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A comparison of positive vicarious learning and verbal information for reducing  
vicariously learned fear

Gemma Reynolds, David Wasely,  
Middlesex University, UK

Güler Dunne  
Kingston University, UK.

Chris Askew  
University of Surrey, UK.

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#### Author Notes

Gemma Reynolds ([g.reynolds@mdx.ac.uk](mailto:g.reynolds@mdx.ac.uk)) and David Wasely ([dw551@live.mdx.ac.uk](mailto:dw551@live.mdx.ac.uk)), Department of Psychology, Middlesex University, United Kingdom; Güler Dunne ([g.dunne@kingston.ac.uk](mailto:g.dunne@kingston.ac.uk)), Department of Psychology, Kingston University, United Kingdom and Chris Askew ([c.askew@surrey.ac.uk](mailto:c.askew@surrey.ac.uk)), School of Psychology, University of Surrey, United Kingdom.

Correspondence concerning this article should be addressed to Gemma Reynolds, Department of Psychology, Middlesex University, The Burroughs, Hendon, London, NW4 4BT. Email: [g.reynolds@mdx.ac.uk](mailto:g.reynolds@mdx.ac.uk)

### **Abstract**

Research with children has demonstrated that both positive vicarious learning (modelling) and positive verbal information can reduce children's acquired fear responses for a particular stimulus. However, this fear reduction appears to be more effective when the intervention pathway matches the initial fear learning pathway. That is, positive verbal information is a more effective intervention than positive modelling when fear is originally acquired via negative verbal information. Research has yet to explore whether fear reduction pathways are also important for fears acquired via vicarious learning. To test this, an experiment compared the effectiveness of positive verbal information and positive vicarious learning interventions for reducing vicariously acquired fears in children (7-9 years). Both vicarious and informational fear reduction interventions were found to be equally effective at reducing vicariously acquired fears, suggesting that acquisition and intervention pathways do not need to match for successful fear reduction. This has significant implications for parents and those working with children because it suggests that providing children with positive information or positive vicarious learning immediately after a negative modelling event may prevent more serious fears developing.

*Keywords:* vicarious learning, childhood fears, fear reduction, modelling, observational learning

Direct (Pavlovian) fear conditioning occurs when a neutral conditioned stimulus (CS) is associated with a traumatic event (an unconditioned stimulus: US) that elicits a fear response (unconditioned response: UR). As a consequence, the CS comes to elicit a fear response (conditioned response: CR) when later presented alone. Direct fear conditioning is considered to be driven by associations between the CS and US (CS-US learning) and has received considerable empirical support (e.g., King, Gullone, & Ollendick, 1998). In addition, Rachman (1977) argued that two indirect pathways, the transmission of information and vicarious learning (observational learning or “modelling”), could also lead to fear development. These pathways have also received good empirical support (see reviews by Askew & Field, 2008; King et al., 1998; Merckelbach, de Jong, Muris, & van den Hout, 1996). The transmission of threat-related information about stimuli as a pathway to fear acquisition has gained support from both self-report (see King et al., 1998; Merckelbach et al., 1996) and experimental research (e.g., Field, 2006; Field & Lawson, 2003; Field & Schorah, 2007; Muris, Bodden, Meckelbach, Ollendick, & King, 2003).

Vicarious learning refers to the acquisition of fear of a stimulus through observation. There are essentially two possible ways in which vicarious learning might occur. Firstly, a child may observe a stimulus causing pain or being aversive to another individual (e.g., a child observing a dog biting another individual), or secondly, a child may see another individual responding fearfully to a particular stimulus (e.g., a child observing another individual responding fearfully to a dog). For normative fears and phobias, the second scenario appears to be the most likely. Indeed, Rachman (1977) discusses a wealth of research in support of the vicarious transmission of fear related to observing fear responses displayed by mothers during air-raids determining whether the observing child developed similar fears (e.g., John, 1941), and combat airmen acquiring fears via observing intense fear shown by crew mates (e.g., Grinker & Spiegel, 1945). Therefore, fears can be transmitted

vicariously merely through observing someone else responding fearfully. Both retrospective self-report (e.g., Merckelbach, de Ruiter, van den Hout, & Hoekstra, 1989; Öst, 1987; Öst & Hugdahl, 1981) and prospective experimental research with monkeys (e.g., Cook & Mineka, 1987; Cook, Mineka, Wolkenstein, & Laitsch, 1985; Mineka & Cook, 1986) has provided evidence for vicarious learning as a potential pathway to fear acquisition. Furthermore, experimental research with children has demonstrated increases in fear cognitions and behavioral avoidance (e.g., Askew & Field, 2007; Askew, Kessock-Philip, & Field, 2008; Askew, Dunne, Özdil, Reynolds, & Field, 2013; De Rosnay, Cooper, Tsigaras, & Murray, 2006; Egliston & Rapee, 2007; Gerull & Rapee, 2002), as well as increases in heart rate and attentional bias (e.g., Reynolds, Field, & Askew, 2014, 2015) following vicarious fear learning.

Like direct conditioning, it has been argued that associative learning processes underpin the indirect pathways to fear acquisition (e.g., Askew & Field, 2008; Davey, 2002; Field, 2006; Reynolds et al., 2015). In informational and vicarious learning, the observer associates a specific stimulus (CS) with either threat-related information about it, or a model's fearful response to it (the model's UR and observer's US), so that the stimulus subsequently evokes a learned fear-related response (CR) in the observer via the CS-US association. Research has indicated similar behavioral and neural processes involved in direct fear conditioning and vicarious fear learning (e.g., Olsson & Phelps, 2007) with particular attention paid to the important role played by the amygdala in the acquisition and expression of fear conditioned both directly (e.g., Fox et al., 2015; LeDoux & Pine, 2016) and via vicarious fear learning (Debiec & Olsson, 2017; Debiec & Sullivan, 2014; Olsson, Nearing, & Phelps, 2007).

The strength of the CR acquired during learning can be influenced by expectancies associated with the CS-US relationship prior to learning (Davey, 1997; Field, 2006; Field &

Purkis, 2011), with recent research demonstrating that observational pre-exposure prior to vicarious fear learning prevents fear responses from occurring in adults (Golkar & Olsson, 2016) and children (Askew et al., 2016). If CS-US associative learning processes underpin informational and vicarious fear learning pathways, it follows that fear-reduction interventions should be targeted at weakening these negative associations (e.g., Bandura, 1969).

One way in which conditioned fear responses are commonly reduced in the direct fear conditioning literature is via repeated exposure to the CS alone (without the US) in a well-established phenomenon known as extinction (e.g., Bouton, 2004; Milad & Quirk, 2012; Myers & Davis, 2007). Traditional learning models commonly attributed the reduction in conditioned fear responses following extinction to the unlearning of the original CS-US association (e.g., Rescorla & Wagner, 1972; McClelland & Rumelhart, 1985; McCloskey & Cohen, 1989). That is, the CS no longer activates the representation of the US and subsequently fails to elicit the CR. However, evidence has demonstrated that in fact much of the original learning remains intact following extinction and thus extinction does not erase the initial CS-US association, but instead forms a new association (CS-no US) that inhibits the expression of the original CS-US association (e.g., Bouton, 1993, 2002, 2004; Delamater, 2004; Myers & Davis, 2002; Rescorla, 2001). Extinction is well-established in adults (e.g., Hygge & Öhman, 1978; Milad, Orr, Pitman, & Rauch, 2005; Prenoveau, Craske, Liao, & Ornitz, 2012) and may be considered an experimental laboratory model of exposure-based therapy (e.g., Bouton, Mineka, & Barlow, 2001; Davey, 1997; Mineka, 1985; Mineka & Zinbarg, 2006).

Recently, Dunne and Askew (2015) implemented extinction as an intervention to reduce vicariously acquired fears in children. While they successfully demonstrated extinction of vicariously acquired fear cognitions for novel animals, similar effects for were

not observed avoidance preferences. Additionally, no extinction of either fear cognitions or avoidance preferences was found for a fear-irrelevant stimulus (flowers). Reynolds, Field and Askew (in press) also found no evidence that an extinction procedure had any effect on vicariously acquired fear cognitions, avoidance preferences, behavioral avoidance, heart rate or attentional bias.

An alternative fear-reduction intervention is to use positive experiences involving the CS to form a new association between the CS and a positive outcome (US). This process is typically referred to as ‘counterconditioning’ in the literature and refers to the phenomenon in which a later contradictory CS-US learning episode results in a weakening of the original CS-US association. While the literature exploring counterconditioning is not as prominent as the literature on extinction, there is evidence that positive vicarious learning (vicarious counterconditioning) is more effective than extinction in reducing children’s vicariously learned fear cognitions, avoidance preferences (Dunne & Askew, 2013; Newall, Watson, Grant, & Richardson, 2017), and heart rate responses (Reynolds, Field and Askew, in press) to stimuli.

Negative verbal information about a stimulus increases fear of it and there is also evidence that positive verbal information about a stimulus can reduce children’s fear (e.g., Field & Lawson, 2003; Muris et al., 2003). Extending this, Kelly, Barker, Field, Wilson and Reynolds (2010) demonstrated that positive verbal information was also an effective intervention for reducing fear cognitions and behavioral avoidance acquired via threatening verbal information. They also found that positive modelling was an effective way to reduce informationally learned fear; however, critically, positive information was significantly more effective at reducing fear beliefs (but not behavioral avoidance) than positive modelling. This suggests that the match between acquisition and intervention pathways could be influential to an intervention’s success. Indirect support for this also comes from a recent study by Askew,

Reynolds, Fielding-Smith and Field (2016) which found that an intervention designed to prevent vicarious fear learning in children was only successful when the pathway of delivery matched the pathway of the later vicarious fear learning event. Specifically, vicarious fear learning was prevented by earlier positive modelling but not by relevant psychoeducational information or correct information about the animal CSs used.

While it is clear then that both positive information and positive modelling can reduce fear responses acquired via verbal information (Kelly et al., 2010), and that fear responses acquired via negative vicarious learning can be reduced by later positive vicarious learning (Dunne & Askew, 2013; Reynolds et al, in press), research has yet to explore whether fear responses acquired vicariously can also be reduced using positive verbal information. Also, it is impossible to discern from Kelly et al.'s (2010) study whether positive verbal information was a more effective method of fear-reduction than vicarious learning because information is a more effective intervention per se (for example, it may be a more explicit form of learning than vicarious learning), and would also therefore be the most effective way to reduce the effects of vicarious fear-learning; or whether it was because the fear-reduction intervention (positive information) matched the pathway via which the fear was initially acquired, whereas positive vicarious learning did not. If the latter is the case this would have important implications for early intervention and later treatment because interventions delivered via specific pathways are likely to be more successful than others. Research has demonstrated that both directly acquired safety information and vicarious extinction are effective means of reducing traditionally acquired conditioned fear (e.g., Golkar, Selbing, Flygare, Ohman, & Olsson, 2013), suggesting that the acquisition pathway does not need to match the intervention pathway to be effective. However, this work is limited to adult populations and does not explore vicariously acquired fear.

Therefore, the current experiment compared the effectiveness of positive vicarious learning and information interventions for reducing children's vicariously learnt fear responses using a variation of Askew and Field's (2007) vicarious learning procedure. It is well-established that fears have a developmental course associated with them (King, Hamilton, & Ollendick, 1988) with specific phobias having a median age of onset of around 7 years (Kessler, Berglund, Demler, Jin, Merikangas, & Walters, 2005) and the majority of animal phobias beginning between the ages of 5 and 9 years (Öst, 1987). Therefore, the study was conducted with children aged 7 to 9 years an age. Previous research has demonstrated that vicarious learning influences fear responses for this age group (e.g., Askew et al., 2013; Askew & Field, 2007; Askew et al., 2016; Dunne & Askew, 2013; Reynolds et al., 2014, 2015, 2017, in-press).

It was hypothesised that children receiving vicarious learning and information interventions would show reduced fear cognitions, avoidance preferences, behavioral avoidance and physiological responding post-fear-reduction compared to no-intervention control group children. Also of interest was whether the positive vicarious intervention would be more effective than the informational intervention due to the match between fear acquisition and reduction pathways, or whether the informational intervention would be more effective than the vicarious intervention by virtue of being generally a more effective form of intervention.

## **Method**

### **Participants**

Ninety-four children from a school in North London, UK, took part in the study. Children were not screened for psychiatric or developmental disorders. Data from two children were excluded because of incomplete responses. Therefore, 92 children remained

(48 males and 44 females) with an age range of 7 to 9 years ( $M = 97.84$  months,  $SD = 11.91$ ). A priori power analysis (G\*Power; Faul, Erdfelder, Lang, & Buchner, 2007) calculated for the critical two-way interactions for initial fear acquisition and subsequent fear reduction, indicated that this was sufficient sample size to detect medium sized effects based on Cohen's (1969) benchmarks of .01, .06, and .14 for small, medium, and large effect sizes respectively.

The headteacher provided consent and all parents/guardians received a detailed information sheet 2 weeks prior to the study, and again 1 week prior to the study, during which time consent could be withdrawn. All children were informed at the start of the study that they could stop any time without reason, and each child gave verbal assent before taking part.

## **Materials**

The majority of the experiment was automated, written in E-Prime 2.0 by the first author, and run on a Dell E6540 15.6" Laptop.

*Animal and Face Stimuli:* During the vicarious learning procedure, 10 color photographs ( $346 \times 444$  pixels) of two Australian marsupials, a quokka and cuscus, in a nonthreatening position in their natural habitat, were used as CSs. These animals were chosen because UK children typically report that they do not know them (e.g., Dunne & Askew, 2013, in press). Nevertheless, as with most animals, children are unlikely to begin the experiment with completely neutral attitudes to them. These marsupials have been successfully used in previous research and baseline measures are typically around the midpoint of the FBQ scale (e.g., Askew & Field, 2007; Askew et al., 2013; Dunne & Askew, 2013; Reynolds et al., 2014).

During the experiment, these photographs were shown on the computer screen with 20 color portrait photographs of faces (also  $346 \times 444$  pixels) taken from the NimStim Face

Stimulus Set (Tottenham et al., 2009). Of these, there were 10 different faces (five males and five females) expressing fear (Face IDs: 06F\_FE\_O, 08F\_FE\_O, 09F\_FE\_O, 12F\_FE\_O, 17F\_FE\_O, 20M\_FE\_O, 25M\_FE\_O, 28M\_FE\_O, 34M\_FE\_O, 40M\_FE\_O) and 10 different faces (5 males and 5 females) expressing happiness (Face IDs: 01F\_HA\_O, 02F\_HA\_O, 05F\_HA\_O, 11F\_HA\_O, 18F\_HA\_O, 22M\_HA\_O, 23M\_HA\_O, 24M\_HA\_O, 26M\_HA\_O, 42M\_HA\_O). Faces were used as negative and positive USs in their original form without editing or re-formatting.

**Verbal Information:** Positive verbal information used by Kelly et al. (2010; see also Field & Lawson, 2003) was given to children receiving the information fear-reduction intervention. The information included the animals eating habits (e.g., ‘feeds on sweet tasting berries’); physical appearance (e.g., ‘soft, fluffy fur’); sounds (e.g., ‘makes a soft purring noise’); behavior (e.g., ‘a safe animal and often comes into the park’); and people’s perceptions of the animal (e.g., ‘a very popular animal in Australia’). The same vignette was used regardless of animal (i.e., only the name of the animal was changed according to the experimental condition).

**Fear Beliefs Questionnaire (FBQ):** The computer-based FBQ (Field & Lawson, 2003) was used to measure fear-related beliefs for the two animals. The questionnaire contained eight questions (four reverse-scored) for each animal, therefore 16 questions in total, such as ‘Would you be scared if you saw a QUOKKA/CUSCUS?’ The question appeared at the top of the screen, with a non-threatening, natural picture of the animal in question in the center of the screen, and five response buttons at the bottom of the screen (‘No, not at all’, ‘No, not really’, ‘Don’t know/Neither’, ‘Yes, probably’, ‘Yes, definitely’). Children completed the FBQ three times in total; before vicarious learning (prelearning), after vicarious learning (postlearning) and following the intervention (post-fear-reduction). Internal consistency was high; prelearning: Cronbach’s  $\alpha = .70$  (Quokka subscale), .70

(Cuscus subscale); postlearning:  $\alpha = .88$  and  $.88$  respectively; and post-fear-reduction:  $.89$  and  $.86$  respectively.

***Nature Reserve Task (NRT).*** The NRT (Field & Storksen-Coulson, 2007) was used to measure avoidance preferences for the two animals prelearning, postlearning and post-fear-reduction. The NRT consisted of a rectangular board measuring 620mm  $\times$  500mm that had been embellished with green felt (to depict grass) pipe cleaner trees and pipe cleaner fences to depict a nature reserve. All embellishments were positioned so children were unable to 'hide' behind them. The researcher consecutively placed either a picture of a quokka or a cuscus (in counterbalanced conditions) at one end of the board. For each animal, children were asked to imagine a small figure of a child was themselves, and to place the figure on the nature reserve where they would choose to be in relation to each animal. The researcher measured the distance (min = 0mm, max = 620mm) between the picture of each animal and the figure. This represented a measure of the child's avoidance preferences for the animals.

***Behavioral Avoidance Task (BAT).*** A BAT (see also Askew & Field, 2007; Field & Lawson, 2003; Reynolds et al., 2014) was used to measure avoidance behavior for the two animals. At the same time, children's heart rate was measured via a Contec Finger Probe Pulse Oximeter. However, unfortunately these data could not be analysed. During the BAT, children were shown two cardboard pet-carrier boxes (size: 26cm  $\times$  46cm  $\times$  34cm) each containing a large round hole (diameter: 14cm) covered in hessian to prevent the child being able to see into the box. Both boxes were empty but children were informed that each box contained one of the animals. A picture of a quokka was displayed on one box, and a picture of a cuscus displayed on the second box. Children were asked to stand on a line marked 1m from the quokka (the first box). The researcher then asked the child if they would like to approach the quokka. The stopwatch was started as soon as children were given the

instruction to begin. If the child made no attempt to approach the box after 15s, or if the child refused to approach the box, they were asked to stand on the line 1m in front of the second box containing the cuscus and the same instructions were given again. After 15s, the trial was over regardless of whether the child had approached the box or not.

## **Procedure**

The study was carried out during school hours, with children participating on an individual basis in a quiet room that was familiar to the child. The program on the computer began with written instructions from 'Safari Sam'; a cartoon character designed to make the program child-friendly. Children first completed the prelearning FBQ followed immediately by the prelearning NRT.

This was followed by the vicarious learning procedure (see Askew & Field, 2007), which was based on the transmission of fear responses via observing the fearful response of other individuals. Children were given the following instructions: "You will now watch a slideshow of pictures of the animals. Sometimes you will also see a picture of someone's reaction to the animal." The procedure consisted of 20 trials presented in random order. There were 10 'fear-paired' trials consisting of randomly selected pictures of one of the animals (e.g., a quokka) presented alongside faces expressing fear (10 different faces). These were interspersed with 10 'unpaired' trials consisting of a randomly chosen picture of the second animal (e.g., a cuscus) alone on the screen. The procedure was counterbalanced so that half the children saw the quokka as their fear-paired animal and half the children saw the cuscus as their fear-paired animal. Based on timing parameters from previous research, the animal picture was first displayed on the screen for 1s, followed by the picture of the faces with both the animal and face pictures remaining on the screen for another 1s. Thus, each trial was a total of 2s. The inter-trial intervals varied randomly between 2s and 4s.

Children then completed the FBQ and NRT a second time (postlearning) to determine whether changes in fear cognitions and avoidance preferences were different for the fear-paired animal compared to the unpaired animal. Immediately after completing the postlearning FBQ and NRT, children were randomly assigned to either the ‘vicarious’, ‘information’ or ‘control’ group and took part in the fear-reduction intervention phase. Children in the vicarious group received a second vicarious learning procedure in which their previously fear-paired animal was now shown with 10 happy faces (10 different faces). The trial and inter-trial timings were the same as for the vicarious learning procedure. Children in the information group received positive information about their fear-paired animal via a recording of a neutral male voice listened to through headphones, as well as in text displayed on the screen. Children in the control group completed an unrelated task which involved watching a slideshow showing 10 unrelated, neutral pictures from the British Picture Vocabulary Scale III (Dunn, Dunn, Styles, & Sewell, 2009) presented alone on the screen for 2s. The researcher was blind to the experimental condition.

Children then completed the FBQ and NRT again (post-fear-reduction) to establish whether the interventions were effective in reducing vicariously acquired fear cognitions and avoidance preferences compared to the control group. Finally, children completed the BAT with heart rate measures to establish whether behavioral avoidance was different for the fear-paired animal compared to the unpaired animal across the three groups. The BAT was only implemented post-fear-reduction; not prelearning or postlearning because of the likelihood of familiarity effects and children realising that the boxes were actually empty after putting their hands inside.

At the end of the experiment, children were fully debriefed about the nature of the study. All questions were answered and children had an information sheet to read containing true information about the animals with age-appropriate worksheets about the animals to

complete in order to reinforce this information. In case it was not already clear, children were told that the boxes were empty and shown inside both boxes.

## Results

### Fear Beliefs

**Acquisition:** A three-way 2(time: prelearning vs. postlearning)  $\times$  2(pairing: fear-paired vs. unpaired)  $\times$  3(group: vicarious, information, control) mixed ANOVA was performed on mean fear beliefs to assess whether fear-related vicarious learning significantly increased fear beliefs. Results demonstrated a significant main effect of time,  $F(1, 89) = 9.28, p = .003, \eta^2_p = .09$  (95% CI [0.01, 0.22]) but no significant main effect of pairing,  $F(1, 89) = 3.43, p = .07, \eta^2_p = .04$  (95% CI [0.00, 0.22]). Crucially, the time  $\times$  pairing interaction was significant,  $F(1, 89) = 9.32, p < .001, \eta^2_p = .21$  (95% CI [0.01, 0.22]) indicating that fear beliefs had significantly changed over time depending on whether the animal was fear-paired or unpaired (i.e., seen in vicarious fear learning or not). Mean fear belief scores for fear-paired and unpaired animals in each group at each time point are shown in Figure 1. After vicarious fear learning, fear beliefs for fear-paired animals increased in all three groups compared to unpaired animals. Simple effects demonstrated that regardless of group, fear beliefs significantly increased from prelearning to postlearning for the fear-paired animal,  $F(1, 89) = 22.37, p < .001$  and significantly decreased from prelearning to postlearning for the unpaired animal,  $F(1, 89) = 4.57, p < .05$ . Additionally, the main effect of group,  $F(2, 89) = 0.62, p = .54, \eta^2_p = .01$  (95% CI [0.00, 0.08]), and the time  $\times$  pairing  $\times$  group interaction,  $F(2, 89) = 0.04, p = .97, \eta^2_p = .001$  (95% CI [0, 0.01]), were nonsignificant, indicating there were no differences in fear vicarious learning between the two groups. This was expected given that all three groups received identical learning manipulations at this stage.

To determine the effects of fear-reduction interventions, a three-way 2(time: postlearning vs. post-fear-reduction)  $\times$  (pairing: fear-paired vs. unpaired)  $\times$  3(group: vicarious, information, control) mixed ANOVA was performed on mean fear beliefs. Results demonstrated significant main effects of time,  $F(1, 89) = 22.64, p < .001, \eta^2_p = .20$  (95% CI [0.07, 0.34]) and pairing,  $F(1, 89) = 12.54, p = .001, \eta^2_p = .10$  (95% CI [0.02, 0.25]) but no significant main effect of group,  $F(2, 89) = 0.75, p = .47, \eta^2_p = .02$  (95% CI [0.00, 0.08]). The significant time  $\times$  pairing interaction,  $F(1, 89) = 11.99, p = .001, \eta^2_p = .12$  (95% CI [0.02, 0.25]) demonstrated that fear-reduction had been successful (see Fig. 1). Crucially, the time  $\times$  pairing  $\times$  group interaction was also significant,  $F(2, 89) = 5.42, p = .006, \eta^2_p = .11$  (95% CI [0.01, 0.23]), indicating that effects of fear-reduction differed across groups. Figure 1 shows that for children receiving fear-reduction interventions, fear beliefs decreased for the previously fear-paired animal, whereas in the control group fear beliefs remained elevated for this animal. To confirm this results, separate two-way 2(time: postlearning vs. post-fear-reduction)  $\times$  2(pairing: fear-paired vs. unpaired) repeated measures ANOVAs were performed on mean fear beliefs in each group. There was a significant time  $\times$  pairing interaction in the vicarious learning group,  $F(1, 30) = 5.66, p = .02, \eta^2_p = .16$  (95% CI [0.001, 0.38]), and the information group,  $F(1, 29) = 12.28, p = .002, \eta^2_p = .30$  (95% CI [0.05, 0.51]) but not the control group,  $F(1, 30) = 0.48, p = .49, \eta^2_p = .02$  (95% CI [0.00, 0.18]). Thus, the results indicate that both positive vicarious learning and information successfully reduced vicariously acquired fear beliefs (see Fig. 1).

Informational learning showed a larger effect size than vicarious learning. To determine if there was a significant difference in the effectiveness of the two fear-reduction methods, mean changes in fear beliefs from postlearning to post-fear-reduction (post-fear-reduction fear beliefs minus postlearning fear beliefs) were first calculated for the fear-paired and unpaired animals. Then changes in fear beliefs for fear-paired animals relative to

changes in fear beliefs for unpaired animals were calculated (mean change in fear beliefs for fear-paired animal minus mean change in fear beliefs for unpaired animal) and compared between groups. A *t*-test comparing effectiveness of fear-reduction in the two groups found no significant difference,  $t(59) = 0.35, p = .73, d = .09$  (95% CI [-0.41, 0.59]). Given the low effect size and adequate power, this suggests that vicarious and verbal fear-reduction were similarly effective.

### Avoidance Preferences

A three-way 2(time: prelearning vs. postlearning)  $\times$  2(pairing: fear-paired vs. unpaired)  $\times$  3(group: vicarious, information, control) mixed ANOVA was performed on mean NRT distances from pre- to postlearning. There was a significant main effect of time,  $F(1, 89) = 7.63, p = .007, \eta^2_p = .08$  (95% CI [0.01, 0.20]) and a significant main effect of pairing,  $F(1, 89) = 26.23, p < .001, \eta^2_p = .23$  (95% CI [0.09, 0.36]). The time  $\times$  pairing interaction was also significant,  $F(1, 89) = 19.44, p < .001, \eta^2_p = .18$  (95% CI [0.06, 0.31]). This showed that there were changes in avoidance preferences over time depending on whether the animal was fear-paired or unpaired. Figure 2 shows that in all three groups, children placed themselves farther away from fear-paired animals at postlearning than at prelearning, but this effect was not observed for the unpaired animal. The main effect of group,  $F(2, 89) = 2.95, p = .06, \eta^2_p = .06$  (95% CI [0.00, 0.16]), and the time  $\times$  pairing  $\times$  group interaction,  $F(2, 89) = 0.06, p = .94, \eta^2_p = .001$  (95% CI [0.00, 0.02]) were not significant. Therefore, results confirmed that vicarious fear learning significantly increased avoidance preferences in all three groups similarly.

To determine the effects of fear-reduction interventions, an identical three-way 2(time: postlearning vs. post-fear-reduction)  $\times$  2(pairing: fear-paired vs. unpaired)  $\times$  3(group: vicarious, information, control) mixed ANOVA was also performed on mean NRT scores and

revealed significant main effects of time,  $F(1, 89) = 43.08, p < .001, \eta^2_p = .33$  (95% CI [0.17, 0.46]), and pairing,  $F(1, 89) = 23.40, p < .001, \eta^2_p = .21$  (95% CI [0.08, 0.34]) but no significant main effect of group,  $F(2, 89) = 0.02, p = .98, \eta^2_p = .00$  (95% CI [0.00, 0.01]). The time  $\times$  pairing interaction was significant,  $F(2, 89) = 21.08, p < .001, \eta^2_p = .16$  (95% CI [0.06, 0.33]), but crucially, the time  $\times$  pairing  $\times$  group interaction was also significant,  $F(2, 89) = 8.43, p < .001, \eta^2_p = .16$  (95% CI [0.04, 0.28]), showing that effects were different in the three groups. To follow up the three-way interaction, separate two-way 2(time: postlearning vs. post-fear-reduction)  $\times$  2(pairing: fear-paired vs. unpaired) repeated measures ANOVAs were conducted for each group. There was a significant time  $\times$  pairing interaction in the vicarious learning group,  $F(1, 30) = 18.01, p < .001, \eta^2_p = .38$  (95% CI [0.11, 0.57]) and information group,  $F(1, 29) = 15.44, p < .001, \eta^2_p = .35$  (95% CI [0.09, 0.55]), but not the control group,  $F(1, 30) = 0.62, p = .44, \eta^2_p = .02$  (95% CI [0.00, 0.19]). Therefore, there was a significant reduction in avoidance preferences for fear-paired animals compared to unpaired animals in the vicarious and information groups but not in the control group (see Fig. 2), indicating a significant reduction in avoidance preferences following both intervention types.

Effect sizes were very similar for vicarious learning and information. Nevertheless, a comparison was conducted to investigate whether one type of fear-reduction procedure was more effective than the other. Mean changes in avoidance preferences from postlearning to post-fear-reduction (post-fear-reduction avoidance preferences minus postlearning avoidance preferences) were first calculated for fear-paired and unpaired animals. Next, changes in avoidance preferences for fear-paired animals relative to changes in avoidance preferences for unpaired animals were calculated (mean change in avoidance preferences for fear-paired animal minus mean change in avoidance preferences for unpaired animal). A *t*-test analysis found no significant difference between groups,  $t(59) = 1.01, p = .32, d = .26$  (95% CI [-0.25,

0.76]). Therefore, there was no evidence of differences between vicarious and verbal information fear-reduction interventions.

### **Avoidance Behavior**

Children in the BAT were given a maximum of 15s to approach each touch box. All children that did not wish to take part were also attributed 15s as their approach time. There were 49 children who did not want to approach their fear paired animal compared to 43 that did, and 42 children who did not want to approach their unpaired animal compared to 51 that did. Only 39 children approached both animals. Across the three groups, there were no significant differences in the number of children who approached the touch box containing the fear-paired animal compared to children who chose not to approach the box,  $\chi^2(2, N = 92) = 1.40, p = .50$ , or for children who did or did not approach the touch box thought to contain the unpaired animal,  $\chi^2(2, N = 92) = 3.68, p = .16$ .

A two-way 2(pairing: fear-paired vs unpaired)  $\times$  3(group: vicarious, information, control) mixed ANOVA was conducted on approach times (see Figure 3). There was a significant main effect of pairing,  $F(1, 89) = 4.04, p = .048, \eta^2_p = .04$  (95% CI [0, 0.15]), indicating slower approach times for fear-paired animals than unpaired animals overall. There was no significant main effect of group,  $F(2, 89) = 0.07, p = .94, \eta^2_p = .001$  (95% CI [0, 0.03]) but the critical pairing  $\times$  group interaction was significant,  $F(2, 89) = 4.86, p = .01, \eta^2_p = .10$  (95% CI [0.01, 0.21]) and was followed up with simple effects analyses comparing approach times for fear-paired and unpaired animals in each group. Results revealed a significant difference in approach times for fear-paired and unpaired animals in the control group,  $F(1, 89) = 13.54, p < .001, \eta^2_p = .13$  (95% CI [0.03, 0.26]). These children that received no fear-reduction intervention took significantly longer to approach fear-paired animals than unpaired animals; that is, they showed vicarious fear learning of avoidance

behavior. However, there was no significant difference between fear-paired and unpaired animal approach times in the vicarious group,  $F(1, 89) = 0.11, p = .74, \eta^2_p = .001$  (95% CI [0, 0.05]), or information group,  $F(1, 89) = 0.25, p = .62, \eta^2_p = 0.003$  (95% CI [0, 0.06]). Results suggested then that both fear-reduction interventions successfully reversed vicarious learning compared to no intervention. Finally, computed differences in approach times for fear-paired and unpaired animals were analyzed to compare the effectiveness of the two fear-reduction interventions: No significant difference between approach times for vicarious and information interventions was found,  $t(59) = 0.67, p = .50, d = .17$  (95% CI [-0.33, 0.67]).

### **Heart Rate**

A three-way mixed ANOVA analysis found all main effects and interactions to be nonsignificant. However, results could not be reliably interpreted because of low power: only 39 children approached both animals and this was less than the number of children needed for sufficient power (.80) to detect medium sized effects.

### **Discussion**

The study used a prospective experimental paradigm to compare the effectiveness of vicarious and informational fear-reduction interventions for reducing vicariously learned fear responses. The research replicated earlier findings demonstrating an increase in fear cognitions and avoidance preferences for animals following vicarious learning (e.g., Askew et al., 2008; Askew et al., 2013; Askew et al., 2016; Gerull & Rapee, 2002; Reynolds, Field, & Askew, 2017), as well as higher behavioral avoidance (e.g., Askew & Field, 2007; Reynolds et al., 2014, 2015). Results also confirmed that vicariously acquired fear cognitions can be reduced using a positive vicarious learning procedure (e.g., Dunne & Askew, 2013; Reynolds et al., in press) and provides the first evidence that vicarious counterconditioning can also successfully reverse vicariously learned avoidance behavior in children.

This is also the first demonstration with children that verbal information can reduce vicariously acquired self-reported fear cognitions and avoidance preferences. Lower levels of vicariously learned behavioral avoidance were also found following positive information compared to controls. A central aim of the current study was to compare fear reduction pathways. No difference in the effectiveness of positive information and positive vicarious learning to reduce vicariously acquired fear beliefs was found, despite sufficient power to detect differences. Kelly et al.'s (2010) procedure could not determine whether 'unlearning' is more potent when delivered via the same pathway as fear was originally acquired by, or if superior unlearning for positive information was simply the result of information being a more effective fear-reduction intervention per se. The current study shows that, for vicarious fear learning in children, fear acquisition and reduction pathways do not have to match for fear reduction to be successful. This is in line with findings from the direct conditioning literature that demonstrate reduction in fear responses following both vicarious extinction and directly acquired safety information (e.g., Golkar et al., 2013). The results also do not support the proposal that information interventions are more effective per se. However, comparisons across studies are difficult because of potential differences in the potency of the fear-reduction interventions across studies. For example, both positive verbal information and vicarious learning were presented to children by one of the researchers in Kelly et al.'s study, but verbal information was presented via an audio recording here and vicarious learning via a series of animal-face picture pairing trials.

A limitation of the study was the inability to interpret the heart rate data as a result of a lack of power. Arguably, physiological responding provides the most reliable evidence that results are not due to demand characteristics because physiological responses are harder to consciously control compared to fear cognitions and avoidance behavior. However, given that previous research (e.g., Reynolds et al., 2014, in press) has demonstrated vicariously

acquired fear responses across all three of Lang's response systems using the current paradigm, it seems unlikely that demand characteristics are at play in the current study.

The researcher remained present at all times during the procedure to ensure that children were paying attention. Nevertheless, a potential limitation of the study was that it was not possible to verify that each child attended to each animal-face pairing. Future research could, for example, use eye tracking to confirm this. This would also enable examination of pupillary responses to the faces and animals as measures of cognitive load (e.g., see Piquado, Isaacowitz, & Wingfield, 2010). It is also worth noting that the current study took place over a single learning session and therefore further research should explore the findings longitudinally at later time points. Similarly, it is possible that the findings may be age specific and differences between learning pathways may be larger in other age groups. For example, informational and observational learning and unlearning pathways may engage different sets of cognitive abilities, so that the potency and effectiveness of an individual pathway may change over development as cognitive systems mature.

An additional suggestion for future research would be to further explore the interaction between learning and intervention pathways by using a research design that compares fear reduction for positive vicarious learning and positive verbal information for both vicariously and verbally learned fears. Given the similarities between neural processes involved in direct and vicarious fear learning (Olsson & Phelps, 2007), it would also be interesting to compare informational and vicarious learning pathways at this level. Research could also use animals paired with neutral faces in the control condition rather than unpaired animals. Other similar studies show decreases in fear responses when pairing animals with happy faces (e.g., Askew & Field, 2007; Dunne & Askew, 2013; Reynolds et al., 2014), implying that the type of facial expression is crucial in determining responses. If neutral faces were used in the control condition, the fear-paired CS and control CS would differ only in

terms of the type of facial expression. This would make it possible to rule out the influence of the presence or absence of a social stimulus per se on learning.

Researchers have argued that CS-US associative learning processes underpin vicarious and informational fear learning (e.g., Askew & Field, 2008; Bandura, 1969; Davey, 2002; Field, 2006; Mineka & Zinbarg, 2006; Reynolds et al, 2015, in press). The current findings that postlearning positive experiences with the CS reduces fear cognitions, avoidance preferences and behavioral avoidance lend support to this because the processes appear to be at the very least analogous to counterconditioning in the associative learning literature: positive experiences (positive USs) with the CS weakened previously learned associations between the CS and negative USs, reducing the fear response (CR). Clinically, this is important as it demonstrates that the use of both positive information and positive modelling immediately after an aversive learning experience may be useful in counteracting negative effects. Thus parents and professionals working with children could potentially be given advice or training on identifying such negative events when they occur and applying 'psychological first aid' to prevent or lessen harmful consequences. Treatment implications are, of course, tempered by the use of a normative sample in the current study. However, the more that is known about processes and mechanisms underpinning vicarious learning and fear reduction, the more successfully early interventions and preventions can potentially be.

In summary, the research represents the first evidence to demonstrate that vicariously acquired fear beliefs, avoidance preferences and behavioral avoidance can be reduced via both vicarious and information-based fear-reduction interventions. Moreover, the study has established that the fear-reduction intervention pathway does not need to match the pathway in which the fear was initially acquired for these types of fears.

### **Disclosure of Interest**

The authors report no conflicts of interest.

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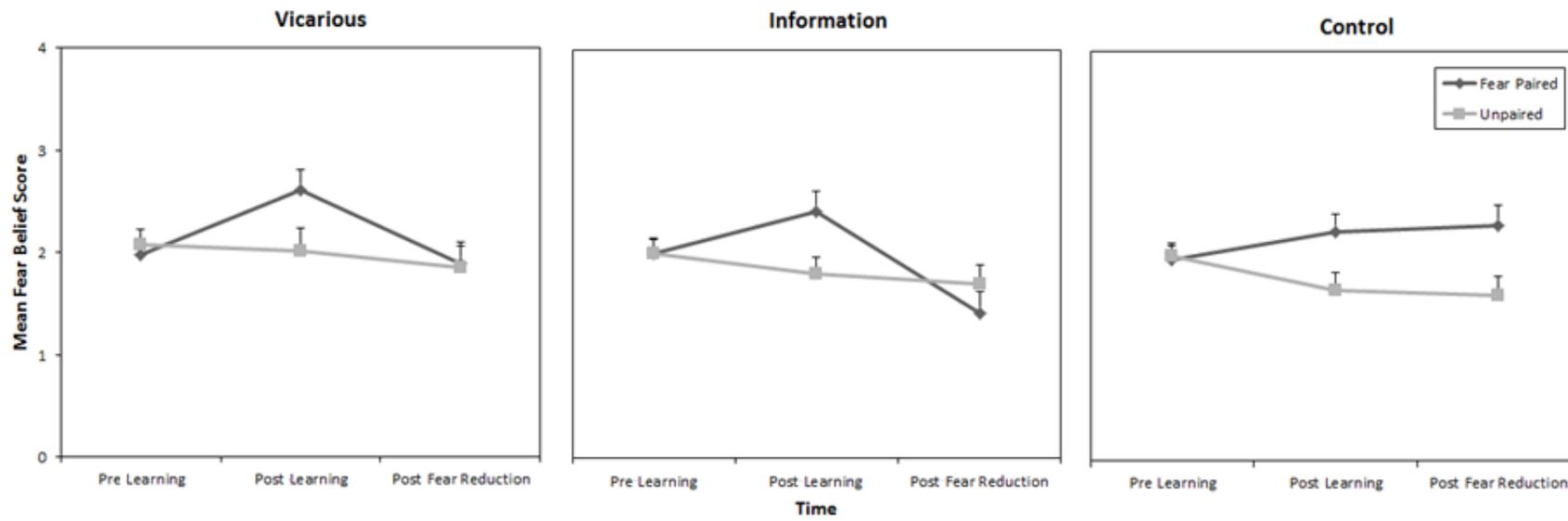


Figure 1. Mean (and SE) fear belief scores for the fear-paired and unpaired animals at each time point for each group

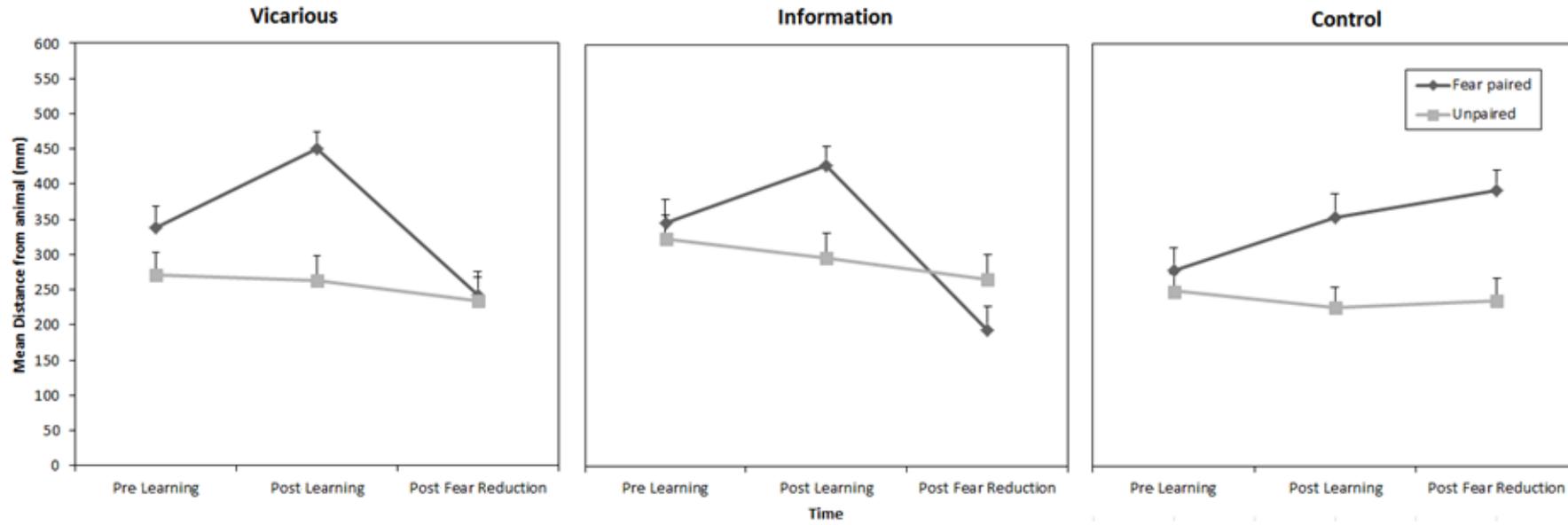
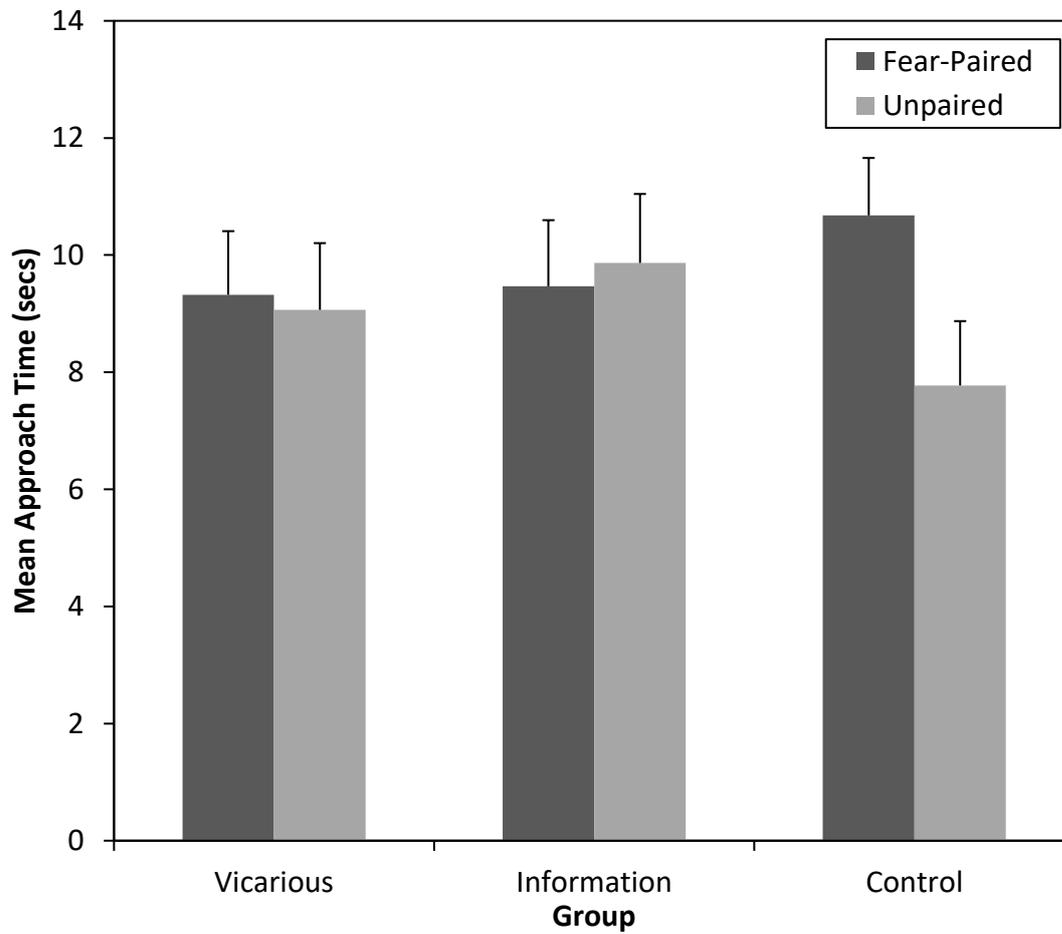


Figure 2. Mean (and SE) distance that children placed themselves from the fear-paired and unpaired animals at each time point for each group



*Figure 3.* Mean (and SE) approach times for the fear-paired and unpaired animals during the BAT for each group