In the 'Face' of Fear: The Relative Effectiveness of Fear Extinction and Counter-Conditioning in Diminishing Vicariously Acquired Childhood Fears.

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Abstract

Fears are a natural occurrence in childhood. However, excessive fears can lead to anxiety that endures into adulthood. Research suggests that vicarious learning and information provision can increase fear in children. However, there is less evidence for how these pathways can be utilised to reduce fears. Counter-conditioning and extinction are techniques that can reduce fear. This study compared the relative effectiveness of counter-conditioning to extinction in reducing fear using a vicarious learning procedure. Seventy-three children aged seven to 12 years old (*M* = 9.30, SD = 1.62) were exposed to pictures of two novel animals presented on a computer screen during a fear acquisition phase. One animal was presented alone (control) and the other animal was paired with a picture of a human face expressing fear (feared animal). During the fear reduction phase, children were randomly assigned to one of three conditions: counter-conditioning (feared animal paired with a happy face), extinction (feared animal without scared face) or a no fear reduction control group (no presentation of stimuli). Changes in fear beliefs and behavioural avoidance were tracked across learning phases. Counter-conditioning and extinction were associated with greater decreases in fear beliefs and avoidance compared to the control condition. Although there was some evidence that counter-conditioning may be more effective at reducing behavioural avoidance than extinction, counter-conditioning and extinction were equally as effective in reducing self-reported fear beliefs. The findings demonstrate that counter-conditioning may be more effective than extinction in reducing learned fears in children.

Keywords: vicarious learning, extinction, counter-conditioning, childhood fears

Statement of Authorship

I hereby certify that the following thesis is my own original work and has not been submitted for a higher degree to any university or institution other than Macquarie University. The following thesis gives full acknowledgement to the work of others, and all sources of information have been indicated.

Signed,

Tiffany Watson

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In the ‘Face’ of Fear: The Relative Effectiveness of Fear Extinction and Counter-Conditioning in Diminishing Vicariously Acquired Childhood Fears.

Anxiety disorders are one of the most common mental health disorders in children under 12 years (Cartwright-Hatton, McNicol & Doubleday, 2006). While the point prevalence of anxiety disorders varies widely in developed nations (2.6 to 41.2%), recent prevalence rates suggest that 10-15% of young children experience internalising problems (e.g., anxiety, depression; Cartwright-Hatton et al., 2006; Egger & Angold, 2006). Childhood anxiety disorders are associated with a range of suboptimal outcomes including poor academic achievement, social problems, and attention problems (Ialongo, Edelsohn, Werthamer-Larsson, Crockett, & Kellam, 1995; Mesman & Koot, 2000). As childhood anxiety can persist into adolescence and adulthood, deficits such as the ones mentioned above are of increasing importance (Cartwright-Hatton et al., 2006). For example, one large study compared 1400 children with and without anxiety over 17 years (Copeland, Angold, Shanahan & Costello, 2014). Results revealed that anxiety predicted adverse functioning in at least one domain of functioning (health, financial or interpersonal) in adulthood (Copeland et al., 2014). There are several posited aetiological pathways to childhood anxiety disorders, including genetic inheritance (Eley, 2007). Longitudinal twin data shows that genetic influences account for 34 to 50% of the variance in anxiety problems for children aged approximately nine years old, while a child’s environment also has a substantial contribution, and can account for 36 to 50% of the variance (Kendler et al., 2008). Fear learning offers one explanation as to how environmental influences may translate into fear development (Field, 2006a). For example, anxiety can be triggered by directly experiencing an aversive event, such as being bitten by a dog that results in the development of a dog phobia. As such, fear learning is an important environmental factor, which may play a substantial role in childhood anxiety onset (Field, 2006a; Field & Nightingale, 2009; Rachman, 1977).

In one influential model of fear learning, Rachman suggested three major pathways for fear learning (Rachman, 1977). These pathways are direct fear conditioning (i.e., direct exposure to a fearful event, such as being bitten by a dog), or two indirect fear-learning paths. Indirect learning can involve verbal instruction and/or information (i.e., receiving threatening or negative information such as “dogs are scary and they bite!”), and vicarious learning experiences (i.e., observing someone else’s fear responses, such as expressing fear of a dog). The latter two processes are transmitted socially, requiring no direct personal experience (Rachman, 1977).

In the last three decades, there has been considerable focus in the *direct* conditioning literature on reducing learned fears. In 2010 over 100 articles focusing on fear reduction in direct conditioning were published (Milad & Quirk, 2012). This is contrasted against the 20-fear reduction papers published in 2001 and the 60 papers published in 2006 (Milad & Quirk, 2012). Research into early intervention that reduces excessive fear during childhood can potentially minimise the impact of childhood anxiety in the longer term, as pre-clinical research suggests that fear reduction administered in early life is robust against the relapse (Yap & Richardson, 2007). However, despite the substantial occurrence of childhood anxiety, there has been limited research on fear reduction in younger populations such as adolescents, children, and infants (Newall, Jacomb, Broeren and Hudson, in press; Yap & Richardson, 2007). Moreover, there have been only three papers published within the *indirect* learning literature on fear reduction (Gast & De Houwer, 2013; Golkar, Selbing, Flygare, Ohman & Olsson, 2013; Newall et al., in press).

This thesis aims to investigate fear reduction in children, using a unique method that is a combination of direct and indirect fear learning. The subsequent section will review fear conditioning and fear reduction literature in direct conditioning, and then provide an examination of the limited extant indirect fear reduction literature with children.

1.1 Direct Conditioning

1.1.1 Fear acquisition.

Nearly all children experience some degree of fear during development (Muris & Field, 2010; Ollendick, King & Muris, 2002). Yet fears make up a significant part of anxiety disorders (Vervliet, Baeyens, Van de Bergh & Hermans, 2013a). Fear can be learned through classical conditioning, whereby fear acquisition involves the pairing of a conditioned stimulus (CS; e.g., a light) with an unpleasant unconditioned stimulus (US; e.g., tactile shock). The US is a usually a biologically and motivationally significant stimulus (e.g., pain), and CSs are typically neutral to the subject initially. The repeated pairing of a CS with a US results in a learned association. In subsequent presentations, the CS then elicits anticipatory fear responses (e.g. avoidance, increased heart rate). For instance, in rodent research, a researcher might pair a white noise CS with a shock US, often delivered through a steel grid floor of an animal chamber (Kim & Richardson, 2010; Laborda & Miller, 2013). Fear responses are then indexed through percentage of freezing (suppressing of all movement except breathing; Baran, Armstrong, Niren, Hanna & Conrad, 2009; Schiller et al., 2008).

The earliest human demonstration of how fear learning can explain the onset of anxiety was a classic study by Watson and Rayner (1920). In that study, the researchers exposed a nine-month-old boy, nicknamed Lil’ Albert, to repeated pairings of a white rat CS with a loud clanging noise US. This clanging noise US was distressing to Lil’ Albert, and he would cry during pairing presentations, typically called ‘fear acquisition’. On subsequent presentations of the white rat CS, Lil’ Albert would exhibit a fear response of crying because he had learned that the CS is a good predictor of something nasty happening to him (Watson & Rayner, 1920).

1.1.2 Fear extinction.

Learned fears can be reduced through repeated exposure to the CS without the US, a technique known as ‘extinction’. Numerous studies have shown that extinction consistently reduces learned fears (for reviews, see Hermans, Craske, Mineka & Lovibond, 2005 and Vervliet et al., 2013a). For instance, rats that have been trained on white noise-shock associations will undergo extinction where they are repeatedly presented with the white noise (CS) without the shock (US). Loss of fear is indexed by the reduction of freezing following the white noise CS over time (Baran et al., 2009; Kim & Richardson, 2010; Laborda & Miller, 2013). Extinction is also the laboratory equivalent of exposure therapy for anxiety disorders. Like extinction, exposure therapy involves encouraging people to gradually ‘expose’ themselves to the fearful and often avoided situation(s) or object(s) without the anticipated negative consequences. As a consequence, the person learns that the feared situation/stimulus does not predict the expected negative outcome, just like with extinction (Berry, Rosenfield & Smits, 2009). As such, fear extinction is critical for the refinement and efficacy of anxiety disorder treatment (Field, 2006a).

While extinction has been shown to reduce fear, contemporary research has demonstrated that it is susceptible to interference (Bouton, 2002; Milad & Quirk, 2012; Vervliet et al., 2013a). For example, recovery of fear following extinction can be seen in multiple instances. One instance is fear *renewal* (Bouton, 2002; Milad & Quirk, 2012). For instance, Neumann and Kitlersirivatana’s (2010) fear renewal study with university students. Students were conditioned to fear pictures of tools (e.g., hammer, screwdriver) by pairing them with an electric shock. Fears were then extinguished by presenting the pictures without the accompanying shock (extinction) in either the same or a different context to acquisition. A test phase was administered after extinction, involving a single presentation of the feared picture in the same context as acquisition. Results illustrated a renewal effect, i.e., when extinction and the test phase are conducted in different contexts, there is a significantly larger fear response at test (renewal) compared to when extinction and the test phase are in the same context (Neumann & Kitlersirivatana, 2010).

Another return of fear phenomenon is *reinstatement* (Bouton, 2002; Sokol & Lovibond, 2012). Reinstatement refers to the brief presentation of the US, an un-paired reminder (Field, 2006a; Milad & Quirk, 2012; Vervliet et al., 2013a). Typically, this leads to the conditioned response ‘recovering’ or being ‘reinstated’ at test compared to subjects that had not been given a reminder (Field, 2006a; Milad & Quirk, 2012). Fear can also return simply due to the passage of time, a phenomenon called *spontaneous recovery* (Bouton, 2002; Vervliet et al., 2013a). Together, these return of fear phenomena suggests that extinction is susceptible to inference because it does not ‘erase’ the original CS-US association but instead creates new learning and memories that ‘mask’ the original learning (Bouton, 2002; Field, 2006a; Vervliet et al., 2013a). Under various circumstances, the original CS-US association can be ‘unmasked’, accounting for the return of fear. For instance, renewal can be seen as the return of fear when tests are conducted in a different context to fear reduction (Bouton, 2002; Neumann & Kitlersirivatana, 2010; Vervliet, Craske & Hermans, 2013b). The vulnerability of extinction to fear recovery offers one account for the models of relapse following successful outcomes of exposure-based therapies. Furthermore, research suggests that the degree by which fear is reduced does not always predict a successful long-term therapeutic outcome (Craske et al., 2008) and that anxious children are less able to distinguish between neutral and fearful stimuli (distinguishing between safety cues and danger signals; e.g., Waters, Henry & Neumann, 2008). Moreover, extinction is also impaired in anxious children (e.g., Liberman, Lipp, Spence & March, 2006) compared to non-anxious children.

Given extinction's susceptibility to inference, research on humans and animals focuses on extinction recall, and explores the factors of successful and lasting extinction (Kindt & Soeter, 2013; Pace-Schott et al., 2013; Vriends et al., 2011). Within research, extinction recall is often assessed at a test, which can be administered immediately after extinction, after a varying time gap (e.g., days, weeks, months), or after additional interventions like renewal or reinstatement (Vervliet et al., 2013a). Lower levels of fear responses at test, indexed by behavioural, physiological and/or cognitive measures for humans, indicate greater success of extinction in reducing the learned fear.

There has been considerably less human fear reduction research conducted in early life (infancy and childhood) than with adults. The extant research in early development has focused on extinction. Most child studies on fear conditioning have focused on the relative differences in acquisition and extinction in anxious and non-anxious samples (Liberman et al., 2006; Waters et al., 2009). For example, one study by Waters and colleagues (2009) compared the subjective self-reported fear responses and skin conductance ratings in anxious and non-anxious children. Skin conductance measures are a 'sweat' response on the middle and index finger that is taken as a physiological index of fear (e.g., Raes & Raedt, 2012; Waters et al., 2009). In Waters and colleagues (2009) study, children between the ages of eight and 12 were conditioned to fear geometric shapes (CS) paired with an unpleasant loud tone (US). Paired CSs in human conditioning are typically termed CS+. There was also a control CS that was not paired with an outcome, to show that any rise in fear ratings or skin conductance was not due to paired associative learning. This control CS is typically called a CS-. After acquisition, children moved onto an extinction phase in which the CS was presented without the tone. Both anxious and non-anxious children acquired fear (Waters et al., 2009). However, anxious children rated the CS+ as more anxiety provoking, and recorded higher skin-conductance responses to both the CS+ and CS- during acquisition compared to non-anxious children. Additionally, anxious children displayed higher skin-conductance responses, but not verbal ratings, after extinction compared to the non-anxious children. That is, anxious children showed poorer rates of extinction than non-anxious children on skin conductance responses. This might explain the continuation of anxiety symptoms even after treatment (Libermann et al, 2006; Waters et al., 2009).

Despite some research with children, the rates of publication in child fear learning are significantly lower than seen with adults (Newall et al., in press). The limited research on children and extinction is largely due to procedural difficulties in conditioning fear in children. For example, Glenn and colleagues (2012) tested a total of 68 children aged eight to 13 years old, however only 40 (59%) were retained in the final analysis due to participant withdrawal and invalidated responses (i.e., children failing to show fear conditioning). An alternate to child research is infant animal research, which offers further expansion on extinction knowledge early in life.

Emerging research conducted in rats suggests that extinction may be especially robust early in life, and may involve erasure rather than masking of the original fear learning. For instance, research has consistently failed to find recovery of fear, post extinction, early in life (Yap & Richardson, 2007; Kim & Richardson, 2009; Kim & Richardson, 2010). To illustrate, Yap and Richardson (2007) conducted a study with infant and juvenile rats. All rats experienced fear acquisition with an odour (CS) paired with a shock (US), followed by extinction and a test. Half of the rats experienced acquisition, extinction, and test in the same context (AAA, each letter denoting each phase). The other half of the rats experienced acquisition, extinction and test in two different contexts (ABA). Test data revealed that the older rats showed renewal of conditioned freezing if extinguished in a different context to the one used for test (ABA) compared to AAA rats. However, infant rats did not show any renewal of fear responses (Yap & Richardson, 2007). A further study by Kim and Richardson

(2010) revealed that reinstatement is also absent in infant rats. Thus, extinction in early life appears to generalise across contexts, protecting, at least in part, against fear return (Kim & Richardson, 2010; Yap & Richardson, 2007). Therefore, rodent research suggests that different processes are involved in extinction in infant rats compared to adult rats and illustrates the importance of examining early life fear reduction processes (Kim & Richardson, 2009; Kim & Richardson, 2010; Yap & Richardson, 2007)

While extinction is the most commonly used method for reducing fear in the clinical context, there are limits to its effectiveness. Research has also shown other numerous factors lead to less-than-optimal extinction recall. For instance, women in specific hormonal cycles (i.e., low estradiol) show impaired extinction compared to women with high estradiol and men (Graham & Milad, 2013). Additionally, healthy adult males show slower learning and worse recall for extinction learning when extinction was administered in the evening as opposed to the morning (Pace-Schott et al., 2013). As can be seen in Waters and colleagues (2009) study anxious children are worse at extinguishing fear than non-anxious children. Therefore, while extinction can reduce fear, its effectiveness may be limited in certain contexts (Graham & Milad, 2013; Neumann & Kitlertsirivatana, 2010; Pace-Schott et al., 2013; Waters et al., 2009).

1.1.3 Counter-conditioning.

An alternative method of fear reduction is counter-conditioning (Bouton, 2002; Kerkhof, Vansteenwegen, Baeyens & Hermans, 2010). Counter-conditioning is the reduction of fear by presenting the CS with a US that has the opposite motivational valence to the US used in fear acquisition (Bouton, 2002; Kerkhof et al., 2010). Although there has been considerably less research on counter-conditioning, the extant research suggests that it may potentially be more effective than extinction (Milad & Quirk, 2012).

Researchers have suggested that counter-conditioning reduces fear by creating positive associations with the CS, rather than allowing the expected fear association to naturally decrease (Bouton, 2002; Kerkhof et al., 2010). For instance, a rat that has previously experienced a light CS paired with an aversive shock (US) would then receive the same light CS with an appetitive US (such as a food pellet) during counter-conditioning to drive down the conditioned fear response.

While not explicitly acknowledged in the literature, counter-conditioning is also used in anxiety treatment. For instance, systematic desensitization, a technique used to manage anxiety in cognitive behavioural therapy (CBT), is a form of counter-conditioning (Anderson, Burpee, Wall & McGraw, 2013; Daleiden & Higa, 2005; Thomas, Cutler & Novak, 2012). Systematic desensitization utilizes relaxation techniques to combat the aversive physiological sensation of anxiety by evoking an appetitive relaxed physiological response during an anxious situation (Daleiden & Higa, 2005).

Despite involving different processes, research suggests that counter-conditioning shares similar features to extinction (Bouton, 2002; Brooks, Hale, Nelson & Bouton, 1995). For example, a study by Brooks and colleagues (1995) examined the effects of reinstatement after counter-conditioning in rats. In that study, adult rats were conditioned to fear a white noise CS by pairing it with a bright light or foot shock (US) administered through the floor of conditioning chambers. Fear was then reduced via counter-conditioning, where rats experienced pairing of the white noise CS with the delivery of an appetitive US - food pellets. As expected, fear declined, and rats showed approach to the food magazine upon CS presentation. Half the rats then received a brief US reminder (reinstatement) - the foot shock - and the other half did not. Results revealed that the reinstated rats showed a recovery of fear while non-reinstated rats did not. Overall, results revealed that counter-conditioning, similar to extinction, is subject to reinstatement (Brooks et al., 1995). Brooks and colleagues (1995) findings suggest that counter-conditioning, like extinction, may not erase the original learned fear association but instead rely on new learning.

Despite some evidence of parallels between extinction and counter-conditioning, the findings are equivocal. There is mounting evidence that in some instances, counter-conditioning is superior to extinction and is distinct in the way it reduces fear. For instance, Raes and Raedt (2012) conducted an experiment that compared extinction to counter-conditioning. University students were conditioned to fear a picture of a human face (CS) by pairing it with an unpleasant white noise (US). A face of the opposite gender served as the CS-. Students were then randomly allocated to one of three intervention groups: an extinction group, a counter-conditioning group using a neutral sounding US (e.g., white noise/tone) or a positive counter-conditioning group using a positive sounding US (e.g., baby laughter). This study used several indices to measure fear including subjective self-report ratings and skin conductance responses. Subjective ratings of each stimulus revealed no differences between extinction and the two counter-conditioning groups after intervention. That is, all groups appeared equally effective at reducing subjective fear ratings. However, the extinction group revealed no significant fear reduction on the skin conductance measure after intervention, whereas the neutral counter-conditioning group displayed a trend towards fear reduction after intervention. In contrast, the positive counter-conditioning group revealed a significant reduction of fear responses following intervention on the skin conductance measure. These results suggest that counter-conditioning may lead to more successful reductions in fear, at least in part, compared to extinction (Raes & De Raedt, 2012).

Kerkhof, Vansteenwegen, Baeyens and Hermans (2011) reported similar findings in their study assessing changes in conditioned preferences following counter-conditioning and extinction. First year university students were conditioned towards or against different types of cookie images (CSs) through eating different cookies every time that cookie image was presented. Therefore, aversive conditioning was achieved by pairing a cookie image CS with a foul tasting cookie (aversive US; Kerkhof et al., 2011). Students then experienced extinction, counter-conditioning, or a no aversion reduction (control). Thus for extinction, the cookie image CS was displayed but was *not* followed by the consumption of cookies. In the counter-conditioning group, the cookie image CS that was previously paired with foul-tasting cookies was now paired with sweet tasting cookies. Results indicated that extinction did not reduce conditioned aversion towards the aversive CS pairing as effectively as counter-conditioning (Kerkhof et al., 2011). That is, counter-conditioning removed conditioned aversion to the CS but extinction did not (Kerkhof et al., 2011). Kerkhof and colleagues (2011) suggest that extinction reduces the expectancy of aversion but does not alter the negative meaning or evaluation connected with an aversive CS (Kerkhof et al., 2011). Whereas counter-conditioning can alter the negative evaluation of the CS, thus, resulting in greater fear reduction (Kerkhof et al., 2011). Similarly, rat research has found that the addition of a positive stimulus (more commonly food) in fear reduction results in lower levels of fear at test (see Anderson, Burpee, Wall & McGraw, 2012; Thomas et al., 2012; Tunstall, Verendeev & Kearns, 2012). It is suggested that the addition of food creates a temporary expectation for a positive outcome with the feared stimulus in rats, thus deepening fear reduction (Tunstall et al., 2012).

In summary, while there is some evidence that both counter-conditioning and extinction create new learning and thus are susceptible to inference, there is also mounting evidence to suggest that counter-conditioning may be more effective at reducing learning fears than extinction (Anderson et al., 2013; Kerkhof et al., 2011; Raes & Raedt, 2012; Thomas et al., 2012). A particularly notable aspect is that there is limited research in counter-conditioning compared to intense research interest in extinction, despite the possibility that counter-conditioning may be more effective and can be utilised in a therapeutic context to improve treatment outcomes for anxiety disorders. To the author's knowledge, there has not been any research to date on counter-conditioning with infant rats or with children in the direct learning field. However, in the indirect learning pathways research is starting to emerge using techniques that appear to be analogous to counter-conditioning. The following section will turn to fear reduction within indirect learning in both children and adults, outlining the extant studies conducted to date.

1.2 Indirect Learning Pathways

While direct learning is pre-eminent in laboratory-based fear research, it is worth noting that there is limited evidence that direct learning is the primary pathway for the development of anxiety disorders. For instance, research suggests that phobic patients rarely report a direct learning event that accounts for anxiety onset (see Poutlon & Menzies, 2002). In contrast, there is ample evidence that indirect learning can lead to anxiety development (see Askew & Field, 2008; Muris & Field, 2010). For example, Otto and colleagues (2007) assessed the impact of indirect media exposure of the terrorist attacks of September 11 on children's and parent's anxiety in a one-year longitudinal study. In that study, parents and children in Boston were assessed for posttraumatic stress disorder (PTSD) and asked questions on their media viewing one year following September 11. Data was compared to interviews conducted with the same cohort approximately four years earlier. Results revealed that greater viewing time among younger children (under 10 years old) was a significant predictor of the frequency of PTSD symptoms (Otto et al., 2007). Furthermore, external factors like behavioural inhibition, depression symptoms, and family function (e.g., emotional expression and family environment) were controlled for. This finding thus illustrates that pathological fear can be learned through indirect exposure to the media (Field, 2006a; Otto et al., 2007; Rachman, 1977).

Empirical studies have repeatedly shown that both vicarious and information pathways are viable accounts of fear development (Askew & Field, 2007; Broeren et al., 2011; Field and Lawson, 2003). Specifically, fear acquisition has been documented across three indices of fear learning - cognitive, physiological and behavioural measures (Askew & Field, 2007; Broeren et al., 2011; Field and Lawson, 2003). However, fear learning has been less documented on physiological measures compared to cognition and behavioural measures (Lester, Field & Muris, 2011; Field & Schorah, 2007; Price-Evans & Field, 2008). An example study that measured all three indices is Lester, Field and Hermans' (2011). Lester and colleagues (2011) conducted an experimental study on 67 children (aged six to 11) measuring anxiety bias towards animals. In that study, children were given ambiguous vignettes about two Australian animals, then randomly allocated to either positive or negative story manipulations. Lester and colleagues (2011) measured fear cognitions, avoidance behaviour and physiological responding throughout the experiment. Results revealed that negative information about the animals significantly increased anxiety responses on cognitive and behavioural measures, while positive information significantly decreased anxiety. However, no significant effects were seen on the physiological measure (heart rate; Lester et al., 2011). Most of the experimental research on indirect fear acquisition has been done using children (Field, 2006a; Field, Argyris & Knowles, 2001). An example of one of the earliest empirical indirect conditioning studies is Field, Argyris and Knowles' 2001 paper. In that study, children aged seven to nine years old reported fear beliefs after vicarious and information fear acquisition to two toy monsters (Field et al., 2001). Vicarious acquisition involved watching a video of an adult female stranger reacting fearfully to the toy, whereas information fear acquisition involved a vignette of negative information about the toy (i.e., this monster has sharp fangs, eats children; Field et al., 2001). Field and colleagues (2001) constructed a self-reported Fear Belief Questionnaire (FBQ) to index fear about the toy monsters across time. Results revealed that negative information (vignettes) significantly increased fear beliefs compared to the no information controls (Field et al., 2001). However, the negative videos (vicarious acquisition) did not significantly alter fear beliefs (Field et al., 2001).

In another study, Askew and Field (2007) evaluated fear acquisition through vicarious learning in children. A total of 80 children (eight and nine years old) were conditioned towards three Australian animals (quoll, quokka, and cuscus) that were very novel for UK-based children. One animal was paired with a picture of a scared face, the other was conditioned with a positive face, and the final with a neutral face on a computer screen. Aside from the FBQ, a Touch Box task was also used to measure changing fear responses. In the Touch Box task (also known as the Behavioural Approach Task or the BAT), children are asked to approach and place their hand inside a box that contains the ‘animal’ (Kelly, Barker, Field, Wilson & Reynolds, 2010). Children are unable to see inside the box, and, of course, the animal is in fact fake. The time taken to approach the box, and how close a child gets to the box, provided a measure of behavioural avoidance (Kelly et al., 2010). Results revealed that fear beliefs were significantly higher when the animal was paired with a scared face, and lower when paired with a happy face, suggesting that vicarious conditioning is a viable pathway for fear development (Askew & Field, 2007; Askew & Field, 2008).

1.2.1 Fear reduction.

While the acquisition of fear through vicarious and information learning is empirically supported through various studies, less is known about fear reduction in indirect conditioning (Askew & Field, 2007; Askew & Field, 2008; Field, 2006a; Field et al., 2001). To date, there are three known studies investigating indirect fear conditioning and reduction in adults (Gast & De Houwer, 2013; Golkar et al., 2013; Newall et al., in press). A recent study by Newall, Jacomb, Hudson and Broeren (in press) assessed the fear reduction of verbally learned fears. University students were given threatening information about an animal (e.g., “It has sharp teeth and is known to bite” for fear acquisition) at the beginning of the experiment. Fear responses were measured using the FBQ and a Touch Box (Behavioural Approach Task). All participants then experienced a fear reduction phase, where they watched the experimenter approach the Touch Box, put their hand into the box to pat the animal while being told how much the experimenter liked the animal (e.g. “It’s very friendly and cute, and has never bitten me!”). This fear reduction phase used both modelling and instructional methods to reduce fears. A final test, conducted in the same or a different context was used to measure fear recovery. Results showed that the modelling and verbal administration of positive information about the animal reduced fear responses for all participants (Newall et al., in press). Those who were tested in a different context to extinction demonstrated a greater fear response than those tested in the same context, that is fears were partially recovered (Newall et al., in press). Newall and colleagues (in press) demonstrated that a combination of both modelling and verbal fear reduction reduced verbally learned fears in adults. However, similar to direct learning literature, the fear reduction was subject to fear recovery (Newall et al., in press).

In another study, Golkar and colleagues (2013) compared the effects of direct extinction to vicarious extinction in adults. Adult participants were directly conditioned to fear an angry male face (CS+) presented on the computer by pairing it with electric shock to the wrist (US; Golkar et al., 2013). Another angry male face was presented alone (CS-). Participants were then randomly assigned to one of three conditions: direct extinction, vicarious extinction, or control (no further fear reduction; Golkar et al., 2013). Direct extinction involved exposure to the face (CS+) without the electric shock. Vicarious extinction involved viewing a video of a stranger taking part in the same experiment with no visible fear response to either face. Finally, participants went through a reinstatement procedure where they received one single presentation of the shock (US) without the face (CS). Fear responses were measured throughout the experiment using skin conductance measures. Golkar and colleagues (2013) found that vicarious extinction resulted in significantly more reduction in fear responses and less fear recovery than direct extinction. This study suggests that fear reduction in indirect learning pathways may be dissimilar to fear reduction in direct learning pathways, and as such may result in less fear recovery (Golker et al., 2013).

However, fear recovery has not been the major focus in indirect learning. Unlike direct learning, indirect learning research has mostly used techniques that are analogous to counter-conditioning. For instance, Gast and De Houwer (2013) assessed the instructional effects of counter-conditioning compared to extinction in adults. Adult participants' preferences were conditioned to two non-word images: one non-word was conditioned negatively (i.e., with a photo of maimed bodies), and one was positively conditioned (i.e., with a photo of flowers). Half the participants were conditioned indirectly, by instructing participants that one photo would be paired with a photo of maimed bodies and one would be paired with a photo of flowers. The remaining participants experienced direct conditioning, where they saw the photos paired with a photo of maimed bodies or a photo of flowers (Gast & De Houwer, 2013). Afterwards, participants were randomly allocated to indirect counter-conditioning, indirect extinction or a control condition. In counter-conditioning, participants were instructed that the negatively paired photo would now be paired with a positive photo. The extinction group was instructed that the negatively paired photo would now be seen by itself, and the control condition received no further information. It is important to emphasise that apart from the participants that experienced *direct* fear conditioning, all other components of the study were instructionally announced but never experienced (indirect learning). Expectancy ratings for what picture participants expected to follow each word (i.e., positive picture, negative picture, no picture, or both positive and negative pictures) were recorded after the acquisition and fear reduction phases. Results revealed that counter-conditioning, but not extinction or the control condition, effectively reduced negative associations across both indirect (instructional) conditioning and direct conditioning (Gast & De Houwer, 2013). The results imply superior fear reduction in both direct and indirect learning when learned fears are counter-conditioned compared to extinguish in adults (Gast & De Houwer, 2013), and appear to be consistent with the literature in direct fear learning (Anderson et al., 2013; Kerkhof et al., 2011; Raes & Raedt, 2012; Thomas et al., 2012).

Fear reduction studies in children using indirect methods are also scarce. There are three studies to date that have examined indirect fear reduction in children (Dunne & Askew, 2013; Kelly et al., 2010; Muris, Huijding, Mayer, Van As & Van Alem, 2011). Kelly and colleagues (2010) were the first to address fear reduction in children via indirect learning preparations in their experimental study. Children aged six to eight years old in the UK were exposed to two unfamiliar Australian animals, the quoll and quokka (Kelly et al., 2010). Negative information was given about one animal by one researcher (e.g., “this animal has long sharp teeth”), while no information was offered about the second animal. Children were then randomly allocated to one of three groups: modelling, positive information, or no intervention (Kelly et al., 2010). In the modelling group, a different researcher placed their hand in the Touch Box of the threatening animal in front of the child without a negative reaction. The positive information group were informed that the threatening information they received from the first researcher was unreliable and that the new researcher thinks the threatening animal is safe (e.g., “he plays with children, and is soft and cute”). The control group completed an unrelated drawing task for the same time period. The researchers found that both modelling and positive information reduced fear significantly more than the control group (Kelly et al., 2010). Furthermore, the positive information procedure was more effective than modelling (Kelly et al., 2010). This latter finding is notable because positive information is very similar to counter-conditioning techniques. Specifically, the animal (CS+) which was previously paired with threatening information (aversive US) is now paired with a US of opposite motivational valence (safety information) to the original US (Bouton, 2002). Furthermore, modelling is more analogous to vicarious extinction, as the child is witnessing the adult experiencing the CS+ (animal) without the negative US (Bouton, 2002). That positive information provision was superior to modelling thus suggests that instructional counter-conditioning (positive information) may be stronger than vicarious extinction (modelling) in reducing learned fears in children (Kelly et al., 2010).

A second study by Muris and colleagues (2011) also explored the effects of information (instructional learning) and imagery (vicarious learning) in reducing learned fears. Similar to Kelly and colleagues' (2010) study, children (nine to 13 years old) acquired fear to an unfamiliar animal via negative information provision (Muris et al., 2011). Children were then randomly assigned to one of three groups: a control group that received no information, a positive information group that received new positive information, or an imagery group. In the imagery group, children were instructed that a fictional character could catch, teach tricks, and play with the animal. Data revealed that both positive information and imagery reduced fear beliefs more than the control condition (Muris et al., 2011). However, consistent with Kelly and colleagues' (2010) results, positive information appeared more effective than imagery (Muris et al., 2011).

More recently, Dunne and Askew (2013) used a very unique procedure that involved a combination of direct and indirect fear reduction with children. In that study, children (six to 10 years old) were conditioned to fear three images of unfamiliar Australian animals (quoll, quokka and cuscus) by pairing them with facial pictures (Dunne & Askew, 2013). The three images were presented on a computer screen and were paired with either a happy face (mother or stranger), a fearful face (mother or stranger) or no image (control; Dunne & Askew, 2013). Fear beliefs were indexed using the FBQ, and avoidance behaviours were measured using a Nature Reserve Task (NRT; Dunne & Askew, 2013; Field & Storksen-Coulson, 2007). The NRT consists of a triangular board with pictures of the animals at each point (Field & Storksen-Coulson, 2007). Children are asked to imagine they are a toy figurine (a Lego piece given to the child) and place themselves (the Lego figurine) where they would like to be if they were visiting the nature reserve (Field & Storksen-Coulson, 2007). Distances from animals are taken as a score of behavioural avoidance, with greater distances indicating greater avoidance (Field & Storksen-Coulson, 2007). Following acquisition, children received ‘unlearning’ (Dunne & Askew, 2013). That is, children saw each animal again with a facial image of the opposite valence to the first acquisition phase. For example, the animal picture paired with a fearful face at acquisition was now paired with a happy face, and vice versa for children who initially had the animal paired with a happy face at acquisition.

The methodology used by Dunne and Askew (2013) is noteworthy for a number of reasons. Children learned fears through the indirect vicarious fear acquisition pathway as they learned about an animal by observing the pairing of that animal with a human face for threat information (Dunne & Askew, 2013). However, the facial expressions are also biologically significant stimuli for humans, as we are social beings (Leopold & Rhodes, 2010). As such, the facial expressions could be considered a US, and the animal pictures a CS, closely reflecting direct learning procedures. Therefore, the technique used by Dunne and Askew (2013) uniquely combines both indirect learning and direct conditioning methodology. Interestingly, Dunne and Askew’s (2013) fear reduction closely resembles counter-conditioning, as the CS+ (animal) was presented with a US of a positive valence (happy face; Bouton, 2002).

Dunne and Askew’s (2013) results revealed that children successfully acquired and reduced fear in this procedure regardless of whether the face used at acquisition and counter-conditioning was the children’s mother’s face, or a stranger. Overall, the results revealed that fear beliefs can be acquired and reduced using this method, and that fear returned to baseline levels after counter-conditioning in children (Dunne & Askew, 2013).

In summary, research with children suggests that counter-conditioning and extinction successfully reduces fears compared to control groups in both the vicarious and information pathways (Dunne & Askew, 2013; Kelly et al., 2010). The limited available research also suggests that counter-conditioning may be more effective at reducing fears compared to extinction both in the direct learning literature (Kerkhof et al., 2011; Thomas et al., 2012) and indirect learning literature (Kelly et al., 2010), but particularly in human research, and especially in adults (Gast & De Houwer, 2013; Raes & Raedt, 2012). However, the impact of counter-conditioning compared to extinction has not been compared in children using indirect or direct learning pathways. Dunne and Askew’s (2013) innovative methodology that combines both direct and indirect learning allows exploration of this issue.

1.3 The Current Study

The current study aims to address whether extinction or counter-conditioning is more effective in reducing learned fears in children. A variation of the Dunne and Askew’s (2013) basic methodology will be used in the current study with children aged seven to 12 years old. Dunne and Askew (2013) based their paradigm on children between the ages of six to 10 years old. As children of this age group (i.e., primary school) have the ability to read and write and thus, were able to answer the self-report questionnaires, a similar age range will be used in this study. However, research shows that anxiety develops heterogeneously across childhood, thus the age range will be extended to 12 year olds in order recruit more children and reach required statistical power (Broeren, Muris, Diamantopoulou & Baker, 2013). Two pictures of novel animals will be used as CSs. During fear acquisition, one animal picture (CS+) will be paired with a negative facial picture US (e.g., looking scared), and the other will be presented alone (CS-). Children will then be randomly assigned to one of three groups: counter-conditioning, extinction, or control. In the counter-conditioning group, children will see the CS+ animal paired with a US of the opposite emotional valence, a positive facial expression (e.g., a face looking happy). Children in the fear extinction group will see the CS+ animal presented alone (without the negative facial picture). Children in the control group receive no fear reduction techniques and instead will view unrelated non-words.

Fear will be indexed using the Fear Belief Questionnaire (FBQ) and the Nature Reserve Task (NRT). These indices will be taken at baseline, post-acquisition and post-fear reduction.

1.3.1 Hypothesis.

This paper makes two predictions regarding the findings of this study. First, that extinction and counter-conditioning will result in greater reduction of fears beliefs (FBQ) and behavioural avoidance (NRT) compared to the control condition **(Hypothesis 1)** based on the existing literature illustrating that both techniques are effective in reducing fear (e.g., Kerkhof et al., 2010; Vervliet et al., 2013a). Additionally, consistent with the limited extant literature (e.g., Gast & De Houwer, 2013; Raes & Raedt, 2012), counter-conditioning could also lead to more reduction of fear beliefs (FBQ) and avoidance on the NRT compared to extinction **(Hypothesis 2)**.

2.0 Methods

2.1 Participants

Of the 73 children that completed the experiment, seven children were excluded for failing manipulation checks, i.e., they showed no awareness of an association between the CS and the US. A total of 66 children, aged seven to 12 years, remained in the final analysis. The mean age was 9.6 years (SD = 1.57). Twenty-eight participants were female, and 53 participants identified themselves as Caucasian Australian. The remainder identified as Asian (n = 7), Middle Eastern (n = 1) or ‘other’ (n = 5). Families were recruited via flyers and advertisements placed in local newspapers, websites, and businesses. The majority of families that participated were Caucasian Australians from a high socioeconomic demographic (80%) and as such were not directly representative of the general population. Of the families that participated, 90% of responses came from mothers, with the average parental age-group of 40-50 years old. Forty-seven percent of parents had postgraduate degrees or higher, 56% had a family history of anxiety. Approximately 2% of families did not participate in the study, and gave the reason that the study did not interest them. Written consent was obtained from each child as well as the child’s parent. Each family received $50 for their participation in the study as reimbursement for time and travel cost. The study was approved by the Macquarie University Ethics Committee for Human Research (reference number 5201400139).

2.2 Materials

2.2.1 Animal pictures.

Two colour pictures (400 x 300 pixels) of novel animals from South America and Asia, the ratel and linsang, were used as conditioned stimuli (CS; see Appendix A). The two animal pictures were selected based on pre-assessed equivalent neutral fear responses in a pilot study. In the pilot study, 30 children, aged seven to 12 years (20 female, M = 9.90 years, SD = 1.92), independently rated animal pictures in an online study. Each child saw six pictures of unfamiliar animals and rated each animal using the Fear Belief Questionnaire (FBQ; see 2.3.3 for a description of the FBQ). The pictures of the ratel and linsang were found to have equal neutral FBQ responses, with no significant differences in FBQ ratings (p > .05).

2.2.2 Faces.

Adult male and female face images (300 x 400 pixels) with fearful and happy facial expressions acted as unconditioned stimuli (US). Four images were used in total (see Appendix B for an example of the facial expressions used). The gender of the face shown was consistent with each participant's gender. Pictures were sourced from the NimStim set of facial expressions (Tottenham et al., 2009). The pictures selected have demonstrated high validity for fear and happy expressions. Tottenham and colleagues (2009) reported that adult participants correctly identified the emotions presented in the pictures.

In the current study, children were asked to identify the emotion of the faces upon the completion of each learning phase. The first seven children were not asked this manipulation check by mistake. As such, participants were not excluded from the overall analyses based on this manipulation check. Notably, 88% (n = 57) of the children rated the face as portraying a fear-invoking emotion, i.e., scared, worried, shocked. As such, only three participants (4%) actually rated the face as an emotion other than fear invoking. All three participants were excluded from the final analysis, not for inaccurate emotion identification but for failing to acquire fear (further outlined in 3.2.2 and 3.3.2).

2.2.3 Computer.

The two learning phases were conducted on a 16-inch Toshiba laptop computer using Tobii-120 software.

2.3 Measures

2.3.1 Parent and child background information.

Parents and children were asked a series of demographic and background questions including age, education, and family history of anxiety.

2.3.2 Spence Children Anxiety Scale.

The Spence Children Anxiety Scale (SCAS) is a 45-item self-report measure used to record child anxiety (Spence, 1997). This scale was used to measure children's baseline anxiety tendencies. The SCAS asks children to rate how often each statement happens to them on a 3 point Likert-scale, never (0) to always (3). An example question is, "I worry about things". Higher scores indicate higher levels of anxiety. The SCAS has previously shown to have high internal reliability (Spence, 1997). In this study, Cronbach's alpha was good (α = .89).

2.3.3 Fear Belief Questionnaire.

The Fear Belief Questionnaire (FBQ; Field & Lawson, 2003) was used to measure changing fear beliefs towards each animal picture, at baseline, after-acquisition and after-fear reduction. Additionally, the FBQ was used to assess fear beliefs towards animal pictures in the pilot study (outlined above). The FBQ consists of eight hypothetical situations, and responses are reported on a 5-point Likert-scale, 0 (No, not at all) to 4 (Yes, definitely). For example, one item asks the participant "Would you be happy if you found this animal in your garden?". Higher scores demonstrate greater cognitive fear towards each animal. The FBQ has been used extensively to assess cognitive fear beliefs in past indirect fear learning research with children (Dunne & Askew, 2013; Field, 2006; Field & Lawson, 2003). See Appendix C for a complete list of the FBQ questions. Cronbach's alpha for the current study was good, ranging from .75 to .88.

2.3.4 Nature Reserve Task.

A variation of the Nature Reserve Task (NRT) was used to measure behavioural avoidance (Field & Storksen-Coulson, 2007). For the current study, the NRT consisted of a green rectangular board (60cm x 30cm) representing a nature reserve or bushland where the two animals live. Photos of each of the animals were positioned at either end of the board. The side of presentation for each animal was counterbalanced across the study. Children were asked to imagine that the board is a bushland, a term familiar to Australian children, and informed that the animals lived at either end of the bushland. Children were then instructed to imagine that they were a Lego figurine visiting the bushland. Children were asked to place ‘themselves’ where they would most like to be while visiting the bushland. Distances from each animal picture were used as indices of avoidance behaviour, with greater distance from each animal indicating greater avoidance of that animal. The NRT has been previously used with children to measure avoidance style and avoidance changes towards fear conditioned animals (Dunne & Askew, 2013; Field & Storkson-Coulson, 2007).

2.4 Procedure

A schematic depiction of the study’s procedures is depicted in Figure 1. All background and SCAS questions were completed online, no more than a week prior to families coming into Macquarie University for the study. The study was conducted with each child individually. Upon arrival, both parents and children completed consent forms.

The children were then administered baseline measures of the FBQ and NRT for each animal, followed by the computerised acquisition phase (see Figure 2 for an outline of the procedure). The order of the FBQ and NRT administration was not counter-balanced across the participants. The acquisition and fear reduction phases were presented as a slide show on a 16-inch computer screen. To ensure that children were motivated to look at the computer screen, each child was instructed that their task was to guess which animal was followed by something surprising. The *acquisition phase* of the study included 20 animal face pairings; one animal (CS+) paired with a scared face (10 times, fear acquisition), and one animal (CS-) presented alone (10 times, Unpaired; see Figure 2 for a schematic depiction). The linsang and ratel pictures were used as CS+ and CS-, and were counterbalanced across children. The animal-face pairings were presented for two seconds in total. The CS+ was presented alone for one-second then with the face US on the opposite side of the screen (randomized) for the remaining one-second. Unpaired CS- trials consisted of the animal picture presented for two seconds alone. Trial order was pseudo-randomized with the constraint that no more than three of a type (e.g., CS+) occurred in sequence. A variable interval of two, three or four seconds followed each trial, consistent with Dunne and Askew's (2013) procedure. The total duration for the acquisition phase was two minutes. To maximise fear learning, children were asked to keep their eyes fixed on the screen for the whole time. Following the acquisition phase, children completed the post-acquisition measures: the FBQ and NRT (for the second time). Additionally, children were asked about what they saw on the computer.

In the second learning phase or *fear reduction phase*, participants were randomly assigned to one of three groups: (1) Extinction Group, (2) Counter-Conditioning Group, or a (3) no fear reduction Control Group. The duration of the fear-reduction phase was two minutes. All participants then completed the FBQ and NRT for the third time and final time (*Test*) after the fear reduction phase was completed. All children were debriefed in the company of their parent and given correct information about the animals.

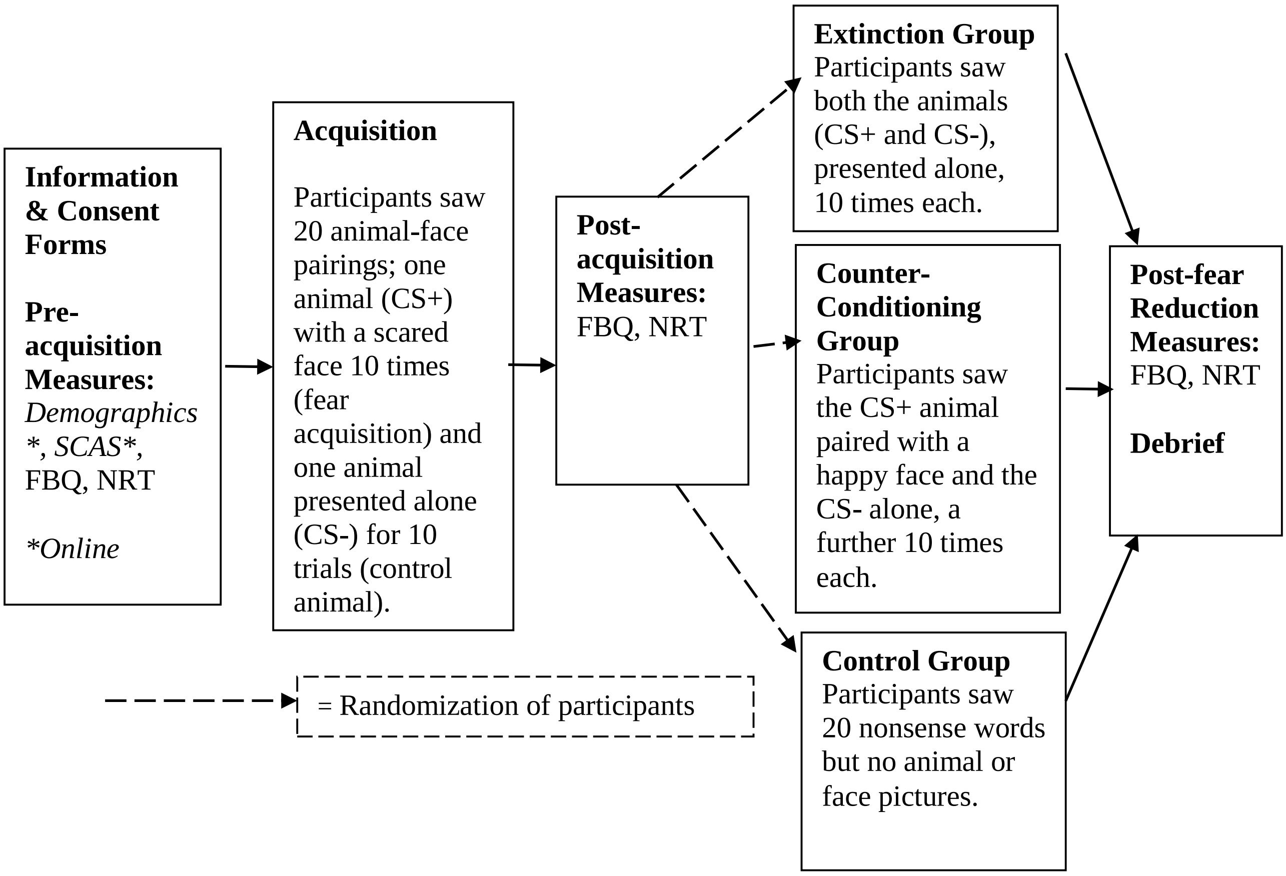


Figure 1. An outline of the study's procedure.

2.4.1 Extinction group.

In the Extinction Group, both animals (CS+ and CS-) were presented alone, without a face, a further 10 times (two second presentation each time).

2.4.2 Counter-conditioning group.

In the Counter-Conditioning Group, children saw both animals a further 10 times. However, for the Counter-Conditioning Group, the animal (CS+) that had previously been paired with a scared face was now paired with the same person displaying a happy facial expression. In this instance, the CS+ was presented alone for one second, and then paired with the happy face US for a further one second. Similar to the acquisition phase trial, for both the Extinction and Counter-Conditioning Group, presentations of the CS+

and CS- were pseudo-randomised with the constraint that no more than three of a type of CS (e.g., CS+) occurring in sequence.

2.4.3 Control group.

The Control Group viewed 20 nonsense words instead of animal pictures for the same length of time (see Appendix D for the complete list of nonsense words).

	Fear Acquisition	Fear Reduction		
	Acquisition 20 trials (10 of each animal)	*Extinction* 20 trial (10 of each animal)	*Counter-conditioning* 20 trials (10 of each animal)	*Control* 20 trials of non-words
CS+	 (1 second) ↓   (1 second)	 (2 seconds)	 (1 second) ↓   (1 second)	eguit* (2 seconds)
CS-	 (2 seconds)	 (2 seconds)	 (2 seconds)	

Figure 2. A schematic depiction of the acquisition and fear reduction phases (extinction, counter-conditioning and control) of the conditioning paradigm.
Note. CS = conditioning stimulus.
* The control task consisted of various non-words (e.g., eguit), taking the place of the animal pictures, presented on a blank screen (see Appendix D for a complete list).

2.5 Data Transformation

2.5.1 FBQ.

For the FBQ, average scores were calculated. Difference scores were taken as an index of discriminant fear learning to the CS+:

FBQ difference score = (Fear beliefs [CS+]) – (Fear beliefs [CS-])

Higher scores illustrated greater discriminant fear beliefs towards the CS+ than the CS-. Furthermore, positive scores indicated more fear for the CS+ than the CS-, whereas negative scores indicated greater fear for the CS- than the CS+.

2.5.2 NRT.

Difference scores were also calculated for the NRT as an index of discriminant avoidance to the CS+:

NRT difference score = (Distance from CS+) – (Distance from CS-).

Larger difference scores indicated a further distance from the CS+ relative to the CS-. Also, positive difference scores indicated greater distance from the CS+ than the CS-, whereas negative difference scores indicated greater distance from the CS- than the CS+.

2.6 Statistical Analysis

This study was a three-group experimental design investigating the relative effectiveness of fear reduction methods (independent variables: Counter-Conditioning Group, Extinction Group, and Control Group) on self-reported fear beliefs and behavioural avoidance (dependant variables).

As specific hypotheses about the three experimental groups were predicted, planned orthogonal contrasts (Hays, 1972) were used for between-subject analysis to eliminate redundancy in analysis of variance, and to increase power. Specifically, the first contrast tested the first hypothesis: that the Control Group would exhibit or report significantly greater fear than the average of the two fear reduction groups (Counter-Conditioning and Extinction) following fear reduction, but not at baseline or post-acquisition (SPSS contrast coding: Control = 2, Counter-conditioning = 1, Extinction =1). The second contrast tested the second hypothesis: that Counter-conditioning would lead to significantly less fear at the end of fear reduction than Extinction, though both groups should be equivalent at baseline and post-acquisition. Thus, the second contrast is a simple between-group comparison between the Counter-Conditioning and Extinction Groups.

There was also three time points: baseline, post-acquisition, and post-fear reduction. To illustrate *fear acquisition*, a mixed within-between group contrasts analysis with Time (baseline to post-acquisition) as a within-subject factor was used. This should illustrate an increase in fear from baseline to post-acquisition across all groups (i.e., only a main effect of Time) with no contrast differences between groups or interactions (i.e., no differential rates of fear acquisition based on group).

To illustrate differences at *Test*, the aforementioned planned orthogonal contrasts in a between-group analysis were utilised to show that differences between groups only emerged after the experimental manipulation.

Greenhouse-Geisser modifications were used when sphericity was not met (Field, 2006). Critical alpha was set at .05, unless specified otherwise, and *F* critical was set at 4.00, unless specified otherwise (Hayes, 1972).

3.0 Results

3.1 Preliminary Analysis

Participant demographic information is displayed in Table 1. Twenty-two participants were in each group. Groups did not differ by age, ethnicity, gender or SCAS score (*ps* = .085 to .318).

3.2 Fear Beliefs

3.2.1 Acquisition.

Results for control verse fear reduction groups (contrast one) reveal that there was no main effect of Time, F (1, 65) = 1.19, p = .279, η_p^2 = .02, and no Time x Group interaction, F (1, 65) = .14, p = .710, η_p^2 = .00. Therefore, there was no difference in fear belief scores from baseline to acquisition. Thus, participants did not acquire fear on the Fear Belief Questionnaire (FBQ; fear beliefs).

Table 1
Demographic Information

		Control (n = 22)		Extinction (n = 22)		Counter-Conditioning (n = 22)	
		M	SD	*M*	SD	*M*	SD
All Participants (n = 66)	Age	7.32	.51	10.09	1.77	9.09	1.34
	SCAS	18.82	15.16	17.86	10.67	24.41	16.78
FBQ Acquisition Subgroup (n = 41)	Age	9.47	1.30	10.20	1.64	9.73	1.30
	SCAS	17.33	13.11	19.00	10.67	28.00	16.64
NRT Acquisition Subgroup (n = 45)	Age	9.67	1.54	9.93	1.83	9.33	1.29
	SCAS	20.33	17.21	15.87	9.69	26.53	18.94

3.2.2 Fear belief acquisition subgroup.

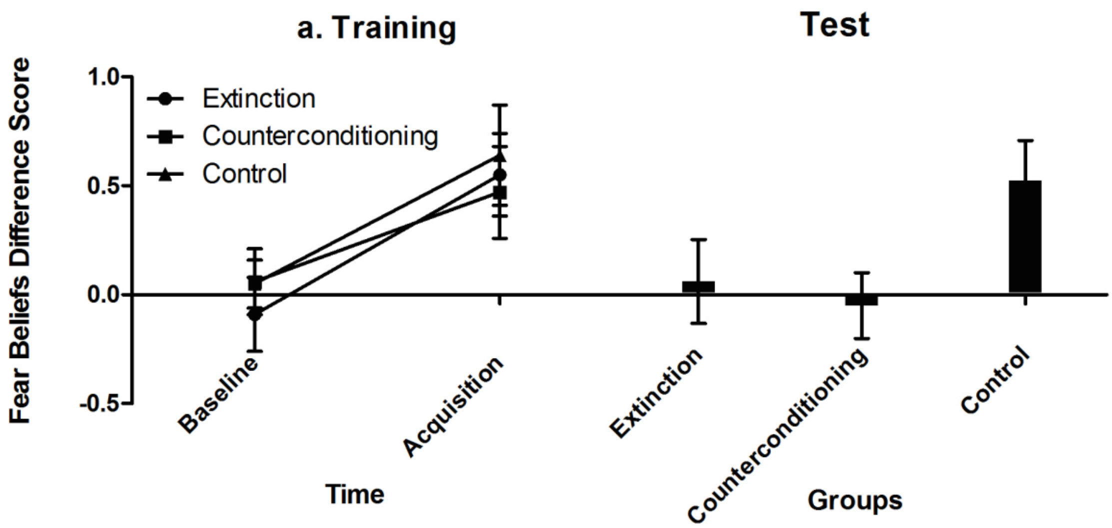
Given that fear acquisition is a requirement before the relative effectiveness of the two fear reduction techniques (extinction and counter-conditioning) can be evaluated, no further analyses were conducted on the complete sample. A second analysis was carried out on a subgroup of participants that acquired fear on the FBQ task (fear beliefs). Twenty-five participants were excluded for failing to acquire fear to the CS+ (i.e., lower FBQ scores to the CS+ compared to the CS- at acquisition compared to baseline scores), leaving a final subgroup sample of *n* = 41 (62%, females = 15). Those excluded did not differ from those included in the subgroup on age, ethnicity, gender or SCAS score (*ps* = .063 to .754; see Appendix E for the demographic information of the excluded group).

Forty-one children remained in the final analysis. The demographics are displayed in Table 1. Experimental groups did not differ by age, ethnicity, gender or SCAS score (*ps* = .120 to .427). For the following analyses, *F* critical was set at 4.08 for contrast one (df = 40) and 4.24 for contrast two (df = 24; Hayes, 1972).

3.2.2.1 Acquisition. The first contrast (control compared to the mean of the two fear reduction groups) x Time analysis revealed a significant main effect of Time, *F* (1, 40) =

7.43, p = .010, η_p^2 = .17, but no significant Time x Group interaction, F (1, 40) = .76, p = .388, η_p^2 = .02, or Group main effect, F (1, 40) = .15, p = .706, η_p^2 < .01. The second contrast (extinction compared to counter-conditioning) x Time analysis also revealed a significant effect of Time, F (1, 25) = 7.92, p = .009, η_p^2 = .27, but no significant Time x Group interaction, F (1, 25) = 1.35, p = .258, η_p^2 = .06. As such, fear beliefs increased from baseline to acquisition across all three groups (as can been seen in Figure 3). Furthermore, the increase in fear beliefs did not differ as a function of group, thus after acquisition all groups showed the same level of fear. Additional contrast analyses also revealed no differences between groups at baseline or at acquisition (*ps* = .354 to .975). Hence, fear belief scores were equivalent at baseline and acquisition across all groups.

3.2.2.2 Fear reduction test. There was a significant difference between control and fear reduction groups (contrast one) at Test, F (1, 40) = 7.95, p = .008, η_p^2 = .17. As can be seen in Figure 3, fear beliefs were significantly lower in the counter-conditioning and extinction groups after the fear reduction phase compared to the control group. However, there was no significant difference between the extinction and counter-conditioning groups (contrast two) after fear reduction F (1, 25) = .19, p = .666, η_p^2 < .00. As such, extinction and counter-conditioning produced equally effective reduction of fear beliefs.



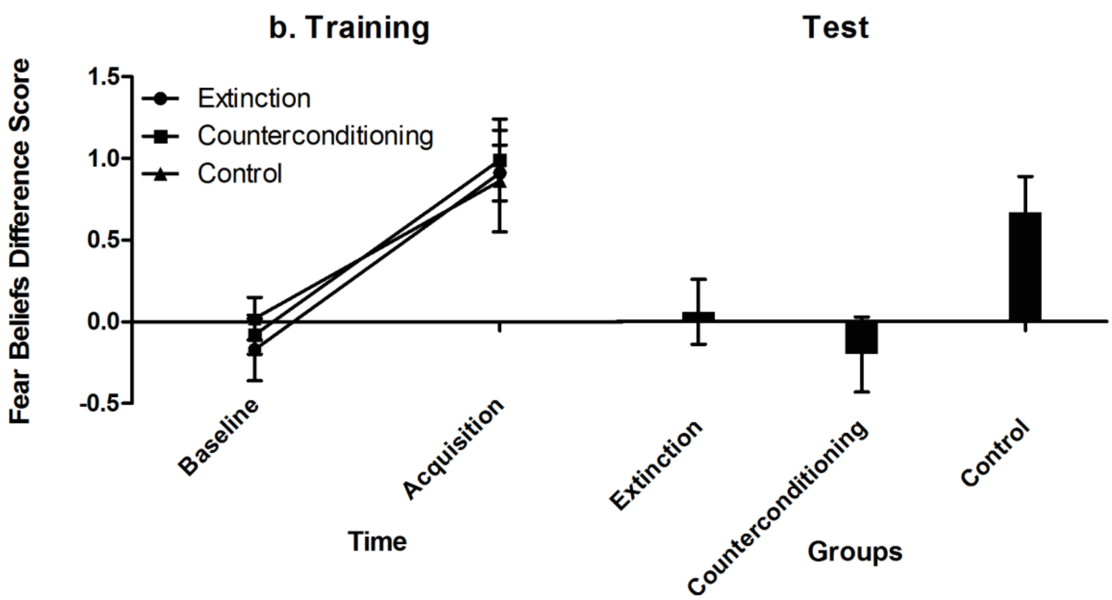


Figure 3a. Means (+/- SEM) of the fear belief difference scores for all participants. *Figure 3b.* Means (+/- SEM) of the fear belief difference scores for participants that acquired fear on the FBQ.

3.3 Avoidance Behaviours

3.3.1 Acquisition.

Overall group results revealed that there was a trend towards a significant effect of Time, F (1, 65) = 3.95, p = .051, η_p^2 = .06, but no Time x Group interaction, F (1, 65) = .34, *p* = .564, η_p^2 = .05, for the control verse fear reduction contrast (contrast one). Despite trending towards significance, scores did not significantly differ from baseline to acquisition, or as a function of group allocation. Hence, behavioural avoidance did not increase from baseline to acquisition (i.e., fear was not acquired).

3.3.2 Avoidance acquisition subgroup.

Analysis of NRT avoidance behaviours indicated that not all participants acquired fear. In the absence of significant fear acquisition, scores at *Test* cannot be attributed to fear reduction methods. Therefore, further analyses were conducted on a sub-group that that acquired fear on the NRT, i.e., children that demonstrated further distances from the CS+ animal after the acquisition phase. Demographics are displayed in Table 1. Twenty-one participants were excluded for failing to acquire fear. Those excluded did not differ from those included by age, ethnicity, gender or SCAS score (*ps* = .278 to .657; see Appendix E for the demographic information of the excluded group).

Forty-five participants acquired fear on the NRT and were subsequently included in the following analyses (68%, females = 20). Groups did not differ by age, ethnicity, gender or SCAS score (*ps* = .191 to .581). Additionally, *F* critical was set at 4.06 for contrast one (df = 44), and 4.18 for contrast two (df = 29) in the following analyses (Hayes, 1972).

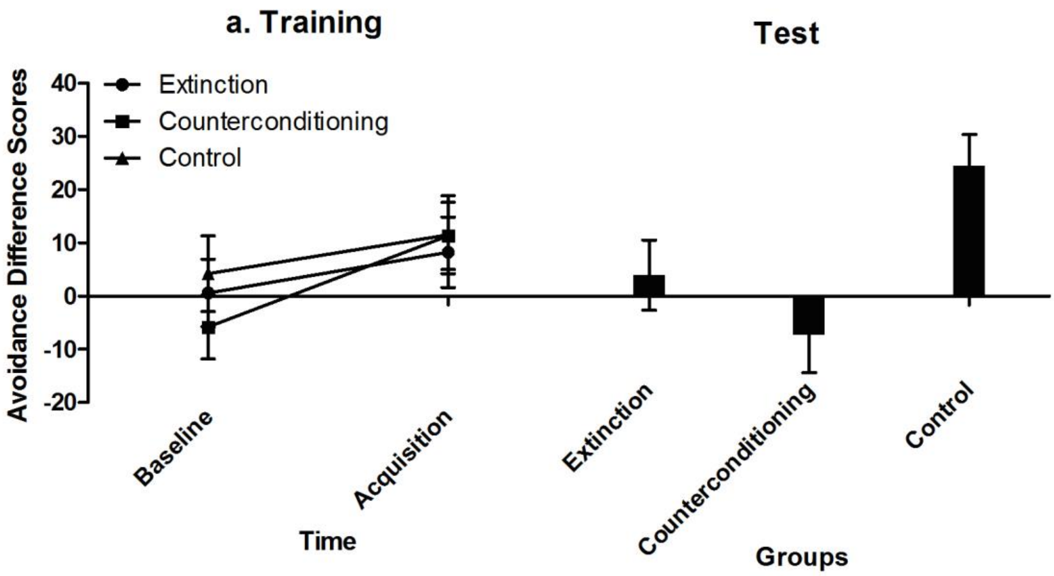
3.3.2.1 Fear acquisition. For the first contrast (control versus the mean of the two fear reduction groups) x Time analysis, results revealed a significant main effect of Time, *F* (1, 44) = 15.31, *p* < .001, η_p^2 = .27, but no significant Time x Group interaction, *F* (1, 44) = .02, *p* = .877, η_p^2 = .00, or Group main effect *F* (1, 44) = 2.13, *p* = .152, η_p^2 = .05. That is, there were greater distances from the CS+ animal at acquisition compared to baseline. Hence, as is evident in Figure 4, avoidance increased from baseline to acquisition.

Furthermore, a significant main effect of Time was found when extinction was compared to counter-conditioning (contrast two) x Time analysis, *F* (1, 29) = 12.60, *p* = .001,

η_p^2 = .32, but no significant Time x Group interaction was detected, *F* (1, 29) = .25, *p* = .103, η_p^2 = .10. As such, avoidance increased from baseline to acquisition measures for extinction and counter-conditioning. Thus, behavioural avoidance increased after the acquisition phase for all three groups, and this avoidance did not differ as a function of group. Follow up analyses confirmed that there were no differences between groups in avoidance scores at baseline or at acquisition (*ps* = .421 to .664).

3.3.2.2 Fear reduction test. Results revealed a significant difference at *Test* between the control and fear reduction groups (contrast one), *F* (1, 44) = 8.47, *p* = .006, η_p^2 = .17. As shown in Figure 4, fear reduction interventions (extinction or counter-conditioning) resulted in lower levels of behavioural avoidance (i.e., less distances from the CS+ animal compared to the CS- animal) than the control condition.

However, no differences were recorded for avoidance levels between extinction and counter-conditioning (contrast two) at *Test*, *F* (1, 29) = 2.93, *p* = .098, η_p^2 = .10. Therefore, extinction and counter-conditioning did not differ at *Test*. However, inspection of Figure 4b suggests that the Extinction Group did not decline in avoidance as much as the Counter-Conditioning Group. Failure to detect this difference could be due to a lack of power, as a large number of participants (32%) were excluded for not acquiring fear. As such, two follow up paired t-tests were conducted (Bonferroni adjusted .05/2 = .025). Results for the extinction group reveal no significant decline in avoidance between acquisition and *Test* scores, *t* (14) = .65, *p* = .524, η_p^2 = .030. However, a significant difference was found between acquisition and *test* scores for the counter-conditioning group, *t* (14) = 3.95, *p* = .001, η_p^2 = .526. Notable the effect size for the counter-conditioning group is moderate, indicating a significant reduction from acquisition to test scores for the counter-conditioning group. These follow up analyses revealed a significant reduction in avoidance after the fear reduction phase in the counter-conditioning group but not the extinction group.



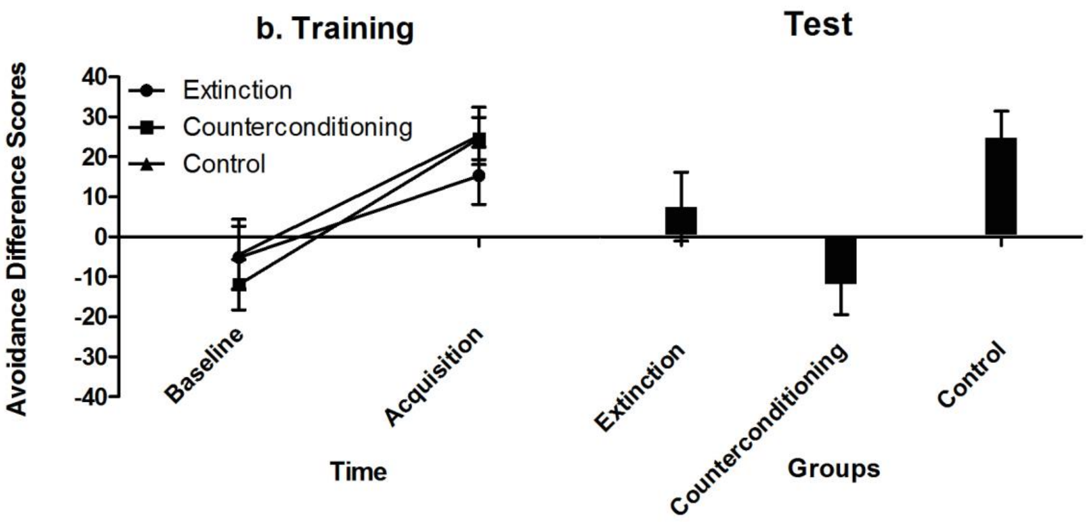


Figure 4a. Means (+/- SEM) of the avoidance difference scores for all participants. *Figure 4b.* Means (+/- SEM) of the avoidance difference scores for all participants that acquired fear on the NRT.

3.4 Subgroup Differences

Results so far support **Hypothesis 1** and partially support **Hypothesis 2**. However it is unclear if extinction and/or counter-conditioning function differently on fear beliefs or avoidance. Hence, analyses were conducted to assess the acquisition and fear reduction of fear beliefs in those who acquired fear on the NRT and the acquisition and fear reduction of avoidance in those who acquired fear on the FBQ.

3.4.1 Avoidance analyses for the fear belief acquisition subgroup.

Analysis assessing changes in behavioural avoidance across time was conducted on the subset of participants that acquired fear on the FBQ (*n* = 41, see Figure 5 for a graphic representation).

3.4.1.1 Acquisition. Analyses revealed no significant main effect of Time or Group x Time interaction between baseline and acquisition measure, for contrast one or contrast two, for behavioural avoidance (*p*s = .127 to .970). Therefore, those that acquired fear on the FBQ (i.e. showed a statistically significant increase in fear beliefs from baseline to acquisition measures) did not acquire fear on the NRT (i.e., did not show an increase in behavioural avoidance from baseline to acquisition). Therefore no further fear reduction analyses were conducted.

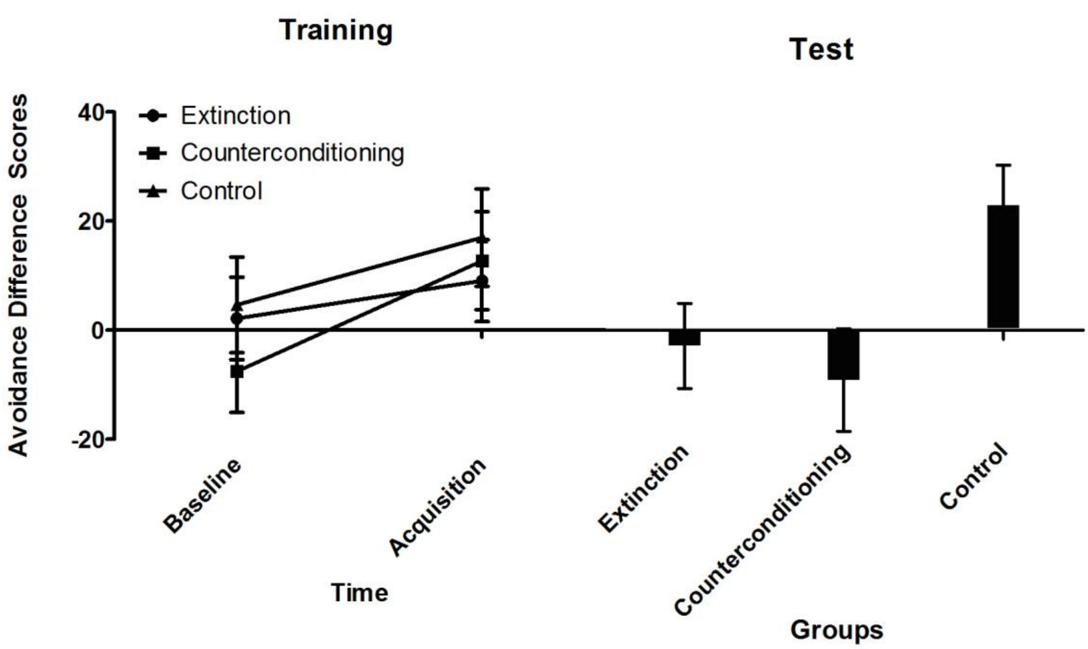


Figure 5. Means (+/- SEM) of the avoidance difference scores for participants that acquired fear on the FBQ.

3.4.2 Fear beliefs in the avoidance subgroup.

Fear beliefs were assessed for the subgroup that acquired behavioural avoidance on the NRT task (n = 45, see Figure 6 for a graphic representation).

3.4.2.1 Acquisition. Control verse fear reduction (contrast one) results reveal no significant main effects of Time or Time x Group interaction effects (*ps* = .066 to .989). Thus, those that acquired fear on the NRT (i.e., showed a statistically significant increase in behavioural avoidance from baseline to acquisition) did not significantly acquire fear on the FBQ (i.e. did not have significant increases in fear beliefs from baseline to acquisition). Thus, no further fear reduction analysis was conducted.

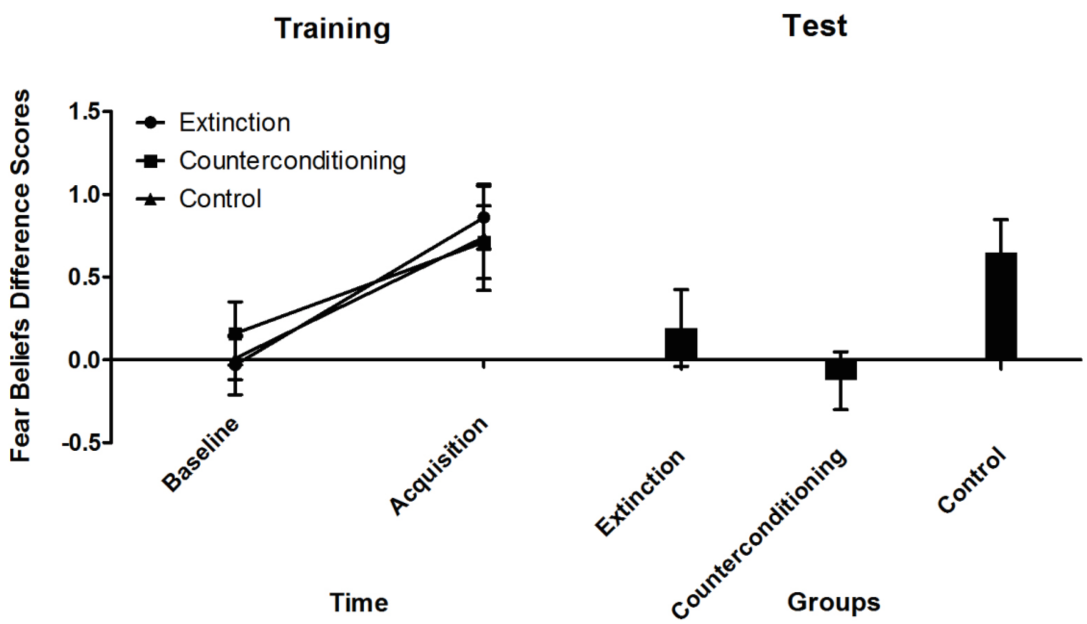


Figure 6. Means (+/- SEM) of the fear belief difference scores for participants that acquired fear on the NRT.

4.0 Discussion

Results showed that, in those that acquire fear vicariously, extinction and counter-conditioning effectively reduced learned fear compared to controls that never underwent fear reduction techniques **(Hypothesis 1)**. Furthermore, levels of fear reduction on the self-report

FBQ (fear beliefs) did not differ significantly between participants who received extinction and participants who underwent counter-conditioning **(Hypothesis 2)**. However, results also tentatively suggest that counter-conditioning may have led to greater decreases in behavioural avoidance (NRT) compared to extinction **(Hypothesis 2)**.

4.1 Fear Reduction

The first hypothesis **(Hypothesis 1)** predicted that fear reduction techniques (extinction and counter-conditioning) would result in greater fear reduction than the control group (no fear reduction). This is supported by the current results. The significant reduction of learned fear (fear beliefs and avoidant behaviours) seen in the Extinction and Counter-Conditioning Groups is in line with past direct (Thomas et al., 2012) and indirect adult research (Gast & De Houwer, 2013; Golker et al., 2013; Newall et al., in press). For example, Raes and De Raedt (2012) found that extinction and counter-conditioning were both effective in reducing fear ratings towards a negatively conditioned facial picture in adult participants. The significant reduction is also consistent with recent child research on counter-conditioning in vicarious fear learning using the same procedure (Dunne & Askew, 2013). Hence, the current results suggest that extinction and counter-conditioning may produce similar fear reduction within children as seen in adults (Gast & De Houwer, 2013; Golkar et al., 2013; Kelly et al., 2010). However, the current results are limited to the specific age-range of children tested (aged seven to 12 years old), and are further restricted by the fact that approximately 35% of children did not acquire fear based on the FBQ and NRT indices. Thus, the results cannot be extrapolated to children outside the specific age-range, and are generalizable only to select children that acquire fear through vicarious learning. Therefore, explanations for the current results need to be treated with some caution and further replication may be necessary. Nonetheless, when fear is *learned*, the results indicate that both counter-conditioning and extinction are successful at reducing vicariously learned fears in school-aged children. These results add to previous papers that propose that indirect extinction and counter-conditioning are viable methods of fear reduction in children (Dunne & Askew, 2013; Kelly et al., 2010).

4.2 Counter-Conditioning Compared to Extinction

Counter-conditioning was also expected to result in lower learned fears (fear beliefs and avoidance) than extinction based on the extant but limited adult research (Kerkhof et al., 2011; Raes & Raedt, 2012) in the area **(Hypothesis 2)**. Contrary to expectations, counter-conditioning did not result in lower levels of fear beliefs (FBQ) than extinction. However, there were lower levels of avoidance (NRT) seen in the counter-conditioning group from *Acquisition* to *Test* measurements. In comparison, the extinction group had equivalent levels of avoidance from *Acquisition* and *Test*. However, this was only evident in follow-up t-tests and not in the main planned contrast analyses. Hence **Hypothesis 2** is partially supported by the avoidance data but not on the self-report measure.

It is typically believed that anxiety is expressed, and thus can be measured, in three different areas of function (Lang, 1968). The three areas are, behavioural expressions (e.g., increased avoidance), internal cognitions (e.g., higher fear beliefs) and physiological indices (e.g., increased sweat; Lang, 1968). In this study, counter-conditioning produced greater fear reduction than extinction in the behavioural measure of fear (avoidant behaviours) but not the cognitive measure of fear (fear beliefs). Additionally, children that showed fear learning on the FBQ (fear beliefs) did not shown fear learning on the NRT (avoidant behaviours) and visa versa. Thus, there appears to be a dissociation between cognitive and avoidance data. This raises the important issue of why some of the current effects are seen in one index (avoidant behaviours) and not in another (self-report/cognitive measure; Culver, Vervliet & Craskes, in press; Raes & De Raedt, 2012). One possibility is that self-report measures of fear can be subject to response biases (van de Mortel, 2008). In particular, self-report measures are easier to ‘fake’, either purposely, to provide socially desirable answers, or the participant may be entirely unaware (van de Mortel, 2008). Furthermore, accurate self-report responses in children are contingent on the sufficient development of underlying cognitive skills required to answer correctly (von Baeyer, Uman, Chambers & Gouthro, 2011). On the other hand, behavioural responses are harder to fake, as they are less subject to cognitive interference. As the NRT has no obvious ‘correct’ answer it is harder for children to answer in a socially desirable manner. Furthermore, it is harder for the children to remember the exact distances they have placed the Lego piece relative to the ‘scary’ animal across the phases of the study, which may minimise the impact of social desirability or a denial of fear. Thus, in the current results, the NRT may provide a more accurate index of fear, explaining the different fear reduction results between the FBQ and NRT measures. Hence, the lower levels of fear found in the Counter-Conditioning Group, compared to the Extinction Group, may be a better indicator of fear-reduction success. Additionally, the NRT as an index of avoidance may be the more important measure. Anxiety literature reveals that behavioural avoidance is the key factor in the maintenance of anxiety disorders (Berman, Wheaton, McGrath & Abramowitz, 2010; Panayiotou, Karekla & Panayuotoi, in press). For example, if an individual avoids a fear-provoking situation then anxiety can never be reduced. This is because avoidance prevents extinction of feared cues in the situation, where the individual learns that in fact nothing catastrophic occurs (i.e., the absence of an anticipated negative US) if they enter the situation. As such, avoidance reduction (NRT) may be a more clinically relevant index of anxiety than reductions in fear beliefs. Hence, the greater fear reduction of avoidance by counter-conditioning compared to extinction could be a more meaningful and accurate measure of the child’s actual fear and how it functions in the real world. However, further studies are needed to verify whether counter-conditioning is indeed more effective than extinction on behavioural avoidance given that the relative effectiveness of counter-conditioning and extinction was only found in follow-up t-tests. A viable next step in future research would be to include additional behavioural indices (e.g., a Behavioural Approach Task; Kelly et al., 2010), which may provide a more accurate measure of fear change.

The tentative but not conclusive results found in the NRT analysis (i.e., differences between extinction and counter-conditioning only found in follow up t-tests) could also be due to a lack of power. A substantial proportion of participants were excluded (~35%) for failing to acquire fear on the NRT. Hence, there was less power to detect a significant difference between counter-conditioning and extinction in the main between-group comparison. As such, further research with larger sample sizes and power estimates could provide clearer evidence for whether counter-conditioning is more effective than extinction in children.

The current results are further explained in light of past research. Past findings using direct conditioning procedures have found that counter-conditioning may be more successful than extinction in reducing fears (Anderson et al., 2013; Kerkhof et al., 2011; Raes & De Raedt, 2012; Thomas et al., 2012). However, there has been limited research comparing counter-conditioning to extinction using indirect conditioning methods. One study, by Gast and De Houwer (2013), found that counter-conditioning compared to extinction resulted in greater changes to indirectly conditioned preferences (negative or positive ratings) towards non-words in adults. However, no past research has explicitly assessed indirect counter-conditioning compared to indirect extinction in the reduction of learned fears in children.

The current results, in line with adult indirect conditioning literature, show that both counter-conditioning and extinction are effective at reducing fear in children (Gast & De Houwer, 2013; Golkar et al., 2013). Furthermore, as the extant past literature implies, there is some suggestion that on behavioural measures counter-conditioning is more powerful than extinction (Anderson et al., 2013; Kerkhof et al., 2011; Raes & Raedt, 2012; Thomas et al., 2012). Hence, this study provides the first insight into the relative effectiveness of counter-conditioning and extinction of vicarious fear learning in children.

4.2.1 Theoretical explanations.

Counter-conditioning may produce better fear reduction by effectively *changing* the valence of the CS into a positive one, *as well as* reducing the expectancy of a negative outcome, whereas extinction only achieves the later. In fear conditioning, fears are dependent on the contingency between a neutral stimulus (e.g., animal picture) and a threatening stimulus (e.g., fearful facial expression; Kerkhoff et al., 2011). Thus, throughout conditioning, the CS (e.g., animal picture) becomes a predictor of a negative experience (US, e.g., fearful facial expression). However, the CS also gains negative emotional valence of its own because of its association with the unpleasant US (Kerkhoff et al., 2011). Thus, by presenting a positive stimulus in order to reduce fear, counter-conditioning may also alter the negative meaning, or valence, connected to the CS (Kerkhof et al., 2011). As such, counter-conditioning specifically targets how an individual evaluates a CS. Conversely in extinction the negative evaluation is addressed secondarily as it is over time that the individual learns that no negative stimulus follows (Bouton, 2002). Hence, extinction does not explicitly address the negative 'meaning' of the CS. In the current procedure, counter-conditioning pairs the animal picture CS with a happy face as opposed to the scared face, and clearly specifies a change of valence assigned to the animal picture. Thus, the reduction of learned behavioural avoidance may be enhanced in counter-conditioned (compared to extinction) as the new learned association involves altering the emotional evaluation of the CS. Additionally, in counter-conditioning, the presence of a positive stimulus reduces uncertainty about what will follow the CS (i.e., the presence of a happy face is a clear indication that the animal picture is not paired with a fearful face). Thus, the positive stimulus reduces the expectancy of a negative outcome (Raes & De Raedt, 2012; Thomas et al., 2012).

Furthermore, the presence of a positive stimulus (counter-conditioning) may ‘replace’ the original fear learning with a new learned association (i.e., the animal picture is clearly associated with a positive outcome; Thomas et al., 2012). The extinction procedure also reduces the expectancy of a negative outcome when no scared face is displayed with the animal picture. However, the absence of a fearful stimulus could theoretically increase the expectancy for a fearful stimulus to follow (Raes & De Raedt, 2012). Thus, the better reduction of avoidance in the Counter-Conditioning Group at *Test* on the NRT, compared to the Extinction Group may be due to the inclusion of a happy face (positive US) reducing the fearful *evaluation* of the animal picture, and *expectancy* of a fearful stimulus (scared face).

Another explanation as to why counter-conditioning may be more effective than extinction in reducing fear is differences in attention to the CS. Gast and De Houwer (2013) proposed that extinction trials are less interesting than counter-conditioning trials as no emotive stimuli appears during extinction. Thus, children may have paid less attention to extinction trials than the counter-conditioning trials, which included a new emotively appealing element (e.g., happy face). In the current study, if children paid less attention to the extinction trails then they may have had less opportunity to learn that the animal was ‘safe’, i.e., no longer paired with the scared face. However, no studies to date have assessed attention towards counter-conditioning and extinction trials. Future studies might include attention measures when administering learning procedures to assess and compare attention across trial types. The conditioning procedures could be administered in conjunction with eye-tracking technology. Eye tracking data could then provide a measure of preferential looking to the CS during extinction and counter-conditioning, and thus measure the amount of attention to the CSs, USs and the overall trials.

4.3 Limitations of the Current Research

While this study offers the first insight into counter-conditioning compared to extinction in school-aged children, the results are somewhat limited. The substantial portion of children that did not acquire fear (~35%) in the paradigm on either the FBQ or the NRT limits the power of this study, and also restricts the potency and generalizability of conclusions. It is worth noting that the number of children that did not acquire fear is comparable to other direct fear conditioning studies with children of a similar age range (e.g., ~40%; Glenn et al., 2012). However, the procedure utilised in this paper has been reliably used previously without the current rates of participant exclusion (Dunne & Askew, 2013; Reynolds, Field & Askew, 2014). Thus, fear acquisition rates in this study could be due to differences between the current methodology and past methodologies (Dunne & Askew, 2013; Reynolds et al., 2014). There are three notable differences between the current procedure and previous procedures by Askew’s laboratory. The current study included older children (up to 12 years old) than previously assessed with this procedure (up to 9 years old; Dunne & Askew, 2013; Reynolds et al., 2014). While it is possible that age contributed to the lack of fear acquisition, it seems unlikely given that those who acquired fear did not differ by age to those that did not acquire fear (excluded) on the two indices of fear.

Previous studies also used different animals - the quoll and quokka as CSs (Dunne & Askew, 2013; Reynolds et al., 2014). The quoll and quokka could not be used in the current study as the study was conducted in Australia, and the quoll and quokka are native Australian animals. Different animals had to be used to ensure that Australian children had no prior knowledge of these animals. The two animal photos utilized (the ratel and linsang) in the current paper were validated in a pilot study (see section 2.2.1 for details). Accordingly, children in the pilot study rated the ratel and linsang as equally novel and equally neutral (averaged ratings of two on the FBQ) in initial fear response. While direct comparisons of ratings for the ratel, linsang, quoll and quokka are not available; it is worth noting that the mean baseline of the quoll and quokka in Dunne and Askew's (2013) paper were not very different from the mean baseline of the ratel and linsang in the current study. Hence, it seems unlikely that the different animal pictures (CSs) are the cause of the low fear acquisition rates observed in the current sample.

The third difference is the adult facial pictures that served as USs. Previous papers gathered and validated their own pictures of adult facial expressions (Dunne & Askew, 2013). Notably, validation was done using adults rather than children (Dunne & Askew, 2013). The current study used the NimStim set of facial expressions, which has also been previously validated using adults (Tottenham et al., 2009). Thus, one possibility is that the lack of fear acquisition may be due to the current sample rating the faces differently to adults. There is some evidence indicating that children are less sensitive at detecting emotional expressions than adults (Batty & Taylor, 2006; Thomas, De Bellis, Graham & LaBar, 2007). However, this does not explain the difference between previous studies with similar aged samples and the current one, as all studies used facial images validated with adults not children (Dunne & Askew, 2013). Moreover, children who rated the adult face (for the acquisition phase) as an emotion other than fearful or shocking emotion (4%, e.g., sad or funny) were all excluded from the final analyses, minimising the misinterpretation of the US faces' emotions as the likely cause of failure to acquire fear in ~35% of our sample. Another possibility is that the adult facial expressions used in the current study may not be as emotionally compelling or salient compared to the ones used in previous papers (Dunne & Askew, 2013). As such, the current facial expressions utilised may have been less effective in eliciting a fear response, and thus explains the lower fear acquisition rates in the current study. Therefore, future studies may need to obtain scary and happy ratings of the facial images with children prior to its use in a conditioning study with child participants.

Furthermore, the inclusion of a pilot study specifically assessing the salience of the USs (emotional expressions) with children could help ensure optimal fear acquisition. Thus, the current study suggests several opportunities for future research. For example, learning may differ depending on the type of the face US used. That is, learning may proceed differently using an adult face compared to a peer's face (i.e., a similarly aged child). An interesting future study might be to compare fear learning with adult face USs to child (peer) face USs.

Additionally, the short presentation duration of the animals (1 second) prior to the US (facial picture) onset might mean that children were not able to fully process the animal picture before the facial picture was displayed. This could inturn have affect fear acquisition and be partially responsible for the low rates of fear acquisition seen in this study. Thus, future studies might consider extending the exposure duration to ensure adequate processing by children.

Furthermore, with this paradigm, it is unclear if the NRT is measuring avoidance of a feared stimulus or safety behaviours by children preferring to place 'themselves' closer to a perceived safety stimulus (CS-). Future research could determine whether the NRT does indeed measure avoidance. A possible future technique could include a third novel emotionally-irrelevant stimulus novel stimuli the child has never seen before. Measurements from the CS+ animal (paired with a scared face), the CS- animal (control animal) and from the emotionally-irrelevant novel stimulus may clarify if the child is exhibiting safety or avoidant behaviours. An additional limitation to this paradigm is that the FBQ does not necessarily measure CS expectancy and evaluation. CS expectancy is the expectation that a US will always follow the CS+ and CS evaluation is the understanding that the CS is followed by something unpleasant, even if the participant is not afraid of the CS. Therefore, it is possible that children learn to expect an animal-face association and understood that the CS is a predictor of something unpleasant but did not evaluate the animal CS as fearful.

Including expectancy and evaluative ratings as well as the FBQ would help clarify if counter-conditioning and extinction reduced expectancy/evaluation as well as fear.

Moreover, the current study suggests several opportunities for future research. The current study was powered to have a 93-96% chance of detecting a moderate effect with the original sample (n=73) from baseline to acquisition for the NRT and FBQ. However, with the exclusions (n[FBQ] = 41 and n[NRT]=45) it only has a 76-81% chance of detected a moderate effect from baseline to acquisition for the NRT and FBQ. All other analyses conducted were planned contrasts (to analyze fear reduction). As such, the authors are currently unaware of any calculators that would allow us to determine power for Hay's planned orthogonal contrast. Based on power analysis for a one-way ANOVA with a 3-group design with the overall sample size (n=73), the current study has a 45% chance of detecting a moderate effect, and an 87% chance of detecting a large effect for FBQ and NRT at post-extinction. However, with the final exclusions we have a 26% chance of detecting a moderate effect and a 59% chance of detecting a large effect for the FBQ (n=41), and a 28% chance of detecting a moderate effect and a 64% chance of detecting a large effect for the NRT (n=45). It should be noted that planned contrasts are generally more powerful than one-way overall ANOVAs, thus we can be certain that the power for the contrasts is higher than a one-way overall analysis. Regardless, the exclusions significantly reduced the current power, highlighting an important limitation to the present paper. Future sample sizes should make allowances for the approximate 35 to 40% of children that might not acquire fear (i.e., increase sample sizes by an additional 40%), to ensure adequate power to detect significant effects.

Finally, the current study, consistent with previous studies (e.g., Dunne & Askew, 2013; Field 2006b), utilised a non-clinical sample and induced fears. Thus, these results cannot be directly extrapolated to clinical anxiety disorders or their treatment. Future studies need to consider fear reduction (extinction and counterconditioning) in established diagnosed clinical fears.

4.4 Future Directions

4.4.1 Return of fear paradigms.

Although the counter-conditioning and extinction produced similar rates of fear decline in the current study, it is difficult to ascertain at this stage whether the processes used to reduce fear via these two techniques – counter-conditioning and extinction - are identical. For instance, while one technique may use erasure, the other may use masking – thus, affecting probability of relapse. Most of the direct conditioning literature suggests that extinction uses masking (Milad & Quirk, 2012; Neumann & Kitlersirivatana, 2010). To date, there is some tentative evidence to suggest that counter-conditioning may be more robust against relapse, and thus may use erasure rather than masking (Kerkhof et al., 2011; Raes & Raedt, 2012). For example, Thomas and colleagues (2012) found that a food-based counter-conditioning paradigm prevented fear renewal in adult rats. Thus, additional research comparing counter-conditioning to extinction in the return of fear may provide further insight into the process used by counter-conditioning and extinction to reduce fear. Specifically, counter-conditioning may produce different fear results after return of fear paradigms (e.g., reinstatement) than extinction in *children*. However, there is also evidence that counter-conditioning, like extinction, may be subject to recovery of fear as well in adults (Brooks et al., 1995). Thus, a promising future research study would be to assess counter-conditioning and extinction in children after a reinstatement reminder. Specifically, after fear reduction (counter-conditioning and extinction), a single unpaired presentation of the US (scared face) could be administered to ‘reinstate’ fear. Return of fear following either counter-conditioning and/or extinction would suggest that fear reduction processes in children are due to masking rather than erasure. However, if one procedure (e.g., counter-conditioning) does not result in the reinstatement of fear then it would suggest processes of fear reduction are qualitatively different between counter-conditioning and extinction, with one procedure being more robust against relapse than the other. This would have significant clinical implications for the refinement and outcomes of childhood anxiety treatment.

4.4.2 Developmental perspective.

A further important step for fear reduction research would be to compare the return of fear paradigms across development. For example, preliminary infant rat research suggests that renewal and reinstatement are absent after extinction in juvenile rats (Kim & Richardson, 2010; Yap & Richardson, 2007). Thus, there is some evidence to suggest that extinction in children may function differently from adults. That is, extinction in early life may be more potent and less susceptible to relapse than later in life. As such, the comparison of extinction across three age groups; infants/toddlers, later childhood, and adulthood, would allow mapping of how extinction functions across development. An adaptation of the current learning procedure with the addition of a reinstatement reminder could index the differences in extinction function across ages. The current learning procedure would need to be adapted to suit younger children, who might have problems attending to a learning procedure administered on a computer. Therefore, real life modelling (e.g., by the experimenter) towards an unknown stimulus might be more appropriate for fear learning, fear reduction and reinstatement in infants/toddlers. Based on past research, it is expected that younger children would have lower levels of fear after reinstatement (perhaps even no recovery of fear), and reinstatement would increase as age increases (Kim & Richardson, 2010; Yap & Richardson, 2007). That is, adults are expected to have higher levels of fear after reinstatement compared to children and infants.

If extinction does differ across development, then a larger study repeating the developmental extinction procedure with the inclusion of two counter-conditioning groups (with reinstatement and without) would be a viable future study. The comparison of extinction to counter-conditioning across development may provide further insight into the processes each technique uses across development to reduce fear. For example, extinction and/or counter-conditioning may result in the erasure of learned fears in infants and young children but not adults. This could not only inform optimal early intervention ages but also impact the type of treatment used at different points of development.

4.5 Clinical Implications

With replication, the current findings may have important implications for clinical practice. The results of the current study support the notion that vicarious counter-conditioning and extinction are advantageous methods of fear reduction in school-aged children. Notably, indirect extinction and counter-conditioning (e.g., watching the therapist perform a feared task) are components of behavioural therapies used to reduce clinical anxiety in children as well as in adults (Berry et al., 2009; Britton, Lissek, Grillon, Norcross & Pine, 2011; Field, 2006a). Furthermore, as counter-conditioning may be superior to extinction in children, this study could inform the refinement of behaviour-based therapies. Given that avoidance is a significant maintaining factor for anxiety disorders and the current results suggest that counter-conditioning functions better than extinction in reducing avoidance for children. Therefore, counter-conditioning may be an effective *first step* in anxiety treatment with children to facilitate extinction (Berman et al., 2010; Panayiotou et al., in press). Thus, using counter-conditioning first (specifically positive modelling) may encourage children to avoid less throughout therapy, thereby increasing and deepening exposure. Exposure, as mentioned previously, is the real life equivalent of extinction and involves the gradual exposure to a feared stimulus, lessening the anxiety associated with it. In addition, there is some evidence to suggest that positive information (informational fear reduction) might be better at reducing learned fears in children than positive modelling (vicarious fear reduction; Muris et al., 2011). Hence, the coupling of positive modelling with positive information (counter-conditioning) in the initial stages of anxiety treatment may provide the most optimal treatment approach for dealing with indirectly learned fears in children.

The long-term success of early intervention for anxiety disorders is a largely untouched area of research, yet expansion in this area offers the potential to significantly impact long-term anxiety outcomes. Preliminary research with rodent models suggests that early life extinction reduces learned fears more effectively than later in life (Yap & Richardson, 2007). Including counter-conditioning first, which may increase the potency of therapies administered, could possibly enhance or speed up early intervention outcomes.

4.6 Conclusion

The current study found that vicarious extinction and counter-conditioning successfully reduce vicariously learned fears in children aged seven to 12 in a laboratory situation. Furthermore, counter-conditioning appears to reduce learned fears better than extinction on avoidant behaviours, though the same could not be said of self-report measures of fear. Thus, this study is, to the author's knowledge, the first to compare the relative success of counter-conditioning to extinction in children. Further research is needed to examine processes of extinction and counter-conditioning in children, and whether they involve the same or different processes. Understanding how counter-conditioning and extinction work in children has the potential to inform the refinement of childhood anxiety interventions in the near future.

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Appendix A: Conditioned Stimulus

Animal stimuli used as conditioned stimuli in the study: ratel (left) and linsang (right).

Linsang: Finally Over Blog Spot. *Listes Thématiques*. Retrieved from: http://www.finallyover.com/article-35613865.html (accessed Jan, 2014)

Ratel: Wikipedia. *Honey Badger.* Retrieved from: http://en.wikipedia.org/wiki/Honey_badger (accessed Jan, 2014)

Appendix B: Unconditioned Stimulus

An example of the male and female, scared and happy, facial pictures used during the acquisition and counter-conditioning phases on the experiment. Faces from NimStim set of facial expressions.

Note. The actual faces used in the experiment are unable to be published; the included images are an example only.

Female Scared

Female Happy

Male Scared

Male Happy

Appendix C: Fear Belief Questionnaire

The Fear Belief Questionnaire (e.g., for the ratel) is shown below.

1. Do you think a Ratel would live in Australia? (Practice question)

No, not at all	No, not really	Don't Know / Neither	Yes, probably	Yes, definitely
0	1	2	3	4

2. Would you be happy to have Ratel for a pet or look after a Ratel for a few weeks?

No, not at all	No, not really	Don't Know / Neither	Yes, probably	Yes, definitely
0	1	2	3	4

3. Do you think a Ratel would hurt you?

No, not at all	No, not really	Don't Know / Neither	Yes, probably	Yes, definitely
0	1	2	3	4

4. Would you go up to a Ratel if you saw one?

No, not at all	No, not really	Don't Know / Neither	Yes, probably	Yes, definitely
0	1	2	3	4

5. Would you go out of your way to avoid a Ratel?

No, not at all	No, not really	Don't Know / Neither	Yes, probably	Yes, definitely
0	1	2	3	4

6. Would you be happy to feed a Ratel?

No, not at all	No, not really	Don't Know / Neither	Yes, probably	Yes, definitely
0	1	2	3	4

7. Would you be scared if you saw a Ratel?

No, not at all	No, not really	Don't Know / Neither	Yes, probably	Yes, definitely
0	1	2	3	4

8. Would you be happy if you found a Ratel in your garden?

No, not at all	No, not really	Don't Know / Neither	Yes, probably	Yes, definitely
0	1	2	3	4

Appendix D: Nonsense Words

A complete list of the nonsense words used for the control condition of the fear reduction procedure.

oldme

datir

egujt

ifnlu

aebrl

baehp

tinga

jutan

aewtk

nrdko

yenpo

aitop

milbe

rigon

euohl

baroc

awrlu

nrcui

glaei

Appendix E: Demographic Information for Excluded Subgroups

Table 2

A table of the age, gender and SCAS scores for all participants, inclusions and exclusions

		All Participants	Control	Extinction	Counter-Conditioning
All Participants (n = 66)	Gender (n & % males)	38 (57.6%)	10 (45.5%)	13 (59.1%)	15 (68.2%)
	Age (*M* & SD)	9.50 (1.57)	7.32 (1.46)	10.09 (1.77)	9.09 (1.34)
	SCAS (*M* & SD)	20.36 (14.51)	18.82 (15.16)	17.86 (10.67)	24.41 (16.78)
FBQ Acquisition Subgroup (n = 41)	Gender (n & % males)	26 (63.4%)	8 (53.3%)	9 (60.0%)	9 (81.8%)
	Age (*M* & SD)	9.78 (1.39)	9.47 (1.30)	10.20 (1.64)	9.73 (1.10)
	SCAS (*M* & SD)	20.80 (13.75)	17.33 (13.11)	19.00 (10.67)	28.00 (16.64)
FBQ Exclusion Subgroup (n = 25)	Gender (n & % males)	12 (48.0%)	2 (28.6%)	4 (57.1%)	6 (54.5%)
	Age (*M* & SD)	9.04 (1.77)	9.00 (1.83)	10.00 (2.16)	8.45 (1.30)
	SCAS (*M* & SD)	19.64 (19.93)	22.00 (19.64)	15.43 (11.09)	20.82 (16.92)
NRT Acquisition Subgroup (n = 45)	Gender (n & % males)	25 (55.6%)	6 (40.0%)	10 (66.7%)	9 (60.0%)
	Age (*M* & SD)	9.64 (1.56)	9.67 (1.54)	9.93 (1.83)	9.33 (1.29)
	SCAS (*M* & SD)	20.91 (16.06)	20.33 (17.21)	15.87 (9.69)	26.53 (18.94)
NRT Exclusion Subgroup (n = 21)	Gender (n & % males)	13 (61.9%)	4 (57.1%)	3 (42.9%)	6 (85.7%)
	Age (*M* & SD)	9.19 (1.60)	8.57 (1.00)	10.43 (1.72)	8.57 (1.40)
	SCAS (*M* & SD)	19.19 (10.71)	15.57 (9.74)	22.15 (12.19)	19.86 (10.64)

Supplementary Material

Raw scores for NRT

	Extinction Group						Counter-Conditioning Group						Control Group					
	CS+			Cs-			CS+			CS-			CS+			CS-		
	Pre-Acq	Post-Acq	Post-Ext	Pre-Acq	Post-Acq	Post-Ext	Pre-Acq	Post-Acq	Post-Ext	Pre-Acq	Post-Acq	Post-Ext	Pre-Acq	Post-acq	Post-Ext	Pre-Acq	Post-acq	Post-Ext
	39	40	30	21	20	30	10	17.5	18.5	50	42.5	43.5	50.5	54	55	9.5	6	5
	13.5	22	14	46.5	38	46	8.5	45	2.5	51.5	15	57.5	47	50	49	13	10	11
	30	44	30	31	17	33	16	50.5	26.5	44	9.5	33.5	10	50	50	50	10	10
	30.00	37.00	60.00	30.00	24.00	8.00	31	55	2.5	29	5	57.5	29.50	40.50	44.00	30.50	19.50	26.00
	11.50	44.50	13.50	47.50	15.50	46.50	26.5	40.5	37	33.5	19.5	23	31.00	52.00	37.50	29.00	8.00	22.50
	56	57	2.5	4	3	57.5	18	33.5	25	42	26.5	35	5.50	57.00	30.00	54.50	4.00	30.00
	7	21.5	24.5	53	38.5	33.5	18	34.5	23	42	25.5	37	45.00	48.50	58.00	14.50	11.50	2.00
	17.5	30	27	42.5	30	33	32.5	38	40.5	26.5	22	19.5	7.5	51	51.5	52.5	9	8.5
	30	39	41.5	30	21	18.5	31.5	34.5	28	28.5	25.5	32	23.00	33.00	37.00	37.00	27.00	23.00
	2.4	8	58.5	57.5	52	1.5	17	50.5	2.5	43	9.5	57.5	32	39.5	49	28	20.5	11
	30.00	33.00	30.00	30.00	27.00	30.00	41	40.5	27	19	19.5	33	51.5	53	51	8.50	7.00	9.00
	42	53	52	19	8	9	30	40	30	30	20	30	8	9	8	52.00	51.00	52.00
	42	54	56	18	6	4	8	55.5	30	52	4.5	30	6	20	45	54.00	40.00	15.00
	19	30	35	41	30	25	50	54	53	10	6	7	40	56	58	20.00	14.00	12.00
	42	53	37	18	7	23	22	45	15	38	15	45	30	31.5	30	30.00	28.50	30.00
Mean	27.46	37.73	34.10	32.60	22.47	26.57	24.00	42.30	24.07	35.93	17.70	36.07	27.77	43.00	43.53	32.20	17.73	17.80
SD	15.29	13.97	17.22	15.13	13.87	16.38	12.15	10.23	14.36	12.20	10.23	14.42	16.99	14.13	13.31	17.03	13.63	12.97
SE	4.09	3.73	4.60	4.04	3.71	4.38	3.25	2.73	3.84	3.26	2.73	3.85	4.54	3.78	3.56	4.55	3.64	3.47
N	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00

Raw scores for FBQ

	Extinction Group						Counter-Conditioning Group						Control Group					
	CS+			CS-			CS+			CS-			CS+			CS-		
	Pre-Acq	Post-Acq	Post-Ext	Pre-Acq	Post-Acq	Post-Ext	Pre-Acq	Post-Acq	Post-Ext	Pre-Acq	Post-Acq	Post-Ext	Pre-Acq	Post-Acq	Post-Ext	Pre-Acq	Post-Acq	Post-Ext
	2.14	2.29	1.57	1.43	1.57	1.71	2.00	2.14	1.86	2.00	2.14	2.14	1.29	1.43	1.14	1.57	1.43	1.43
	1.29	1.43	1.00	1.43	1.43	1.43	2.14	2.86	2.29	1.71	1.86	2.00	1.29	1.71	2.00	0.29	0.71	0.00
	3.00	3.86	2.29	3.29	2.29	2.29	0.29	1.57	0.71	0.57	0.57	0.43	1.71	4.00	2.86	1.14	0.00	1.57
	1.71	3.00	2.86	2.43	1.86	1.86	2.29	2.71	2.86	2.86	2.86	2.29	1.86	2.86	2.57	2.58	1.57	1.43
	1.43	2.29	1.14	0.86	0.00	2.14	0.71	3.00	2.00	1.29	1.00	2.00	3.43	4.00	4.00	3.29	4.00	4.00
	0.86	1.43	0.86	1.56	0.86	1.14	2.29	3.57	1.57	2.14	1.29	3.29	2.43	2.57	2.57	2.14	1.29	1.43
	1.29	2.14	1.57	2.57	1.71	2.71	2.57	3.29	2.71	2.57	1.86	2.43	1.29	2.57	1.14	1.29	1.29	0.14
	1.29	2.00	1.29	1.71	1.57	1.29	2.43	2.57	2.43	2.86	2.86	2.29	1.71	2.14	1.57	1.86	2.43	1.57
	2.14	3.71	2.14	3.14	2.86	2.43	2.71	3.71	1.71	2.00	2.57	2.00	1.57	1.86	2.00	1.86	1.71	2.29
	1.86	2.29	2.14	2.57	2.00	2.14	2.71	3.00	2.29	2.71	2.00	2.14	2.43	3.14	3.14	1.57	0.86	1.00
	0.86	1.00	1.00	0.29	0.43	0.43	2.43	3.43	1.57	2.71	2.00	3.14	1.29	1.86	1.43	1.43	1.00	0.57
	1.57	2.43	2.29	2.29	2.14	2.14							1.57	1.86	1.86	2.14	2.43	2.29
	2.00	2.57	1.71	1.14	0.86	0.00							2.29	2.71	2.71	2.86	2.71	2.86
	3.00	3.29	2.86	3.14	2.29	3.14							1.29	2.00	1.71	1.43	2.00	1.29
	2.29	2.86	2.14	1.43	1.00	1.14							1.86	3.14	2.86	1.57	1.57	1.71
Mean	1.78	2.44	1.79	1.95	1.52	1.73	2.05	2.90	2.00	2.13	1.91	2.20	1.82	2.52	2.24	1.80	1.67	1.57
SD	0.66	0.82	0.66	0.90	0.77	0.84	0.80	0.64	0.61	0.73	0.73	0.73	0.60	0.80	0.81	0.74	0.96	1.02
SE	0.18	0.22	0.18	0.24	0.21	0.23	0.25	0.20	0.19	0.23	0.23	0.23	0.16	0.21	0.22	0.20	0.26	0.27
N	15.00	15.00	15.00	15.00	15.00	15.00	11.00	11.00	11.00	11.00	11.00	11.00	15.00	15.00	15.00	15.00	15.00	15.00

Analysis on Raw Scores

Fear Belief Questionnaire (FBQ) raw score analysis for the CS+ animal.
Results for control verse fear reduction groups (contrast one) reveal that there was no main effect of Time, F (1, 65) = .062, p = .805, η_p^2 = .001, and no Time x Group interaction, F (1, 65) = .508, p = .478, η_p^2 = .008. Results for contrast two, extinction compared to the counterconditioning group reveal that there was no main effect of Time, F (1, 44) = .176, p = .688, η_p^2 = .004, and no Time x Group interaction, F (1, 44) = .151, p = .699, η_p^2 = .004. Therefore, there was no difference in fear belief scores from baseline to acquisition. Thus, participants did not acquire fear on the FBQ. Follow up analysis revealed no group differences in fear belief scores at baseline or at acquisition (ps = .590 to .998)

Nature Reserve Task (NRT) raw score analysis for the CS+ animal.
Results for control verse fear reduction groups (contrast one) reveal that there was no main effect of Time, F (1, 65) = 3.594, p = .063, η_p^2 = .053, and no Time x Group interaction, F (1, 65) = .173, p = .679, η_p^2 = .003. Results for contrast two, extinction compared to the counterconditioning group reveal that there was a significant main effect of Time, F (1, 44) = 5.189, p = .028, η_p^2 = .110, but no Time x Group interaction, F (1, 44) = 1.667, p = .204, η_p^2 = .038. Therefore, there was no difference from baseline to acquisition between the control and fear reduction groups. However, there was a different between the two fear reduction groups. Thus, all groups did not acquire fear on the NRT. Follow up analyses confirmed that there were no differences between groups in raw avoidance scores (CS+ or CS-) at baseline or at acquisition (ps = .485 to .755). However, analysis revealed significant difference between groups after fear reduction for both the CS+ scores, t(42) = 6.274, p = .004 and the CS- scores, t(42) = 5.826, p = 006. Which is somewhat expected as the CS+ animal and the CS- animal were measured on the same NRT board. Thus while CS+ and CS- do not necessarily have to be functions of each other it is possible that they are given the forced choice nature of the NRT.