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# Reductions in Children's Vicariously Learnt Avoidance and Heart Rate Responses Using Positive Modeling

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Recent research has indicated that vicarious learning can lead to increases in children's fear beliefs and avoidance preferences for stimuli and that these fear responses can subsequently be reversed using positive modeling (counterconditioning). The current study investigated children's vicariously acquired avoidance behavior, physiological responses (heart rate), and attentional bias for stimuli and whether these could also be reduced via counterconditioning. Ninety-six (49 boys, 47 girls) 7- to 11-year-olds received vicarious fear learning for novel stimuli and were then randomly assigned to a counterconditioning, extinction, or control group. Fear beliefs and avoidance preferences were measured pre- and post-learning, whereas avoidance behavior, heart rate, and attentional bias were all measured post-learning. Control group children showed increases in fear beliefs and avoidance preferences for animals seen in vicarious fear learning trials. In addition, significantly greater avoidance behavior, heart rate responding, and attentional bias were observed for these animals compared to a control animal. In contrast, vicariously acquired avoidance preferences of children in the counterconditioning group were significantly reduced post-positive modeling, and these children also did not show the heightened heart rate responding to fear-paired animals. Children in the extinction group demonstrated comparable responses to the control group; thus the extinction procedure showed no effect on any fear measures. The findings suggest that counterconditioning with positive modelling can be used as an effective early intervention to reduce the behavioral and physiological effects of vicarious fear learning in childhood.

Childhood fears and phobias are some of the most prevalent psychological disorders (e.g., Merckelbach, De Jong, Muris, & Van den Hout, 1996; Muris, Merckelbach, De Jong, & Ollendick, 2002). Research demonstrates that normal fearfulness in children decreases as they get older (Gullone & King, 1997) and that these fears usually appear and

disappear as part of normative development, often reflecting the experiences of the child (Field & Purkis, 2011). There are several ways in which phobic levels of fear may develop. Learning through observing someone else's (a "model") reaction to a stimulus (vicarious learning) has been proposed as an indirect pathway through which childhood fears develop (Rachan, 1977). Indeed, the retrospective reports of children and adults suggest that intense, persistent fears can be acquired through observation (e.g., Merckelbach, De Ruiter, Van den Hout, & Hoekstra, 1989; Ollendick & King, 1991; Öst & Hugdahl, 1981; see Askew & Field, 2008). However, there are several limitations of retrospective self-report accounts, in particular the potential for memory bias (e.g., Öst, 1987). Therefore, ideally,

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experimental research should be carried out prospectively, with children at an age when phobias typically begin.

A substantial body of prospective, experimental research has indicated that vicarious learning can lead to increases in children's fear cognitions and behavioral avoidance of animals (e.g., Askew, Dunne, Özdil, Reynolds, & Field, 2013; Askew & Field, 2007; Askew, Kessock-Philip, & Field, 2008; Dubi, Rapee, Emerton, & Schniering, 2008; Dunne & Askew, 2013; Egliston & Rapee, 2007; Gerull & Rapee, 2002), and more recently physiological responses and attentional bias toward threat (Reynolds, Field, & Askew, 2014). However, the exact mechanisms underlying the process of vicarious fear learning in children are still not fully understood.

It has long been assumed that vicarious learning is underpinned by similar associative learning mechanisms as direct conditioning (e.g., Askew & Field, 2008; Bandura & Rosenthal, 1966; Berger, 1962; Field, 2006a; Hygge & Öhman, 1978; Mineka & Cook, 1993). Typically, conditioning occurs when a neutral stimulus (a conditioned stimulus [CS]) is associated with a traumatic event (an unconditioned stimulus [US]) that elicits a fear response (unconditioned response [UR]), and consequently the CS comes to elicit the same response (conditioned response [CR]) when encountered alone. As such, conditioning is seen to be driven by stimulus-stimulus (S-S) associations between the CS and US. Similarly, vicarious learning has also been conceptualized as S-S learning in which an observer associates a CS with the model's response (observer's US) to that CS and subsequently the CS evokes a CR related to the US. For example, if a child observes a model's fearful response (US) to dogs (CS), then dogs may become associated with this modelled response and subsequently evoke a similar fearful response in the child (CR). If vicarious fear learning is a form of S-S (CS-US) associative learning then breaking or preventing this association should eliminate the fear response (see Askew & Field, 2008; Field, 2006a). Thus, identifying which characteristics of associative learning are shared by vicarious learning could potentially influence the development of more appropriate interventions and the prevention of fear.

Not only is it adaptive for individuals to learn to fear potentially dangerous aspects of their environment, but it is equally vital that this learning is flexible so that nonthreatening stimuli that have previously been considered dangerous can be recategorized as safe. Counterconditioning occurs when a learned response is altered in a second, contradictory, learning episode; for example, presenting a CS together with a positive US may weaken an existing fear-related response to the CS by creating a new positive CS-US association. Recent research has shown that fear associations acquired via verbal information can be "unlearned" using positive modelling: Kelly, Barker, Field, Wilson, and Reynolds (2010) demonstrated that children's fear cognitions and behavior toward novel animals, acquired through verbal information, could be "unlearned" using

positive information or a positive modelling procedure. Fear responses had not been vicariously acquired in Kelly et al.'s study; however, Dunne and Askew (2013) subsequently showed that vicariously learned increases in fear beliefs and avoidance preferences for animals also return to baseline levels following vicarious counterconditioning. This suggests that vicarious learning in children shares some of the characteristics of classical conditioning.

This initial evidence for counterconditioning has been fairly limited in terms of fear response systems. Self-reported fear or anxiety in both children and adults are typically associated not just with cognitive (e.g., fear beliefs) and behavioral (e.g., avoidance preferences) responses but also with changes in physiological and attentional responses. Recent research has demonstrated that vicarious fear learning leads to changes in all three of Lang's (1968) response systems; subjective report, avoidance behavior, and physiological responses (Askew & Field, 2007; Askew et al., 2008; Reynolds et al., 2014). Dunne and Askew's (2013) study showed that vicariously acquired fear beliefs (subjective report) are reduced to baseline levels following vicarious counterconditioning. With respect to Lang's second response system, avoidance behavior, Dunne and Askew measured avoidance preferences using the nature reserve task (Field & Storksen-Coulson, 2007), in which children indicate how much they would avoid an animal by placing a figure representing themselves on a board relative to the animal. Although avoidance behavior is implied by the task, the relation between avoidance preferences in the nature reserve task and actual avoidance behavior may not be straightforward (Broeren, Lester, Muris, & Field, 2011; Reynolds et al., 2014). Therefore, although counterconditioning of avoidance behavior was implied, it should also be directly investigated in a behavioral avoidance task.

Research also indicates that both anxious and nonanxious individuals show increased attention for threatening stimuli (Cisler & Koster, 2010; Field, Hadwin, & Lester, 2011; Garner, 2010; MacLeod, Mathews, & Tata, 1986; Merckelbach et al., 1996; see Mogg & Bradley, 1998). Reynolds et al. (2014) found children showed attentional bias for animals following vicarious fear learning, and this effect was moderated by increases in their fear beliefs. This is particularly important because research has demonstrated that the fear systems are relatively independent and do not always correlate (e.g., Hodgson & Rachman, 1974; Zinbarg, 1998), thus it cannot be assumed that because vicarious learning has been demonstrated to lead to changes in fear beliefs, avoidance behaviour, and physiological responding, it will also lead to changes in attentional bias. However, it is not yet known if learnt attentional bias can also be eliminated. If research were able to demonstrate that attentional bias toward threat can be reduced, this would be a clear indication that one of the key elements of fear has been reduced. Similarly, research has established increases in

children's heart rate responses for stimuli, Lang's third (physiological) fear response system, following fear-related vicarious learning (Reynolds et al., 2014). However, it is not yet clear if a vicarious counterconditioning intervention would return these responses to pre-learning levels.

Counterconditioning is not the only way to reverse a learned fear response. Extinction is a well-established behavioral phenomenon in which repeated exposure to a CS alone, in the absence of its associated aversive US, leads to the gradual diminishing of the previously established fear CR (e.g., Bouton, 2004; Craske et al., 2008; Milad & Quirk, 2012; Myers & Davis, 2007). For example, following the contiguous presentation of a tone (CS) and shock (US), the tone will come to evoke a fear response (CR) in the absence of the shock. But subsequently presenting the tone (CS) in nonreinforced trials results in a reduction of the fear response. Early influential accounts (e.g., Rescorla & Wagner, 1972) proposed that extinction is the result of the destruction of the association between the CS and US. Thus the CS no longer activates a representation of the US and hence does not elicit a CR. More recent accounts (e.g., Bouton, 1993) represent extinction as a form of "new learning," whereby a new opposing CS–no US association competes with the original CS–US association. Post-extinction phenomena indicating that extinguished CRs can be recovered (e.g., spontaneous recovery, renewal, reinstatement, and reacquisition) support the idea of extinction representing an inhibitory learning process (see Bouton, 2002, for a review). Extinction theory is typically based on laboratory experiments with rodents, but there is also a wealth of evidence for extinction in human adults (e.g., Hygge & Öhman, 1978; Milad, Orr, Pitman, & Rauch, 2005; Prenoveau, Craske, Liao, & Ormitz, 2012). Laboratory fear extinction can be viewed as an experimental model of exposure-based therapies for anxiety disorders (Bouton, Mineka, & Barlow, 2001; Davey, 1997; Mineka, 1985; Mineka & Zinbarg, 2006), and hence the effectiveness of extinction procedures for reducing vicariously learned fears is an important topic for investigation with far-reaching clinical implications (Askew & Field, 2008). Dunne and Askew (2015) investigated the extinction of vicariously acquired fear responses in children with contradictory results: They found evidence of extinction of fear beliefs but not avoidance preferences for one stimulus type (animals), but for another type of stimulus (flowers) they found no extinction at all. These findings may reflect specific characteristics of the two fear measures Dunne and Askew used, which were both essentially self-report, and extinction should be investigated for other measures that are less under conscious control, such as heart rate and attentional bias.

Therefore, the current study explores counterconditioning and extinction as potential procedures for reducing previous vicariously acquired fear responses in children. Both these procedures are essentially laboratory models of common clinical practices and are therefore well suited for

examination using Askew and Field's (2007) vicarious learning paradigm, which is itself a nonthreatening experimental analogue of fear learning outside of the laboratory. In the basic vicarious learning procedure, children see one animal presented with faces expressing fear (fear-paired) and another animal presented alone (unpaired control). In addition, one third of children here were assigned to a vicarious counterconditioning group (animal with happy faces), a third were assigned to an extinction group (animal alone), and the remaining children were assigned to a control group. Based on previous evidence of the reduction of fear using positive modelling (e.g., Dunne & Askew, 2013; Kelly et al., 2010), it was predicted that counterconditioning would lead to reductions in learned fear cognitions, behavioral avoidance, physiological responses, and attentional bias. Given that extinction following conditioning is a generally well-documented effect in animals and adults (e.g., Bouton, 1993, 2004), it was expected that, like counterconditioning, CS-alone presentations would also reduce vicariously learned fear responses in children.

## METHOD

### Participants

Ninety-seven children took part from two primary schools in Essex, UK, with an age range of 7.04 to 11.69 years and a mean age of 9.22 ( $SD = 1.31$ ) years. This age group was chosen because normative fears are thought to concentrate on animals around this age (e.g., Field & Purkis, 2011) and because children of this age group are likely to have less extensive learning histories that may otherwise affect learning (e.g., Field, 2006a). Approximately half of the children who were invited to participate returned signed parental consent forms. Children were mainly White British and from mixed socioeconomic backgrounds. All children at the schools within the age range were invited to participate by letter sent home with the children, but only children who returned signed parental consent forms took part. Children and their families were not offered any incentive or payment for taking part. All participating children gave verbal assent on the day of the experiment. One participant's data were excluded on the basis that the child did not fully understand the procedure. Therefore, 96 children (49 boys, 47 girls) remained in the study, with 32 children randomly allocated to each of three groups. Ages of children in the three groups did not differ significantly (counterconditioning:  $M = 9.11$  years,  $SD = 1.42$  years; extinction:  $M = 9.36$  years,  $SD = 1.32$ ; control:  $M = 9.19$  years,  $SD = 1.27$ ),  $F(4, 95) = 0.56, p = .69$ .

### Materials

For the automated parts of the procedure, a program written in E-Prime 2.0 by the first author was used on a Samsung

RF511 Laptop and a ProLite T2451MTS 24-in. touchscreen monitor.

**Animals.** Twenty color pictures of two Australian marsupials were used as animal CSs: 10 pictures of a quokka and 10 of a cuscus, each measuring  $346 \times 444$  pixels. These animals were chosen for their unfamiliarity to U.K. children (see also Askew & Field, 2007; Field & Lawson, 2003).

**Faces.** Ten pictures of scared faces (five male, five female) taken from the NimStim Face Stimulus Set (Tottenham et al., 2009) were used as face USs. Pictures measured approximately  $346 \times 444$  pixels.

**Fear Beliefs Questionnaire.** The Fear Beliefs Questionnaire (FBQ; Field & Lawson, 2003; see also Askew & Field, 2007; Reynolds et al., 2014; 2015; for use within a vicarious learning paradigm) contained seven identical questions (four reverse-scored) about the quokka and cuscus and measured children's fear beliefs for each animal CS, for example, "Would you be scared if you saw a CUSCUS?" The questionnaire was computerized, and children touched the screen to indicate a response on a 5-point Likert-type response scale: 0 (*no, not at all*), 1 (*no, not really*), 2 (*don't know/neither*), 3 (*yes, probably*), 4 (*yes, definitely*). A picture of the animal in question was also displayed on the screen. Internal consistency was high; before vicarious learning: Cronbach's  $\alpha = .73$  (Quokka subscale),  $.73$  (Cuscus subscale); after vicarious learning:  $\alpha = .87$  and  $.86$ , respectively; and after the fear reduction intervention phase:  $\alpha = .86$  and  $.85$ , respectively.

**Nature Reserve Task.** Avoidance preferences for animal CSs were measured using a Nature Reserve Task (NRT; (Field & Storksen-Coulson, 2007; see also Askew & Field, 2007; Reynolds et al., 2014; 2015; for use within a vicarious learning paradigm). Children are asked to imagine that a green felt covered rectangular board ( $680 \times 500$  mm) is a nature reserve. To add to the realism, one pipe cleaner tree was placed in each corner and a pipe cleaner fence was placed along the edge of the board. All trees and fences were positioned so that children were unable to position their figure in order to hide behind the embellishments. A picture of each of the animals was displayed consecutively at one end of the board to represent the animal in the reserve. Two LEGO figures (a male and female) represented the child: Boys were given the male figure and girls the female figure. Children were asked to place the LEGO figure where they wished to be in the reserve. The distance between the figure and picture of the animal was measured (in mm) to determine approach or avoidance

preferences for the child. The order of presentation of each animal was counterbalanced across participants.

**Behavioral Avoidance Task and Heart Rate Response.** To measure behavioral avoidance for CSs (see Askew & Field, 2007; Field & Lawson, 2003; Kelly et al., 2010) two pet carrier boxes (size =  $260 \times 460 \times 340$  mm) ostensibly containing the animals were positioned 1 m from a line where the child was standing. On each of the boxes was a picture of the animal children were told was inside, small breathing holes, and a large hole (diameter = 14 cm) allowing the child to put their hand in the box. The hole was covered with hessian to prevent the children from seeing into the box. Children were given the instructions, "In this box, we have a quokka. In this box, we have a cuscus. If you want to, please could you walk towards the box and put your hand into the box up to the wrist." Children were timed approaching the boxes consecutively. The cuscus was always approached first, followed by the quokka (both from the line positioned 1 m from the boxes). If the child did not approach the box within 15 s, it was assumed they were withdrawing their consent to participate and the procedure moved on. During this task, online measures of children's heart rate were recorded from a finger using a Contec Finger Probe Pulse Oximeter. The researcher recorded heart rate at 0 s baseline (as the task commenced), as the child stepped forward approaching the box, as the child put their hand in the box, and finally as the child withdrew their hand from the box. Heart rate was chosen to measure physiological responding because research has demonstrated it to be a good measure of fear or anxiety; in contrast to a physiological measure such as skin conductance, which may be more suited to measuring aggression (e.g., Weems, Zakem, Costa, Cannon, & Watts, 2005).

**Dot-Probe Task.** For the final part of the procedure, an adapted version of the pictorial dot-probe task used by Bradley, Mogg, White, Groom, and de Bono (1999; see also Field, 2006b; Reynolds et al., 2014) was used to explore attentional biases toward the animals. First a fixation cross appeared on the computer screen for 500 ms, followed by pictures of the two animal CSs (quokka and cuscus,  $346 \times 444$  pixels) presented simultaneously for 500 ms, one on the left the other on the right. The pictures disappeared to immediately reveal a dot probe (either : or ..) "behind" one of the animal pictures. If the probe was ":" children pressed the red button on the left side of a response box, if the probe was ".." children pressed the blue button on the right side of a response box. Children were asked to locate the probe as quickly as possible, and the probe remained on the screen until they had responded. Response times and accuracy were recorded. Two different pictures for each animal were used making four different



pairs of pictures. For each pair, the position of the picture on the left or right of the screen was also counterbalanced. Therefore, each of the four picture pairs appeared twice over eight trials, with the position of the picture on the screen being reversed. Each of these combinations were repeated with each of the two probes (: and ..) appearing equally on the left or right of the screen over 32 individual trials. Each trial was presented twice, creating a total of 64 trials (see Field, 2006b). Therefore, there were an equal number of congruent and incongruent trials for each animal stimulus. Before the trials commenced, children were given 16 practice trials.

## Procedure

Children participated on an individual basis in a quiet room of the school. The procedure took approximately 25 min in total. Children first completed the pre-learning NRT. The automated procedure then began with the first FBQ followed immediately by the vicarious learning procedure. Consistent with previous experiments (e.g., Askew et al., 2013; Askew & Field, 2007; Dunne & Askew, 2013; Reynolds et al., 2014, 2015), during vicarious learning all children were presented with a slideshow on the monitor of 20 CS-US pairing trials: 10 animal-face trials (fear-paired CSs) and 10 animal-alone trials (unpaired CSs). In each pairing, the animal appeared first on the left-hand side of the screen for 1 s and remained on the screen when the picture of the face appeared on the right-hand side of the screen. Both pictures then remained presented for a further 1 s, so each trial was 2 s long in total. The intertrial interval varied randomly between 2 s and 4 s (see, e.g., Askew & Field, 2007; Askew et al., 2008). The order of trials was random, and the animal seen with fear faces or alone was counterbalanced across children so that half the children saw the quokka with fear faces and the cuscus alone on the screen and the other half of the children saw the cuscus with fear faces and the quokka was presented alone.

Post-learning the FBQ and NRT were completed for a second time to explore changes in fear beliefs and avoidance preferences as a result of vicarious learning. Children were then randomly allocated to one of three fear reduction groups: counterconditioning, extinction, or control. Counterconditioning-group children were presented with a second vicarious learning procedure, but this time the fear-paired CS was presented 10 times together with happy face USs for 2 s. The unpaired CS was not seen again in this phase. Children in the extinction group saw ten 2-s presentations of the previously fear-paired CS alone on the screen. In contrast, the control group saw no presentations of CSs or USs. Instead these children watched a slideshow showing 10 unrelated pictures from the British Picture Vocabulary Scale III (Dunn, Dunn, Styles, & Sewell, 2009) presented alone on the screen for 2 s, for example, a guitar, a teapot and a balloon (no

pictures displayed animals or faces). The number of trials and the intertrial timings were the same as during vicarious learning in order to maintain consistency.

Post-fear reduction intervention, the FBQ, and NRT were completed for a final time to investigate whether changes in fear beliefs and avoidance preferences for CSs had occurred as a result of the interventions. Children were then asked to place the heart rate monitor on their finger and to stand on a white line positioned 1 m from the pet carrier boxes. They then completed the touch box task while their heart rate was being recorded. Finally, children completed the dot-probe task to measure attentional bias for the animals CSs. Children were fully debriefed with an age-appropriate explanation of the study's aims and experimental manipulation, correct written information about the animals, and worksheets to complete in order that they did not leave with false beliefs about the animals.

## RESULTS

A rejection criterion of  $\alpha = .05$  was used for all analyses. Effect sizes ( $r$ ) are reported where interpretable and otherwise partial eta-squared. Cohen's (1988, 1992) suggestions about what constitutes a large or small effect are as follows:  $r = .10$  is a small effect,  $r = .30$  is a medium effect, and  $r = .50$  is a large effect. For partial eta-squared:  $\eta^2_p = .02$  is a small effect,  $\eta^2_p = .13$  is a medium effect, and  $\eta^2_p = .26$  is a large effect.

### Avoidance

**Avoidance Preferences.** A three-way 2 (pairing type: fear-paired vs. unpaired)  $\times$  3 (time: pre-learning, post-learning, post-intervention)  $\times$  3 (group: counterconditioning, extinction, control) mixed analysis of variance (ANOVA) conducted on avoidance preferences indicated that the main effect of time was significant,  $F(1.55, 186) = 5.34, p = .011, \eta^2_p = .05$ , 95% confidence interval (CI) [.003, .11], but there was no significant main effect of group,  $F(2, 93) = 0.77, p = .47, \eta^2_p = .02$ , 95% CI [0, .08], or pairing type,  $F(1, 93) = 2.77, p = .099, \eta^2_p = .03$ , 95% CI [.0, .12]. The Time  $\times$  Group interaction was significant,  $F(4, 186) = 8.27, p < .001, \eta^2_p = .15$ , 95% CI [.06, .23], but the Pairing Type  $\times$  Group interaction was not,  $F(2, 93) = 1.22, p = .30, \eta^2_p = .03$ , 95% CI [0, .10]. The important Pairing Type  $\times$  Time interaction was significant,  $F(2, 186) = 12.22, p < .001, \eta^2_p = .12$ , 95% CI [0.04, 0.20], indicating a significant change in avoidance preferences over time that was different for fear-paired and unpaired animals. The critical effect for comparing the reduction of avoidance preferences across groups was the Pairing Type  $\times$  Time  $\times$  Group interaction, and this was also significant,  $F(4, 186) = 3.37, p = .01, \eta^2_p = .07$ , 95% CI [.004, .13], showing that effects of vicarious learning and fear reduction interventions were different in each group.

To determine the effects of fear reduction interventions, separate two-way 2 (pairing type: fear-paired vs. unpaired)  $\times$  3 (time: pre-learning, post-learning, post-intervention) repeated measures ANOVAs were carried out for each group. For the counterconditioning group, results demonstrated no main effect of pairing type,  $F(1, 31) = 0.007$ ,  $p = .94$ ,  $\eta^2_p = .00$ , 95% CI [.0, .01], but a significant main effect of time,  $F(2, 62) = 11.17$ ,  $p < .001$ ,  $\eta^2_p = .27$ , 95% CI [.08, .41]. More important, the Pairing Type  $\times$  Time interaction was significant,  $F(2, 62) = 4.39$ ,  $p = .02$ ,  $\eta^2_p = .12$ , 95% CI [.004, .27], showing that avoidance preferences

changed over time depending on pairing type. Planned contrasts comparing avoidance preferences for fear-paired and unpaired animals at each time point indicated a significant difference in avoidance preferences for the fear and unpaired animals post-learning compared to pre-learning,  $F(1, 31) = 4.25$ ,  $p = .048$ ,  $\eta^2_p = .12$ , 95% CI [.0, .33], but no significant difference post-intervention compared to pre-learning,  $F(1, 31) = 0.22$ ,  $p = .65$ ,  $\eta^2_p = .01$ , 95% CI [.0, .15]. Figure 1a displays mean distances (mm) children placed their figure from the fear-paired and unpaired animals and shows that avoidance preferences increased

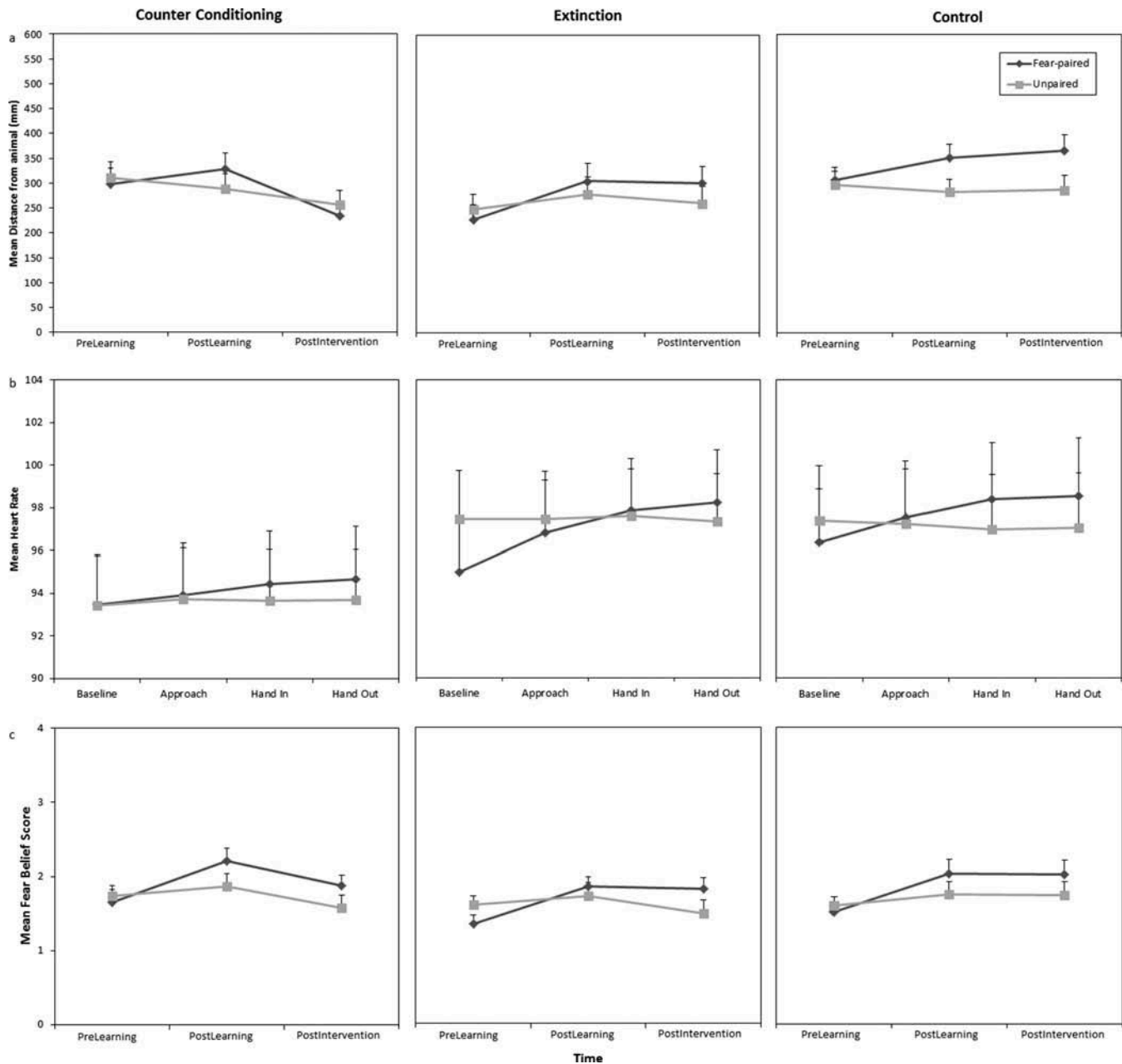


FIGURE 1 (a) Mean (and SE) distance that children placed themselves from the fear-paired and unpaired animals at each time point (pre-learning, post-learning, and post-intervention) for each group (counterconditioning, extinction, and control). (b) Mean (and SE) heart rate for the fear-paired and unpaired animals each group (counterconditioning, extinction, and control). (c) Mean (and SE) fear belief scores for the fear-paired and unpaired animals at each time point (pre-learning, post-learning, and post-intervention) for each group (counterconditioning, extinction, and control).

significantly after vicarious learning but were not significantly different to baseline levels following vicarious counterconditioning.

For the extinction group, results indicated no significant main effect of pairing type,  $F(1, 31) = 0.29, p = .59, \eta^2_p = .01, 95\% \text{ CI } [.0, .16]$ , but a significant (Greenhouse-Geisser adjusted) main effect of time,  $F(1.26, 38.92) = 11.72, p = .001, \eta^2_p = .27, 95\% \text{ CI } [.06, .46]$ . The critical Pairing Type  $\times$  Time interaction for extinction was also significant,  $F(2, 62) = 7.65, p = .001, \eta^2_p = .20, 95\% \text{ CI } [.04, .35]$ . Planned contrasts comparing avoidance preferences for each pairing type indicated a significant difference in fear beliefs for fear-paired and unpaired animals at post-learning compared to pre-learning,  $F(1, 31) = 8.71, p = .006, \eta^2_p = .22, 95\% \text{ CI } [.02, .43]$ , and a significant difference post-intervention compared to pre-learning,  $F(1, 31) = 12.25, p = .001, \eta^2_p = .28, 95\% \text{ CI } [.05, .49]$ . Figure 1a shows that avoidance preferences increased after vicarious learning and remained elevated even after extinction.

Finally, results for the control group showed a significant main effect of pairing type,  $F(1, 31) = 4.55, p = .04, \eta^2_p = .13, 95\% \text{ CI } [.0, .34]$ , but not of time,  $F(1.25, 62) = 1.27, p = .28, \eta^2_p = .04, 95\% \text{ CI } [0, .13]$ . The important Pairing Type  $\times$  Time interaction was significant,  $F(1.57, 62) = 8.33, p = .002, \eta^2_p = .21, 95\% \text{ CI } [.03, .33]$ . Planned comparisons for the interaction indicated a significant difference in fear beliefs for the fear-paired and unpaired animals at post-learning compared to pre-learning,  $F(1, 31) = 12.93, p = .001, \eta^2_p = .29, 95\% \text{ CI } [.06, .50]$ , and a significant difference post-intervention compared to pre-learning,  $F(1, 31) = 9.43, p = .004, \eta^2_p = .23, 95\% \text{ CI } [.03, .45]$ . Therefore, although all groups showed significant effects of fear vicarious learning of avoidance preferences, reduction in avoidance preferences was found only in the counterconditioning group (see Figure 1a).

**Avoidance Behavior.** For the behavioral avoidance task, children were given a maximum of 15 s to approach each touch box, and consequently any child that did not wish to take part was attributed 15 s as their approach time. In the counterconditioning group, eight children chose not to touch the fear-paired animal and six children chose not to touch the unpaired animal; in the extinction group, 10 children chose not to touch the fear-paired animal and nine children chose not to touch the unpaired animal; in the control group, 11 children chose not to touch the fear-paired animal and nine children chose not to touch the unpaired animal. Approach (yes or no) was predicted from pairing type, group, and their interaction with a generalized linear mixed model using the `glmer()` function in the `lme4` package (Bates, Maechler, Bolker, & Walker, 2014) in R. Observations of responses were nested within participants and a random slopes model was fit allowing for variation in approach across children. There was no significant effect of

adding the main effects of group,  $\chi^2(2) = 0.23, p = .89$ ; pairing type,  $\chi^2(1) = 3.08, p = .08$ ; or their interaction,  $\chi^2(2) = 0.47, p = .79$ . There was also no significant difference in the ages of children who did not want to approach both animals ( $M = 109.83, SD = 15.86, 95\% \text{ CI } [102.96, 117.28]$ ), and children willing to approach them ( $M = 110.80, SD = 15.79, 95\% \text{ CI } [106.93, 114.28]$ ),  $t(94) = -0.24, p = .81, r = .02$ , nor a significant difference in the age of children who did not approach just their fear-paired animal ( $M = 112.20, SD = 14.50, 95\% \text{ CI } [107.07, 117.50]$ ), compared to those who chose to approach it ( $M = 109.92, SD = 16.28, 95\% \text{ CI } [106.18, 113.85]$ ),  $t(94) = -0.65, p = .49, r = .07$ .

A two-way 2 (pairing type: fear vs. unpaired)  $\times$  3 (group: counterconditioning, extinction, control) mixed ANOVA performed on approach times showed a significant main effect of pairing type,  $F(1, 93) = 11.33, p = .001, \eta^2_p = .11, 95\% \text{ CI } [.02, .23]$ , indicating longer approach times for fear-paired animals ( $M = 6.69, SD = 6.27, 95\% \text{ CI } [5.42, 7.96]$ ), compared to unpaired animals ( $M = 5.10, SD = 6.31, 95\% \text{ CI } [3.81, 6.40]$ ). However, the main effect of group,  $F(2, 93) = 0.43, p = .65, \eta^2_p = .009, 95\% \text{ CI } [0, .06]$ , and the Pairing Type  $\times$  Group interaction,  $F(2, 93) = 0.90, p = .41, \eta^2_p = .02, 95\% \text{ CI } [0, .04]$ , were nonsignificant, though the effect size showed a small effect by Cohen's (1988, 1992) criteria. Therefore, although in each group, fear-paired animals—counterconditioning ( $M = 5.56, SD = 5.96, 95\% \text{ CI } [3.36, 7.77]$ ); extinction ( $M = 6.88, SD = 6.46, 95\% \text{ CI } [4.67, 9.08]$ ); control: fear-paired ( $M = 7.63, SD = 6.39, 95\% \text{ CI } [5.42, 9.83]$ )—showed longer approach times than unpaired animals—counterconditioning ( $M = 4.69, SD = 5.93, 95\% \text{ CI } [2.45, 6.92]$ ); extinction ( $M = 5.41, SD = 6.55, 95\% \text{ CI } [3.17, 7.64]$ ); control ( $M = 5.22, SD = 6.60, 95\% \text{ CI } [2.98, 7.46]$ ); avoidance of animals was not significantly different.

### Heart Rate

A three-way 3 (pairing type: fear-paired, happy-paired, unpaired)  $\times$  4 (time: baseline, approach, hand-in, hand-out)  $\times$  3 (group: counterconditioning, extinction, control) mixed ANOVA conducted on heart rate scores indicated a significant main effect of time,  $F(1.83, 108.02) = 16.45, p < .001, \eta^2_p = .22, 95\% \text{ CI } [.09, .34]$ , but not of pairing type,  $F(1, 59) = 0.024, p = .88, \eta^2_p = .02, 95\% \text{ CI } [0, .02]$ , or group,  $F(2, 59) = 0.66, p = .52, \eta^2_p = .02, 95\% \text{ CI } [0, .11]$ . The Pairing Type  $\times$  Group interaction,  $F(2, 59) = 2.71, p = .08, \eta^2_p = .08, 95\% \text{ CI } [0, .22]$ , and the Time  $\times$  Group interaction,  $F(6, 177) = 1.68, p = .13, \eta^2_p = .05, 95\% \text{ CI } [0, .10]$ , were not significant. More important, the Pairing Type  $\times$  Time interaction was significant,  $F(1.40, 82.49) = 16.96, p < .001, \eta^2_p = .22, 95\% \text{ CI } [.08, .36]$ . Follow-up tests indicated greater increases in children's heart rate from baseline to approaching boxes for fear-paired animals



compared to unpaired animals,  $F(1, 59) = 15.03, p < .001, \eta^2_p = .20, 95\% \text{ CI } [.05, .37]$ . These differences between fear-paired and unpaired animals were mirrored at other time points: As children put their hand in the box compared to baseline,  $F(1, 59) = 21.64, p < .001, \eta^2_p = .27, 95\% \text{ CI } [.09, .43]$ , and as the children withdrew their hand from the box compared to baseline,  $F(1, 59) = 19.68, p < .001, \eta^2_p = .25, 95\% \text{ CI } [.08, .41]$ . Thus greater increases in heart rate were always observed for animals children had seen with fear faces.

The crucial Pairing Type  $\times$  Time  $\times$  Group interaction was also significant,  $F(6, 177) = 2.24, p = .04, \eta^2_p = .07, 95\% \text{ CI } [0, .12]$ , and was followed up with separate ANOVAs conducted on each group. For the counterconditioning group, results showed no significant main effect of pairing type,  $F(1, 22) = 0.72, p = .41, \eta^2_p = .03, 95\% \text{ CI } [0, .25]$ , or time,  $F(1.34, 66) = 2.87, p = .09, \eta^2_p = .12, 95\% \text{ CI } [0, .18]$ , or Pairing Type  $\times$  Time interaction,  $F(1.63, 66) = 1.93, p = .17, \eta^2_p = .08, 95\% \text{ CI } [0, .16]$ , so children's heart rates did not increase from baseline measures either during or after approaching the animals (see Figure 1b). For the extinction group, results found no significant effect of pairing type,  $F(1, 19) = 2.93, p = .10, \eta^2_p = .13, 95\% \text{ CI } [0, .40]$ , but a significant main effect of time,  $F(2.17, 57) = 10.92, p < .001, \eta^2_p = .37, 95\% \text{ CI } [.10, .44]$ , and a significant Pairing Type  $\times$  Time interaction,  $F(1.22, 57) = 7.13, p = .01, \eta^2_p = .27, 95\% \text{ CI } [.01, .29]$ . Planned contrasts indicated that compared to the unpaired animal, children's heart rate significantly increased for the fear-paired animal at approach compared to baseline,  $F(1, 19) = 8.69, p = .008, \eta^2_p = .31, 95\% \text{ CI } [.03, .55]$ , as children put their hand in the box compared to baseline,  $F(1, 19) = 9.00, p = .007, \eta^2_p = .32, 95\% \text{ CI } [.03, .56]$ , and as children withdrew their hand compared to baseline,  $F(1, 19) = 7.69, p = .012, \eta^2_p = .29, 95\% \text{ CI } [.02, .53]$  (see Figure 1b). Similarly, results for the control group showed no significant main effect of pairing type,  $F(1, 18) = 1.66, p = .21, \eta^2_p = .08, 95\% \text{ CI } [0, .35]$ , or time,  $F(1.56, 54) = 3.50, p = .054, \eta^2_p = .16, 95\% \text{ CI } [0, .24]$ , but the Pairing Type  $\times$  Time interaction was significant,  $F(1.32, 54) = 9.09, p = .003, \eta^2_p = .34, 95\% \text{ CI } [.03, .35]$ . Planned contrasts for this interaction revealed that compared to the unpaired animal, children's heart rate significantly increased for the fear-paired animal at approach compared to baseline,  $F(1, 18) = 10.06, p = .005, \eta^2_p = .36, 95\% \text{ CI } [.04, .59]$ , as children put their hand in the box compared to baseline,  $F(1, 18) = 10.05, p = .005, \eta^2_p = .36, 95\% \text{ CI } [.04, .59]$ , and as children withdrew their hand compared to baseline,  $F(1, 18) = 11.51, p = .003, \eta^2_p = .39, 95\% \text{ CI } [.06, .61]$ . Therefore, in the extinction and control groups heart rate increased significantly during and after approaching the fear-paired animals (compared to a control animal), but children who had experienced counterconditioning did not show any significant increases in heart rate (see Figure 1b).

## Fear Beliefs

A three-way 2 (pairing type: fear-paired vs. unpaired)  $\times$  3 (time: pre-learning, post-learning, post-intervention)  $\times$  3 (group: counterconditioning, extinction, control) mixed ANOVA was performed on average fear belief scores for the two animals. The main effects of pairing type,  $F(2, 93) = 0.59, p = .56, \eta^2_p = .01, 95\% \text{ CI } [0, .07]$ , and group,  $F(1, 93) = 3.43, p = .067, \eta^2_p = .04, 95\% \text{ CI } [0, .13]$ , were nonsignificant, but there was a significant effect of time,  $F(1.72, 186) = 17.08, p < .001, \eta^2_p = .16, 95\% \text{ CI } [.05, .22]$ . The Pairing Type  $\times$  Group interaction was nonsignificant,  $F(2, 93) = .24, p = .79, \eta^2_p = .005, 95\% \text{ CI } [0, .05]$ , as was the Time  $\times$  Group interaction,  $F(4, 186) = 1.56, p = .18, \eta^2_p = .03, 95\% \text{ CI } [0, .08]$ . However, the more critical Pairing Type  $\times$  Time interaction was significant,  $F(1.81, 168.61) = 18.74, p < .001, \eta^2_p = .17, 95\% \text{ CI } [.07, .26]$ , indicating that there had been significantly different changes in fear beliefs over time depending on whether animals had been seen with fear faces. Planned contrasts comparing fear beliefs for pairing types over time indicated a significant change in fear beliefs following vicarious learning for fear-paired compared to unpaired animals,  $F(1, 93) = 25.91, p < .001, \eta^2_p = .22, 95\% \text{ CI } [.09, .35]$ , and similarly from pre-learning compared to post-intervention,  $F(1, 93) = 23.97, p < .001, \eta^2_p = .21, 95\% \text{ CI } [.08, .34]$ . This shows that fear beliefs increased for fear-paired animals and remained elevated even after the fear reduction interventions. The Pairing Type  $\times$  Time  $\times$  Group interaction was nonsignificant,  $F(4, 186) = 0.62, p = .65, \eta^2_p = .01, 95\% \text{ CI } [0, .04]$ , indicating that there were no significant between-group differences in fear belief reduction. Figure 1c displays the mean fear-belief scores for the fear-paired and unpaired animals in each group (counterconditioning, extinction, and control), at each time point (pre-learning, post-learning, and post-intervention) and shows that, compared to control animals, fear beliefs for fear-paired animals increased in all groups following vicarious learning and remained elevated in all groups even after the fear reduction interventions. Thus, vicarious learning was successful, but there were no significant effects of counterconditioning or extinction compared to the control group.

## Attentional Bias

Three children chose not to complete the dot-probe task. Reaction times less than 200 ms and all trials in which children pressed the incorrect response button were excluded. Log reaction times were used to adjust for possible outliers (see Ratcliff, 1993). For the counterconditioning group, the number of incorrect responses was 3.58% when the probe was fear-paired and 3.53% when the probe was unpaired. For the extinction group, the number of incorrect responses was 4.35% when the probe was fear-paired and 4.35% when the probe was unpaired. For the control group,

the number of incorrect responses was 3.02% when the probe was fear-paired and 3.33% when the probe was unpaired. A two-way 2 (pairing type: fear-paired vs. unpaired)  $\times$  3 (group: counterconditioning, extinction, control) mixed ANOVA conducted on incorrect responses indicated no significant effect of pairing type,  $F(1, 90) = 0.07$ ,  $p = .79$ ,  $\eta^2_p = .001$ , 95% CI [0, .03]; group,  $F(2, 90) = 0.97$ ,  $p = .39$ ,  $\eta^2_p = .02$ , 95% CI [0, .09]; or the Pairing Type  $\times$  Group interaction,  $F(2, 90) = 0.12$ ,  $p = .89$ ,  $\eta^2_p = .003$ , 95% CI [0, .03].

A 2 (probe pairing type: fear-paired, unpaired)  $\times$  3 (group: counterconditioning, extinction, control) mixed ANOVA conducted on log transformed reaction times indicated a significant main effect of pairing type,  $F(1, 90) = 8.75$ ,  $p = .004$ ,  $\eta^2_p = .09$ , 95% CI [.01, .21]. Table 1 shows log reaction times for fear-paired and unpaired animals. Overall log reaction times were significantly shorter for fear-paired animals, indicating an attentional bias for these animals. At the group level, log reaction times were identical for fear-paired and unpaired animals following counterconditioning, suggesting no attentional bias in this group, but there were small differences in reaction times following extinction, and larger differences in the control groups. However, there was no significant main effect of group,  $F(2, 90) = 0.64$ ,  $p = .53$ ,  $\eta^2_p = .01$ , 95% CI [0, .08], or Pairing Type  $\times$  Group interaction,  $F(2, 90) = 2.45$ ,  $p = .09$ ,  $\eta^2_p = .05$ , 95% CI [0, .15]. Thus, an overall attentional bias was found for fear-paired animals compared to unpaired animals (indicated by significantly faster detection times for these animals) with no significant differences between fear reduction groups.

### Age Differences

Correlation analyses were carried out to explore whether there was any relationship between the age of the children (in months) and the different measures of fear at each time point for each animal. All correlations were nonsignificant with the exception of a significant relationship found between age and log transformed reaction times for the unpaired animal:  $r(93) = -.29$ ,  $p = .005$ , showing that

older children were faster at responding to the unpaired animals during the dot-probe task.

## DISCUSSION

The current research aimed to investigate the effect of two potential fear-reduction procedures, counterconditioning and extinction, on vicariously acquired fear responses in children. The key findings were that results (a) replicated previous findings showing that fear-related vicarious learning leads to increases in children's fear beliefs and avoidance preferences (e.g., Askew et al., 2013; Askew et al., 2008; Dunne & Askew, 2013; Reynolds et al., 2014), as well as demonstrating that compared to a control animal, children showed higher behavioral avoidance (e.g., Askew & Field, 2007; Dubi et al., 2008; Gerull & Rapee, 2002), heart rate, and attentional bias for fear-paired animals (Reynolds et al., 2014); (b) confirmed Dunne and Askew (2013) findings indicating that counterconditioning is successful in returning children's learned avoidance preferences to baseline levels; (c) for the first time demonstrated lower heart rate responses for fear-paired animals in a group receiving vicarious fear learning then positive modeling compared to a control group receiving vicarious fear learning only; and (d) showed that fear responses following vicarious fear-learning and then CS-only presentations were comparable to a control group receiving vicarious fear-learning only. Thus there was little evidence of extinction.

Heart rate measures were not taken before and after each manipulation, so there is only equivocal evidence that changes in heart rate responses are due to vicarious learning. However, given that the type of animal seen in each type of pairing was counterbalanced across children, any differences in responding for fear-paired compared to unpaired animals is likely to be due to the vicarious learning manipulation rather than some characteristic of an individual animal stimulus. Following vicarious learning, rises in heart rate were greater when children approached previously fear-paired animals compared to previously unpaired animals, showing support for recent

TABLE 1

Mean, Standard Deviation, and 95% Confidence Interval (CI) Reaction Times (RTs) and Log Transformed Reaction Times for Detecting the Probe When It Appeared Behind the Fear-Paired or Unpaired Animals, for the Counterconditioning, Extinction, and Control Groups

		<i>Dot Probe (ms)</i>	
		<i>RTs</i>	<i>Log RTs</i>
Counterconditioning	Fear-paired	870.40 ( <i>SD</i> = 289.31), 95% CI [743.41, 997.40]	2.92 ( <i>SD</i> = 0.14), 95% CI [2.86, 2.98]
	Unpaired	896.68 ( <i>SD</i> = 362.62), 95% CI [778.97, 1014.39]	2.92 ( <i>SD</i> = 0.15), 95% CI [2.87, 2.98]
Extinction	Fear-paired	955.83 ( <i>SD</i> = 392.91), 95% CI [830.83, 1080.82]	2.95 ( <i>SD</i> = 0.17), 95% CI [2.89, 3.01]
	Unpaired	959.81 ( <i>SD</i> = 328.18), 95% CI [843.96, 1075.66]	2.96 ( <i>SD</i> = 0.14), 95% CI [2.91, 3.01]
Control	Fear-paired	851.85 ( <i>SD</i> = 376.18), 95% CI [722.75, 980.94]	2.89 ( <i>SD</i> = 0.20), 95% CI [2.83, 2.95]
	Unpaired	911.40 ( <i>SD</i> = 294.22), 95% CI [791.75, 1031.06]	2.94 ( <i>SD</i> = 0.14), 95% CI [2.88, 2.99]

research indicating that fear vicarious learning increases children's physiological responses to novel stimuli (Reynolds et al., 2014). This is important because although there is a wealth of research indicating increased heart rate in real or imaginary feared situations (e.g., McNeil, Vrana, Melamed, Cuthbert, & Lang, 1993; Sartory, Rachman, & Grey, 1977), apart from one recent study with children (Reynolds et al., 2014), research focusing on physiological responses specifically created by vicarious learning remains limited and exclusively with adults (e.g., Kravetz, 1974). Furthermore, though again conclusive evidence of vicariously learnt heart rate responding was not found (because measures were taken at one time point only), results of the current study support the proposition that vicarious counterconditioning can reverse children's vicariously learned heart rate increases, because heart rate responses to fear-paired animals found in the control group were not found for children who received positive modelling (counterconditioning). Although a nonclinical sample of children was investigated here, this finding has potential clinical implications for early intervention in vicariously learned fears. In addition, the finding has implications for the theoretical literature because physiological responses are arguably more difficult for children to consciously control than self-report or even behavioral measures; therefore any evidence suggesting vicarious counterconditioning might affect such responses adds support to its role as an effective fear reversal mechanism.

The experiment also explored whether vicarious learning can create attentional bias for novel stimuli and whether it would be present following counterconditioning or extinction procedures. Results demonstrated an attentional bias toward the fear-paired animal compared to the unpaired animal in all three groups. No baseline measures of attentional bias were taken, so the effect of vicarious learning on changes in attentional bias over time were not investigated. However, given that comparisons between animals were within-child, and animals and pairing condition were counterbalanced across children, explanations for differences in attention for fear-paired and unpaired animals cannot be explained by anything other than the associative link between the animal and the US face (or lack of), in other words, by vicarious learning. Previous dot-probe research has demonstrated attentional bias toward threat in both clinically anxious adults (e.g., MacLeod et al., 1986; Mogg, Bradley, & Williams, 1995) and children (see Hadwin & Field, 2010, for a review), but it is not yet clear how attentional bias develops. The current dot-probe evidence, along with evidence from a visual search task with similar-age children (Reynolds et al., 2014), suggests that vicarious learning experiences can contribute to the development of attentional bias for threatening stimuli in children. Clinically, this finding is important because attentional biases not only play a likely causal role in anxiety

disorders (see Mathews & MacLeod, 2002), but also may maintain anxiety by causing stimulus avoidance and preventing the extinction of fear beliefs (Field, 2006a; Merckelbach et al., 1996).

The vicarious learning procedure used in the current experiment represents a benign analogue of what happens outside of the laboratory and thus provides an invaluable means of developing and assessing new potential preventions and early interventions with a nonanxious sample of children. The current study did not demonstrate differences in attentional bias following either of the fear-reduction interventions compared to the control group. Thus, although the findings provide an initial framework for the potential development of early interventions to reduce vicariously learnt attentional bias, future work is still required. In this respect, it is also worth noting that lack of significant differences between groups may have been influenced by low power. Despite the fact that mean logRTs were faster for fear-paired animals than unpaired ones overall, in the counterconditioning group logRTs were almost identical for paired and unpaired animals, suggesting no attentional bias in this group; however, this *prima facie* difference between the counterconditioning and other groups was not significant and yielded a fairly small effect size.

Extinction in the form of CS-alone presentations did not show a significant effect on children's fear responses. Implementing direct, nonreinforced exposure to the feared stimulus was not effective in reversing fear beliefs or avoidance preferences. In addition, children demonstrated high levels of behavioral avoidance, heart rate responses, and attentional bias for animals seen in vicarious fear learning, similar to a control group receiving no fear reduction intervention. Therefore, the current study did not support the proposition that extinction is an effective means of reducing vicariously acquired fear in children of this age. Recently, however, Golkar, Selbing, Flygare, Öhman, and Olsson (2013) showed that *vicarious* extinction, in which participants watched a learning model observe an extinction procedure, reduced adults' previously conditioned fear responses and blocked recovery of these responses more effectively than *direct* extinction, in which participants watched the extinction procedure directly without a learning model. Vicarious extinction has yet to be demonstrated in children, but one possibility is that extinction might have been more effective in the current study if it had been vicariously presented. Counterconditioning in the current study was vicarious, and fear reduction procedures may be more successful when the fear reduction intervention pathway matches the acquisition pathway (Öst, 1985). For example, Kelly et al. (2010) found greater unlearning of informationally acquired fear beliefs using positive information than positive modelling, and Askew, Reynolds, Fielding-Smith, and Field (2016) showed that positive modeling is a more effective prevention of vicarious fear learning than information.

Another explanation for differences in findings for extinction and counterconditioning is that the latter is more potent. If extinction is new learning that the CS predicts no traumatic outcome (Bouton, 1993), this is likely to be less potent than new learning that the CS predicts a positive outcome. The extinction procedure used here is also likely to be relatively weak compared to clinical extinction procedures, and the measures used may not be sensitive enough to pick up subtle extinction effects. A final possibility is that the current study simply did not use the necessary number of extinction trials to get an extinction effect. An interpretation for nonsignificant findings can be that the lack of effect is due to the manipulation not being potent enough, and this could be investigated in future by increasing the number of extinction trials.

Another way that fear reduction interventions were unsuccessful was in the vicarious counterconditioning of children's learned fear beliefs, attentional bias, and behavioral avoidance of animals. Following counterconditioning, fear beliefs acquired via fear-learning appeared to decrease but remained elevated in the extinction and control groups. However, analysis of the data failed to detect a significant difference in changes in fear cognitions across groups. This was unexpected given that previous research has demonstrated a significant reduction in previously elevated fear beliefs following positive modeling (Dunne & Askew, 2013; Kelly et al., 2010). This nonsignificant result was most likely because fear beliefs also decreased for the unpaired animal in the counterconditioning group; that is, counterconditioning for the fear-paired animal appears to have generalized to the unpaired animal. This may not have occurred in Dunne and Askew's (2013) study because children were also presented with a third, happy-paired animal, which was subsequently fear-paired during counterconditioning. Generalization from paired animals to unpaired animals may have been less likely because there were always two types of opposing visual information (fear vs. happy) seen with paired animals. During counterconditioning in the current study, however, only happy faces were seen with animals, making generalization more likely. Of course, interpretations of nonsignificant effects must be made with caution, as nonsignificance may also be explained by lack of power. However, effect sizes were also low, indicating that a power explanation is unlikely here.

There are several possible explanations for counterconditioning having different effects on different domains of fear responding. First, it may be that differential responding is the result of differences between the measures used, although this seems unlikely given previous research (e.g., Reynolds et al., 2014). Second, it could potentially be that there was an insufficient number of counterconditioning trials to have a significant effect across all response systems. It is possible that less intensive counterconditioning has more of an effect on automatic, less controllable systems such as attentional bias and heart rate, but not conscious, effortful systems such as fear beliefs. However, this is not

consistent with findings demonstrating that counterconditioning can successfully return children's learned fear beliefs and avoidance preferences to baseline levels (see also Dunne & Askew, 2013). Future work is required to explore whether counterconditioning would be more effective across other fear response systems if more trials were used. Finally, the lack of effect on fear beliefs and behavioral avoidance results may also be to the result of demand characteristics. Arguably, these responses are more under conscious control than, for example, heart rate. However, this explanation also seems unlikely given that the avoidance preferences during the nature reserve task should be similarly susceptible to demand characteristics, yet counterconditioning was found to have a significant effect on this measure (see also Dunne & Askew, 2013).

A potential limitation of the current study is that the behavioral avoidance, heart rate, and attentional bias measures were taken only once, post-intervention, without a pre-learning baseline measure. The research clearly indicates higher heart rate and attentional bias after vicarious learning in the control group compared to the other groups, suggesting that vicarious learning led to increases in these measures. However, the lack of baseline measures could, in theory, mean that any differences in recorded responses between groups might not be indicative of changes due to vicarious fear learning or fear reduction but reflect pre-experiment group differences on these measures. It might also mean that the procedure was less sensitive to differences between groups, for example, in the case of reversal of attentional bias. This potential limitation was considered less problematic at the design stage than issues that might arise from taking these measures more than once. The current methodology was preferable due to concerns that children would realize the touch boxes were empty after putting their hands inside them and that if the task was used a second time, behavioral avoidance and heart rate measures would be unreliable.

Attentional bias measures were taken only once because of the length, arduousness, and repetitive nature of the task, as well as the time it would have added to the experiment as a whole for children. In addition, research has demonstrated that measuring attentional bias at multiple time points yields poor test-retest reliability (e.g., Brown et al., 2014). Repeated testing of this type was therefore deemed inappropriate for this age group and may have led to unreliable results. The attentional bias task was completed after the behavioral avoidance task, which potentially could have influenced the results given that the behavioral avoidance task in itself could be seen as a learning experience. Thus, future research might benefit from carrying out pre-learning baseline measures in a separate sitting and by considering counterbalancing the order of measures where appropriate.

In addition, generalization of the results should be made with caution given that a nonclinical, predominantly White



British sample of children was investigated. The results cannot be generalized to all children with fears and phobias, as vicarious counterconditioning may only be effective in reducing vicariously acquired fears. Future research is required to explore whether vicarious counterconditioning can also reverse fears acquired in other ways.

To summarize, the findings confirm that fear vicarious learning can influence all three of Lang's (1968) anxiety response systems as well as attentional bias in children. They also show that vicarious counterconditioning may be an effective intervention for reversing some elements of children's vicariously acquired fear. This increases our understanding of vicarious counterconditioning as a potential intervention for vicariously acquired fear in childhood by showing that counterconditioning results in a reversal of vicariously learned avoidance preferences. Following counterconditioning, children did not demonstrate the increases in heart rate to fear-paired animals that were seen in children who received no fear reduction intervention. An extinction procedure, on the other hand, was not successful in reducing vicariously learned fear beliefs and avoidance preferences. Furthermore, behavioral avoidance, heart rate, and attentional bias were not significantly different following the extinction manipulation compared to a group that did not receive any fear reversal procedure. Clinically, the findings have important implications for the reduction of vicariously acquired fear in that counterconditioning with positive modeling following a negative vicarious learning episode may reduce levels of learned fear. This form of fear reduction intervention may be more effective for children than simply observing the feared stimulus again without a negative outcome.

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