapter 4, a particularly elegant way to compare the extinction of fear and disgust responses would be to use a single measure that would demonstrate both fear and disgust responses during conditioning, so that any differences between these emotions on this measure during extinction could not be attributed to differences in the way in which they were assessed. Specifically, it seems likely that CSs that had been paired with either a disgusting US or a fearful US would elicit EGG responses. If it could then be shown that only the CS that had been paired with the disgusting US continued to elicit EGG responses at the end of extinction, this would be a very convincing demonstration that disgust responses are more resistant to extinction than fear responses.
In addition to the measures already mentioned, functional magnetic resonance imaging (fMRI) may be a particularly useful tool to further examine disgust responses and dislike or like of CSs during conditioning and extinction. fMRI has been used to study fear conditioning and extinction (e.g., Milad et al., 2007). To date, however, it has not been used in the context of disgust conditioning and extinction, which is in keeping with the fact that there have been very few studies on disgust conditioning and only one other study on learned disgust extinction. Indeed, to my knowledge, fMRI has not been used in any studies to examine evaluative conditioning or extinction. As noted earlier, the insula is involved in disgust responding. Therefore, one would expect that participants would show insula activity in response to a CS that had been paired with a disgusting US. If participants continued to show insula activity to that CS during extinction, that would be further, clear evidence of resistance to extinction. At present, the brain region/s involved in dislike are not as well known as those involved in disgust and fear. In the future, however, fMRI may be a useful tool to track dislike of CSs during fear conditioning and extinction. Furthermore, fMRI may be beneficial in terms of distinguishing between different affective states. This type of research may be valuable in extending our knowledge of evaluative responses. It may also be particularly informative in suggesting mechanisms underlying evaluative responding and may present additional avenues for targeting maladaptive negative evaluative responses following exposure-based treatments.

In general, much can be gained from the study of evaluative responses in clinical populations. In addition, supplementary measures of disgust and dislike such as EGG and fMRI may provide valuable insights into evaluative responding. Finally, it may also be useful to examine the extinction of learned disgust responses to other types of CSs such as odours and flavours in future research, as there may be variations in the extinction of disgust responses dependent on the nature of the CSs and USs used.
A final note: A conceptual comparison of fear and disgust

Both disgust and fear serve a function in protection against threat. However the nature of the threat that elicits these emotions seems to be different. Disgust appears to be elicited when the threat is internal (e.g., sickness), distal (e.g., the harm from eating mouldy bread only appears after a delay), and somewhat ambiguous (i.e., it is not always clear what harm will occur; certainly this would have been the case several generations ago when there was no concept of germs and infection). In contrast, fear appears to be elicited when the threat is external (e.g., being attacked), proximal (i.e., the harm is immediate), and generally fairly obvious (i.e., the potential harm is specific). It also seems that disgust is less connected to cognitions of threat than fear and is more of a visceral, “gut reaction”, although further empirical evidence to support this proposal is required. That is, it may be easier to articulate why one is feeling afraid (e.g., “The snake will bite and kill me”) than it might be to articulate why one is feeling disgusted (e.g., “It’s just gross”).

Of course, these emotions also overlap and influence one another. For example, disgust of spiders as a child might lead to avoidance of them. Consequently, the lack of experience with spiders may then lead to a fear of them as they become unknown and opportunities to extinguish beliefs regarding their likelihood to harm are diminished (Merckelbach, de Jong, Arntz, & Schouten, 1993). Correspondingly, disgust inductions have been shown to enhance feelings of fear and anxiety, which suggests that disgust may contribute to the vulnerability to develop an anxiety disorder (Merckelbach, de Jong, Muris, & van den Hout, 1996; Muris, Mayer, Huijding, & Konings, 2008). As an illustration of this, Muris et al. (2008) showed that when school children were provided with disgust-related information about an unknown animal, they reported higher disgust and fear beliefs about that animal than before they knew anything about the animal. In addition, they reported
lower disgust and fear beliefs about an animal for which they were provided cleanliness-related information. However, there is also evidence that disgust inductions do not influence fear and anxiety. For example, Marzillier and Davey (2005) showed that disgust did not affect reported anxiety but that induced anxiety did increase reported levels of disgust. They maintain that the role of disgust in anxiety disorders is not simply to enhance feelings of anxiety but rather that it has an independent role, consistent with the findings of Olatunji et al. (2007c) as well as Moretz and McKay (2008). Related to this, de Jong et al. (2000) have argued against the notion that the contaminating qualities of spiders are merely due to their fear-evoking properties rather than disgust (as was argued by Thorpe & Salkovskis, 1998). de Jong et al. (2000) contend that if it were the case that the contaminating qualities of spiders were due to fear rather than disgust, then all phobic stimuli would have contaminating properties. This is clearly not the case. Indeed, they cite unpublished work which demonstrated that in contrast to spider-fearful individuals, wasp-fearful participants were still prepared to eat their favourite chocolate bar after it had been in brief contact with their phobic animal, although both groups had virtually identical levels of fear. This finding is inconsistent with the proposal that the contaminating properties of spiders are simply due to their fear-eliciting characteristics. The comparison of disgust to fear is not only an interesting theoretical discussion but it may also help to elucidate a greater understanding of disgust by drawing parallels and distinctions between it and fear, an emotion about which much more is known.

Conclusions

The research in this thesis addresses the neglect of certain affective states that play a significant role in anxiety disorders. On the basis of the current and related research, one can conclude that evaluative responses such as disgust and dislike persist beyond extinction.
and exposure. Evidence of a reduction of evaluative responses may be observed under certain conditions, yet the decline of these responses appears to be much slower than the decline of fear and may not be complete. It is also possible that the reduction of evaluative responses occurs via a different mechanism to the one that affects fear. For these reasons, disgust and dislike warrant special attention in the assessment, formulation, and treatment of certain anxiety disorders such as small animal phobias, BII phobia, OCD, and PTSD. As noted in the very first paragraph of this thesis, there is much room for improvement in the treatment of anxiety disorders. Enhanced understanding of the more subtle aspects involved in the aetiology and maintenance of anxiety disorders, in particular the role of evaluative responses, is likely to lead to superior treatments for these disorders. Future research should examine disgust and dislike in clinical populations as well as consider strategies to target these negative and dysfunctional evaluative responses in order to improve symptom reduction and diminish relapse rates.
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