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Stimulus fear-relevance and the vicarious learning pathway to childhood fears

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Abstract

Enhanced fear learning for fear-relevant stimuli has been demonstrated in procedures with adults in the laboratory. Three experiments investigated the effect of stimulus fear-relevance on vicarious fear learning in children (aged 6-11 years). Pictures of stimuli with different levels of fear-relevance (flowers, caterpillars, snakes, worms, and Australian marsupials) were presented alone or together with scared faces. In line with previous studies, children's fear beliefs and avoidance preferences increased for stimuli they had seen with scared faces. However, in contrast to evidence with adults, learning was mostly similar for all stimulus types irrespective of fear-relevance. The results support a proposal that stimulus preparedness is bypassed when children observationally learn threat-related information from adults.

Keywords: Anxiety, Vicarious Learning, Fears, Preparedness, Observational learning

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Stimulus fear-relevance and the vicarious learning pathway to childhood fears

Anxiety is one of the most common psychological disorders of childhood (Cartwright-Hatton, McNicol, & Doubleday, 2006). It often impacts negatively on children's social and educational functioning and persists into adulthood (Cartwright-Hatton, 2006). Fears are distributed non-randomly in the population; for example, fears of certain animals and natural events are more common than other types (Agras, Sylvester, & Oliveau, 1969; Merckelbach, De Jong, Muris, & Van den Hout, 1996). This uneven distribution is typically explained using evolutionary-based theories such as preparedness theory (Seligman, 1970, 1971). Proponents of this theory argue that because certain evolutionarily 'fear-relevant' stimuli threatened our ancestors' survival, natural selection favoured the genes of those who avoided them. Consequently, compared to fear-irrelevant stimuli, fear learning for fear-relevant stimuli will: i) occur more readily; ii) be more robust; and iii) be less cognitive/rational because it is mediated by parts of the brain that developed early in human evolution (Mineka & Öhman, 2002; Öhman & Mineka, 2001; Seligman, 1970, 1971). Selective associations for fear-relevant stimuli are demonstrated in the laboratory when there is evidence of either: faster learning (in less trials), a larger conditioned response (CR), or superior resistance to extinction.

Children can learn to fear a stimulus by observing someone else responding fearfully to it in a process referred to as vicarious (or 'observational') learning (Rachman, 1977). Recent experimental evidence indicates that vicarious learning is a viable pathway to fear in childhood. Toddlers (12-14 months) learn to be more wary of strangers after observing their mothers acting in a socially anxious manner with them (De Rosnay, Cooper, Tsigaras, & Murray, 2006). Similar effects have been found for animal fears: Gerull and Rapee (2002) demonstrated that 15-20 month old toddlers show fear and avoidance for fear-relevant stimuli (rubber snakes or spiders) after observing their mother display negative (fearful/disgusted) facial expressions toward them. Conversely, observationally learnt fear can be prevented if children have positive maternal modelling experience with the stimulus beforehand (Egliston & Rapee, 2007). Askew and Field (2007) showed that children's (7-9 years) fear beliefs for previously unknown animals (Australian

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marsupials) increased after they saw them with pictures of scared faces and remained elevated for at least one week. Fear-related attitudes for these animals were also indirectly detected post-learning and again 3 months later using affective priming to avoid potential demand characteristics associated with direct self-report. Askew and Field also found that children were more cautious about approaching boxes they believed contained the animal they had seen alongside scared faces. These experimental studies with children demonstrate that vicarious learning leads to changes in two of Lang's (1968) three anxiety response systems: the language behaviour system and the behavioural avoidance response system. Furthermore, experiments with children (Askew & Field, 2007, 2008; Askew, Kessock-Philip, & Field, 2008), adults (Olsson & Phelps, 2004; Olsson, Nearing, & Phelps, 2007), and monkeys (Mineka & Cook, 1993) indicate that vicarious learning can be conceptualised as associative learning in which the object of learning is the conditioned stimulus (CS) and the model's behaviour is the unconditioned stimulus (US). Also notable is that explicit awareness of the CS-US contingencies does not appear necessary for vicarious learning in adults (Olsson & Phelps, 2004) or children (Askew & Field, 2007).

Earlier experimental studies with monkeys also offer compelling evidence for selective associations being made through vicarious learning. A series of studies by Mineka, Cook, and colleagues showed that non-snake-fearful rhesus monkeys can rapidly acquire persistent fear of snakes after exposure to monkeys responding fearfully to snakes (e.g. Cook & Mineka, 1989, 1990; Mineka & Cook, 1986, 1993; Mineka, Davidson, Cook, & Keir, 1984). Although nonprimates are known to acquire avoidance behaviour for fear-irrelevant stimuli relatively easily via observational learning (e.g. Del Russo, 1975; Kohn, 1976; Mason & Reidinger, 1982) this learning was found only for fear-relevant stimuli such as snakes and not for fear-irrelevant stimuli such as flowers (Cook & Mineka, 1989, 1990). In contrast, Dubi, Rapee, Emerton, and Schniering (2008) found no significant differences in toddlers' observational learning for fear-relevant (snakes and spiders) and fear-irrelevant (flowers and mushrooms) stimuli using Gerull and Rapee's (2002) modelling procedure.

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Although a wealth of evidence demonstrates selective associations in direct conditioning laboratory procedures (see Davey, 1995; Mineka & Öhman, 2002; Öhman & Mineka, 2001, for an overview) equivalent vicarious learning studies are relatively scarce. Askew and Field (2007) established fear-related vicarious learning in children for Australian marsupials (the quoll, quokka, and cuscus). The current experiments used Askew and Field's procedure to compare vicarious learning for these animals with fear-relevant and irrelevant stimuli. In Experiment 1 vicarious learning for quolls and cuscuses was compared to learning for stimuli (flowers) traditionally used as fear irrelevant CSs (e.g. Cook & Mineka, 1989; Öhman, Flykt, & Esteves, 2001; Öhman & Soares, 1998). Experiment 2 compared learning for the two marsupials with learning for novel stimuli (uncommon caterpillars) similar to those typically used as fear relevant CSs. A final experiment compared vicarious learning for the marsupials with learning for more well-established fear-relevant stimuli (snakes) and another set of stimuli sharing perceptual similarities (worms).

EXPERIMENT 1

All experiments used Askew & Field's (2007) vicarious learning procedure: children saw each stimulus (CS: a marsupial, flower, caterpillar, snake or worm) presented together with either scared faces (USs) or alone (control condition). Thus, during two counterbalanced within-subject conditions, children saw one 'scared-paired' and one 'unpaired' CS. Self-reported fear beliefs for CSs were measured before and after vicarious learning by Fear Beliefs Questionnaire (FBQ; Field & Lawson, 2003). Children's avoidance preferences were also determined using the 'Nature Reserve Task' (Field & Storksen-Coulson, 2007).

Method

Participants

Sixty-four children (28 boys, 36 girls) aged between 6.25 and 10.08 years ($M = 101.06$ months, $SD = 12.35$ months) were recruited from south-west London, UK. All parents gave

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informed consent and children gave verbal assent. Children were randomly assigned to either the marsupial ($n = 32$, 14 girls, 18 boys) or flower ($n = 32$, 22 girls, 10 boys) condition.

Materials

Marsupials and flowers

Six colour pictures of two Australian marsupials (400×400 pixels) were used as unfamiliar CSs: three of a quoll and three of a cuscus. In addition, six colour pictures of flowers were used, three pictures of red avens and three of the dotted loosestrife (each measuring approximately 400×300 pixels). These flowers were chosen because they are likely to be relatively unknown to UK children (compared to say roses or daffodils).

Faces

Ten (5 males, 5 females) portrait photographs (400 pixels wide by 385 to 494 pixels high) of scared faces were used as USs. Pictures were taken from the NimStim Face Stimulus Set (Tottenham, Borscheid, Ellertsen, Marcus, & Nelson's, 2002).

Fear Beliefs Questionnaire (FBQ)

The FBQ (Field & Lawson, 2003) was used to measure children's fear-related beliefs for CSs. Eight identical questions (four reverse scored) determined children's feelings about the marsupials and flowers (e.g., "Would you be happy if you found a cuscus/quoll/red avens/dotted loosestrife in your garden?"). Children responded on a 5-point Likert response scale (0 = 'No, not at all', 1 = 'No, not really', 2 = 'Don't know/Neither', 3 = 'Yes, probably', 4 = 'Yes, definitely'). Internal consistency was moderate before learning: Cronbach's $\alpha = .65$ (Quoll subscale), $.55$ (Cuscus subscale), $.68$ (Dotted Loosestrife subscale) and $.78$ (Red Avens subscale); and high after learning: $\alpha = .88$, $.86$, $.93$, and $.93$ respectively.

Nature reserve task

Children's approach-avoidance cognitions were determined using Field and Storksen-Coulson's (2007) nature reserve task. Originally adapted from the Family System Task (Gehring &

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Marti, 2000; Gehring & Wyler, 1986), in the nature reserve task children are asked to imagine a 45 cm x 60 cm green rectangular board is a nature reserve. They are visiting the reserve and should place themselves (represented by a Playmobil figure of the same gender as the child) where they would most like to be in the park. Photos of the two CSs were at either end of the board: depending on the group to which the child was assigned, either one flower or one marsupial at each end. The board was otherwise empty except for a few trees around the edges so that there would be nothing for their figure to 'hide behind'. The distance from the centre of the child's figure to the centre of each CS was measured to determine relative approach-avoidance preferences for each stimulus.

Procedure

The experimenter explained to children what they would be asked to do and that they could leave the study at any time. Children gave verbal assent. The procedure was computerised using custom written (by the last author) software in Visual Basic.net. ExacTicks 1.1 (Ryle Design, 1997) ensured ms accurate reaction time measurements. The software was run on a Hewlett Packard 6720s laptop computer with a 15" monitor.

Children were randomly assigned to one of two CS groups, 'marsupial' or 'flower', and the first FBQ was administered. Next, during vicarious learning children saw CS images (one of two flowers or marsupials depending on CS group) together with scared face images on a computer screen (a 'scared-paired' trial). The other flower or marsupial CS was presented alone in a no-learning control condition (an 'unpaired' trial). Children were informed that faces showed the person's response to encountering the CS. Children saw 20 trials in random order in a counterbalanced within-subject design. There were 10 scared-paired and 10 unpaired trials, so that the marsupial group saw 10 marsupial-face trials and 10 marsupial-alone trials, and the flower group saw 10 flower-face and 10 flower-alone trials. One scared-paired trial consisted of a randomly chosen CS picture appearing alone on the screen for 1s followed by a further 1s together with a face US. In an unpaired trial the CS appeared on its own for 2s. The side of the

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screen images appeared on was randomly determined. Between each trial there was a randomly determined 2s to 4s interval. Following vicarious learning the second FBQ was administered and finally the nature reserve task. Children were fully debriefed using puzzles, games, and correct information about the animals following the experiment.

Results

Effect sizes are reported as r where appropriate and otherwise as partial eta-squared (η_p^2).

Fear beliefs

A two-way 2(pairing type: scared-paired vs. unpaired) \times 2(CS type: marsupial vs. flower) mixed ANOVA was used to compare pre-vicarious learning fear belief scores. Fear beliefs for marsupials ($M = 1.73$, $SE = 0.10$) were significantly higher than for flowers ($M = 1.17$, $SE = 0.10$), $F(1, 62) = 15.75$, $p < .001$, $r = .45$, before learning. Changes in average fear beliefs pre- to post-vicarious learning were calculated for scared-paired and unpaired animals (see Fig. 1) and a two-way 2(pairing type: scared-paired vs. unpaired) \times 2(CS type: marsupial vs. flower) mixed ANOVA was performed on these scores. There was a significant main effect of pairing type on changes in fear beliefs, $F(1, 62) = 9.69$, $p = .003$, $r = .37$. This shows the effect of fear-related vicarious learning generally: increases in fear beliefs for scared-paired CSs (pre-learning: $M = 1.48$, $SD = 0.69$; post-learning: $M = 2.14$, $SD = 1.13$) were significantly greater than for unpaired CSs (pre-learning: $M = 1.42$, $SD = 0.71$; post-learning: $M = 1.69$, $SD = 0.99$). In contrast, the main effect of CS type, $F(1, 62) = 0.68$, $p = .41$, $r = .10$ and the pairing type \times CS type interaction, $F(1, 62) = 0.33$, $p = .57$, $r = .07$, were non-significant. The lack of significant interaction indicates that fear-related learning was no different for marsupials and flowers and is unlikely to be due to lack of power given the very small effect size.

Correlational analysis indicated that there was no relationship between the age of children and increases in fear beliefs for scared-paired marsupials, $r(30) = .01$, $p = .96$, but increases in

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fear beliefs for scared-paired flowers were greater for older children, $r(30) = .38$, $p = .031$.

Insert Figure 1

Avoidance preferences

Figure 2 shows the distances (cm) from each CS that children placed a figure representing them in the nature reserve task. Distance measurements were analysed using a two-way $2(\text{pairing type: scared-paired vs. unpaired}) \times 2(\text{CS type: marsupial vs. flower})$ mixed ANOVA. The main effect of pairing type was significant, $F(1, 62) = 41.71$, $p < .001$, $r = .66$. This demonstrates that children would prefer to avoid CSs seen with scared faces ($M = 42.10$, $SD = 13.32$) compared to CSs seen alone ($M = 20.62$, $SD = 13.47$). The main effect of CS type, $F(1, 62) = 0.24$, $p = .63$, $r = .06$ and the pairing type \times CS type interaction, $F(1, 62) = 0.03$, $p = .86$, $r = .02$, were non-significant, indicating no significant difference between marsupials and flowers in vicariously acquired avoidance. Again, the low effect size for this interaction suggests that the effect is close to zero and therefore unimportant. A final correlational analysis found no relationship between age and the distance children placed their figure from scared-paired marsupials, $r = .06$, or flowers, $r = -.28$.

Insert Figure 2

EXPERIMENT 2

Experiment 1 showed that post-vicarious learning increases in children's fear beliefs and avoidance preferences were similar for fear-irrelevant flower stimuli and the Australian marsupials used by Askew and Field (2007; Askew et al., 2008). A second experiment investigated whether enhanced learning would be observed for novel stimuli more similar than marsupials to those traditionally believed to be fear-relevant. Vicarious learning research looking at fear-relevancy effects has used stimuli such as spiders and snakes as their fear-relevant stimuli. However, children will have prior experience with these animals and their baseline fear beliefs for them are not likely to be neutral. As such, using these stimuli may

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confound stimulus novelty with stimulus fear-relevancy. It is interesting then to investigate vicarious fear learning for fear-relevant stimuli with which children are less familiar. In general, fear-relevance appears to be associated with perceptual characteristics of animals such as sliminess and ugliness (Bennett-Levy & Marteau, 1984). When Davey (1994) ranked UK adults' self-reported fears for indigenous animals small furry animals such as the squirrel, guinea pig, and rabbit tended to be at the bottom of the list (except for rats and mice). Invertebrates that were slimy and suggestive of mucus or faeces, such as slugs, snakes, eels, and worms were among the most feared animals. Consequently two caterpillars (the automeris and nymphalis) that UK children were unlikely to know were chosen as fear-relevant stimuli in Experiment 2.

Method

Participants

Fifty-nine children (36 boys, 23 girls) aged 6.58 years to 11.58 years ($M = 8.96$ years, $SD = 17.53$ months) were recruited from primary schools in the London area. Children were randomly assigned to the marsupial ($n = 30$, 11 girls, 19 boys), or caterpillar ($n = 29$, 12 girls, 17 boys) conditions.

Materials

Marsupials and caterpillars

Quoll and cuscus pictures from Experiment 1 were used again in Experiment 2. Fear-relevant CSs were six colour pictures of two caterpillars (all between 400×210 and 400×320 pixels): three pictures of an automeris and three of a nymphalis caterpillar.

Fear Beliefs Questionnaire

The FBQ was identical to Experiment 1 except that flower names were replaced with names of caterpillars. Internal consistency before learning: Cronbach's $\alpha = .71$ (Cuscus subscale), $.74$ (Quoll subscale), $.70$ (Automeris subscale) and $.55$ (Nymphalis subscale). After learning: $\alpha = .79$, $.69$, $.65$, and $.68$ respectively.

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Procedure

The procedure was identical to Experiment 1 except that caterpillars were used instead of flowers. Also, nature reserve task measurements were taken individually for each CS in Experiment 2 to ensure that scores were independent of each other. Consequently only one marsupial or caterpillar was on the board when the child positioned their figure, instead of both simultaneously as in Experiment 1.

Results

Fear beliefs

Pre-learning fear beliefs were compared using a 2(pairing type: scared-paired vs. unpaired) \times 2(CS type: marsupial vs. caterpillar) mixed ANOVA. No significant differences were found in fear beliefs for marsupials and caterpillars before vicarious learning. Figure 3 shows mean changes in fear beliefs for marsupials and caterpillars. A two-way 2(pairing type: scared-paired vs. unpaired) \times 2(CS type: marsupial vs. caterpillar) mixed ANOVA conducted on the changes in average fear belief scores for animals revealed a significant main effect of pairing type, $F(1, 57) = 4.97, p = .030, r = .28$. This result demonstrates vicarious learning had a significant effect on fear beliefs: greater increases in fear beliefs were observed for scared-paired CSs (baseline: $M = 1.94, SD = 0.78$; post-learning: $M = 2.30, SD = 0.79$) compared to unpaired CSs (baseline: $M = 1.95, SD = 0.73$; post-learning: $M = 2.07, SD = 0.73$). The main effect of pairing type, $F(1, 57) = 0.09, p = .77, r = .04$, and the pairing type \times CS type interaction, $F(1, 57) = 0.03, p = .88, r = .02$, were non-significant. This lack of significant interaction indicates that vicarious learning did not differ for marsupials and caterpillars. The effect size for the interaction was very close to zero indicating a trivial effect. Finally, no relationship between the age of children and increases in fear beliefs for scared-paired marsupials or scared-paired caterpillars was found ($r = .13$ and $.15$ respectively).

Insert Figure 3

Avoidance preferences

Figure 4 shows the mean distances (cm) children placed their figures from each marsupial or caterpillar. The two-way 2(pairing type: scared-paired vs. unpaired) \times 2(CS type: marsupial vs. caterpillar) mixed ANOVA showed a significant effect of pairing type, $F(1, 57) = 8.82, p = .004, r = .37$, but the main effect of CS type, $F(1, 57) = 0.03, p = .87, r = .02$, and the pairing type \times CS type interaction were non-significant, $F(1, 57) = 0.04, p = .85, r = .03$. Thus distance between children's figures and a CS (i.e. avoidance) was greater when the CS had been presented with scared faces ($M = 33.20, SD = 15.98$) than when it had been presented alone ($M = 28.76, SD = 13.83$) and this effect was similar for marsupials and caterpillars. The effect size for the interaction was again close to zero, indicating a practically non-existent effect. A correlational analysis found no relationship between children's age and avoidance of marsupials, $r = -.23$, but the correlation was approaching significance for caterpillars, $r(27) = -.35, p = .065$, suggesting a trend for greater avoidance in younger children.

Insert Figure 4

EXPERIMENT 3

Experiments 1 and 2 demonstrated that vicarious learning of fear in children is similar for three types of stimuli: flowers, marsupials, and caterpillars, which vary in level of fear-relevancy. These stimuli were used because UK school children are unlikely to already have high fear beliefs for them. However, although flowers are commonly used fear-irrelevant stimuli, nothing is known about the fear-relevance of the caterpillars apart from their visual similarities with fear-relevant invertebrate stimuli. It remains possible therefore that these stimuli are not fear-relevant enough to elicit enhanced fear-related learning. Although snakes are more typical fear-relevant stimuli in learning studies, they are already so familiar to school children that even novel species are likely to elicit fear beliefs and avoidance behaviour prior to the experiment. Thus fear beliefs questionnaire scores could potentially show ceiling effects following vicarious learning. In Experiment 3, vicarious learning for marsupials was compared to snakes using a

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series of newly created fear response measures calibrated to avoid ceiling effects. In addition, learning was compared to a third stimulus-type, worms. Worms are visually similar to snakes but not typically used as fear-relevant stimuli in learning experiments.

Method

Participants

Eighty-two children (43 boys, 39 girls) aged 6.29 years to 9.73 years ($M = 103.46$ months, $SD = 8.13$ months) were recruited from primary schools in Suffolk and Essex, UK. Children were randomly assigned to the marsupial ($n = 28$, 11 girls, 17 boys), snake ($n = 28$, 13 girls, 15 boys) or worm ($n = 26$, 15 girls, 11 boys) conditions.

Materials

Marsupials, Worms, and Snakes

Quoll and cuscus pictures from Experiments 1 and 2 were used again in Experiment 3. Fear-relevant CSs were six colour pictures of two snakes: three pictures of a keelback snake and three of a boomslang snake. Additional CSs were six colour pictures of two worms: three pictures of a *Lumbricus rubellus* (shortened to 'Lumbricus') and an *Allolobophora Chlorotica* (shortened to 'Allolobophora')

Fear Beliefs Questionnaire

The FBQ was identical to Experiments 1 and 2 except that there were three versions for marsupials, snakes, and worms. Internal consistency before learning: Cronbach's $\alpha = .71$ (Quoll subscale), $.73$ (Cuscus subscale), $.80$ (Lumbricus subscale), $.82$ (Allolobophora subscale), $.83$ (Keelback subscale) and $.82$ (Boomslang subscale). After learning: $\alpha = .83$, $.82$, $.79$, $.87$, $.93$, and $.94$ respectively.

Cognitive, behavioural, and physiological fear responses

A potential problem with using the FBQ to measure fear beliefs for snakes could be

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baseline levels of fear already being at the top end of the scale, meaning that an increase from baseline cannot be detected. To avoid this possibility, three additional cognitive, behavioural, and physiological self-report measures of fear were used, which were designed to give a more finely calibrated scale and a higher overall ceiling. The three measures were created to reflect Lang's (1968) three anxiety response systems: language behaviour, overt behaviour, and physiological responses. Each questionnaire consisted of six graded questions to which children could respond on the same 5-point scale used in the FBQ. Questions on the behavioural scale began with, 'If you knew there was a room nearby with a [the stimulus animal] in a large closed glass box, would you be able to walk into the room?', followed by questions about whether children would be able to stay in the room, touch the glass of the box, put their hand in the box but not touch the animal, touch the animal, and finally whether they would lift the animal out of the box. Higher scores indicated more approach behaviour and lower scores more avoidance. For the cognitive scale, the questions followed the same graded format but this time asked if children would feel scared in each of the scenarios. Higher scores indicated more fear cognitions. Finally, questions on the physiological scale asked children whether their heart would beat faster in each scenario, with higher final scores indicating greater self-reported physiological fear.

Internal consistency was high for all scales. Before learning for the Behavioural scale: Cronbach's $\alpha = .89$ (Quoll), $.91$ (Cuscus), $.92$ (Keelback), $.91$ (Boomslang), $.94$ (Allolobophora), $.93$ (Lumbricus), for the Cognitive scale: $.90$ (Quoll), $.95$ (Cuscus), $.97$ (Keelback), $.95$ (Boomslang), $.92$ (Allolobophora), $.92$ (Lumbricus), and for the Physiological scale: $.87$ (Quoll), $.96$ (Cuscus), $.94$ (Keelback), $.96$ (Boomslang), $.92$ (Allolobophora) and $.90$ (Lumbricus). After learning for the Behavioural scale: $\alpha = .92, .88, .92, .95, .95$ and $.95$, respectively, for the Cognitive scale: $.93, .95, .97, .96, .95$ and $.94$ respectively, and for the Physiological scale: $.91, .92, .97, .96, .96$ and $.94$ respectively.

Procedure

The procedure followed the same design as Experiments 1 and 2 except that marsupials, worms, and snakes were used instead of marsupials and caterpillars or flowers. A new custom written (by the fourth author) program was created in E-Prime and run on a Samsung RF511 laptop computer and a ProLite T2451MTS 24" Touchscreen Monitor. The Nature Reserve Task was procedurally the same as previous experiments but using the new animals.

RESULTS

Fear beliefs

Pre-learning fear belief scores for children in the snake CS group indicated that there was still room on the scale for average fear beliefs to increase due to learning: for the scared-paired snake, 42.9% of children responded on average at or below 2, the mid-point of the scale; 32.1% responded between 2 and 3; and 25.0% responded 3 to 4. No children used 4, the highest point on the scale. For the unpaired snake, 50.0% of children responded on the lower part of the scale on average, 25.0% responded 2 to 3, and 25.0% responded between 3 and 4. Only one child responded using the highest point of the scale pre-learning. A two-way independent ANOVA conducted on fear belief scores before vicarious learning indicated a main effect of animal type, $F(2, 79) = 5.49, p = .006, \eta_p^2 = .12$. Follow-up Bonferroni-adjusted comparisons indicated children's fear beliefs were significantly higher for snakes ($M = 2.29, SE = 0.15$) than both marsupials ($M = 1.74, SE = 0.15$) and worms ($M = 1.63, SE = 0.15$). There was no significant difference in fear beliefs for marsupials and worms.

Mean changes in fear beliefs for marsupials, snakes, and worms are displayed in Figure 5. A two-way 2(pairing type: scared-paired vs. unpaired) \times 3(CS type: marsupial vs. snake vs. worm) mixed ANOVA conducted on the changes in average fear belief scores for the three animals indicated a significant main effect of pairing type, $F(1, 79) = 18.05, p < .001, r = .43$. This shows that vicarious learning resulted in a significant increase in fear beliefs for scared-paired CSs (baseline: $M = 1.89, SD = 0.86$; post-learning: $M = 2.20, SD = 1.01$) compared to unpaired CSs

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(baseline: $M = 1.89$, $SD = 0.92$; post-learning: $M = 1.84$, $SD = 0.99$). The main effect of CS type, $F(2, 79) = 2.19$, $p = .118$, $\eta_p^2 = .053$, was non-significant, but the pairing type \times CS type interaction, $F(2, 79) = 3.87$, $p = .025$, $\eta_p^2 = .089$, was significant, indicating different fear-related learning for marsupials, snakes, and worms. The pairing type \times CS type interaction was followed up with simple effects analysis comparing the change in fear beliefs for the scared-paired and the unpaired animal in each group. Results indicated a significant increase in fear beliefs compared to unpaired animals for scared-paired marsupials, $F(1, 79) = 21.93$, $p < .001$, $r = .47$, and marginally significant for scared-paired snakes, $F(1, 79) = 3.89$, $p = .052$, $r = .22$, but no significant increase for scared-paired worms, $F(1, 79) = 0.59$, $p = .45$, $r = .09$.

A final correlational analysis indicated that there was a borderline significant correlation between increased age and increases in children's fear beliefs for scared paired marsupials, $r = .36$, $p = .063$, but not snakes, $r = -.01$, or worms, $r = -.26$.

Insert Figure 5

Self-reported fear cognitions

For scared-paired snakes pre-vicarious learning, 57% of children responded on average on the lower half (0 to 2) of the 5-point scale; 10.7% responded between 2 and 3; and 32.8% of children responded 3 to 4. Only two children responded with the highest possible average score on the scale of 4. For unpaired snakes, 53.6% responded below the mid-point, 21.4% responded 2-3, and 25.0% responded higher than 3. Four of the 28 children used the highest point on the scale. Thus, across children in the snake group, there was still room on the scale for fear cognitions to increase. Before vicarious learning there was a significant difference in children's fear cognitions for the three CSs, $F(2, 79) = 9.70$, $p < .001$, $\eta_p^2 = .20$. Bonferroni post-hoc comparisons indicated children reported being more scared of marsupials ($M = 1.81$, $SE = 0.20$) and snakes ($M = 2.05$, $SE = 0.20$) than worms ($M = 0.85$, $SE = 0.21$).

Mean changes in fear cognitions over time are displayed in Figure 6, with higher scores indicating more fear cognitions. Mixed ANOVA showed a significant main effect of pairing type,

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$F(1, 79) = 29.01, p < .001, r = .52$ indicating that vicarious learning significantly increased cognitive fear for scared-paired CSs (baseline: $M = 1.54, SD = 1.17$; post-learning: $M = 2.21, SD = 1.26$) compared to unpaired CSs (baseline: $M = 1.63, SD = 1.28$; post-learning: $M = 1.66, SD = 1.25$). The main effect of CS type was non-significant, $F(1, 79) = .19, p = .83, r = .05$, but the pairing type \times CS type interaction was significant, $F(2, 79) = 3.81, p = .026, \eta_p^2 = .09$ indicating different changes in fear cognitions for marsupials, snakes, and worms. As for fear beliefs, simple effects analysis indicated a significantly greater increase in fear cognitions for scared-paired marsupials, $F(1, 79) = 29.26, p < .001, r = .52$, and snakes, $F(1, 79) = 4.99, p = .028, r = .24$, compared to unpaired animals, but for worms this difference was only approaching significance, $F(1, 79) = 3.02, p = .086, r = .19$. There was no relationship between age and increases in fear cognitions for scared paired marsupials, $r = .13$, snakes, $r = .12$, or worms, $r = -.03$.

Insert Figure 6

Self-reported approach-avoidance

Of children who saw snakes with scared faces, 14.3% scored below 1 on the pre-learning approach-avoidance scale; 32.1% responded below the mid-point; 42.9% responded 2-3; and 25% responded higher than 3. Only three children (10.7%) used the highest approach point on the scale and no children used the lowest point, suggesting that across the group as a whole there was still room on the scale for approach to increase or decrease. This was similar for unpaired snakes: 50% of children responded below the mid-point of the scale; 28.6% responded 2-3; and 21.4% above 4. Four out of 28 children used the highest point on the scale and no one used the lowest point. A two-way 2(pairing type: scared-paired vs. unpaired) \times 3(CS type: marsupial vs. snake vs. worm) mixed ANOVA performed on baseline behavioural scale scores found no significant difference in children's self-reported approach-avoidance intentions for marsupials, snakes, and worms before vicarious learning, $F(2, 79) = 1.58, p = .21, \eta_p^2 = .04$.

Mean changes in self-reported approach-avoidance intentions for marsupials, snakes, and

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worms are shown in Figure 6. Positive scores indicate increases in approach behaviour and negative scores indicate increased avoidance. A two-way 2(pairing type: scared-paired vs. unpaired) \times 3(CS type: marsupial vs. snake vs. worm) mixed ANOVA conducted on changes in average self-reported approach-avoidance intentions for the three animals indicated a significant main effect of pairing type, $F(1, 79) = 26.92, p < .001, r = .50$. This effect shows that vicarious learning resulted in increased avoidance intentions (decreased approach) for scared-paired CSs (baseline: $M = 2.54, SD = 1.10$; post-learning: $M = 2.13, SD = 1.13$) compared to unpaired CSs (baseline: $M = 2.49, SD = 1.21$; post-learning: $M = 2.62, SD = 1.15$). The main effect of CS type, $F(2, 79) = 0.66, p = .52, \eta_p^2 = .02$, was non-significant, but the pairing type \times CS type interaction, $F(2, 79) = 2.81, p = .066, \eta_p^2 = .07$, was marginally significant, suggesting different self-reported approach-avoidance intentions for marsupials, snakes, and worms. Given this effect replicated the fear beliefs and fear cognitions data, simple effects analyses were used to compare the change in self-reported approach-avoidance for scared-paired and unpaired animals in each group. Compared to unpaired CSs, significant increases in avoidance intentions were detected for scared-paired marsupials, $F(1, 79) = 15.94, p < .001, r = .41$, and snakes, $F(1, 79) = 16.48, p < .001, r = .42$, but not worms, $F(1, 79) = 1.02, p = .32, r = .11$. Thus, the same pattern was observed as for fear beliefs and fear cognitions: fear-related vicarious learning increased children's self-reported avoidance of marsupials and snakes, but not worms. A correlational analysis indicated that there was no relationship between children's age and increases in self-reported approach-avoidance behaviour for scared paired marsupials, snakes, or worms ($r = .10, -.12, \text{ and } .05$ respectively).

Self-reported physiological responses

For scared-paired snakes, 42.9% of children responded on the lower half of the physiological scale before learning; 35.7% responded 2-3 on the scale; and 21.4% above 3. Three out of 28 children responded 4, the highest point on the scale, suggesting there was still adequate room on the scale for self-reported physiological responses to increase. A similar

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pattern of responding was seen for unpaired snakes: 46.4% scored below the mid-point; 28.6% responded 2-3 on the scale; and 25% scored higher than 3. No children responded 4, the highest point on the scale. An analysis of children's self-reported physiological responses to animals at baseline indicated that children reported greater fear-related physiological responses to marsupials ($M = 2.13$, $SE = 0.19$, $p < .001$) and snakes ($M = 2.12$, $SE = 0.19$, $p = .001$) than for worms ($M = 1.02$, $SE = 0.20$) before vicarious learning, $F(2, 79) = 10.38$, $p < .001$, $\eta_p^2 = .21$.

Mean changes in self-reported physiological responses to marsupials, snakes, and worms are displayed in Figure 6, with higher scores indicating increases in heart rate. A mixed ANOVA conducted on changes in self-reported physiological scores for the three animals demonstrated a significant main effect of pairing type, $F(1, 79) = 14.07$, $p < .001$, $r = .39$. This indicates that following vicarious learning children reported significantly increased heart-rate responses for scared-paired CSs (baseline: $M = 1.74$, $SD = 1.24$; post-learning: $M = 2.13$, $SD = 1.25$) compared to unpaired CSs (baseline: $M = 1.80$, $SD = 1.16$; post-learning: $M = 1.67$, $SD = 1.14$). There was no main effect of CS type, $F(2, 79) = 0.95$, $p = .39$, $\eta_p^2 = .02$, or pairing type \times CS type interaction, $F(2, 79) = 1.29$, $p = .28$, $\eta_p^2 = .03$, indicating no difference in self-reported physiological responses for marsupials, snakes, and worms. There was also no relationship between age and increases in self-reported physiological responses to scared paired marsupials, snakes, or worms ($r = .17$, $.001$, and $-.21$ respectively).

Avoidance preferences

The mean distance (cm) children placed their figure from each marsupial, snake, or worm is displayed in Figure 9. A two-way 2(pairing type: scared-paired vs. unpaired) \times 3(CS type: marsupial vs. snake vs. worm) mixed ANOVA indicated a significant main effect of pairing type, $F(1, 79) = 13.91$, $p < .001$, $r = .39$, but the main effect of CS type, $F(2, 79) = 0.82$, $p = .44$, $\eta_p^2 = .02$, and the pairing type \times CS type interaction were non-significant, $F(2, 79) = 0.11$, $p = .90$, $\eta_p^2 = .003$. Children placed their figures further away from scared paired CSs ($M = 29.61$, $SD = 18.83$) than unpaired CSs ($M = 23.87$, $SD = 17.22$), showing fear-related vicarious learning increased

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avoidance preferences. The non-significant interaction indicated that the effect of vicarious learning on avoidance preferences was similar for marsupials, snakes, and worms. Finally, no relationship between age and avoidance preferences for scared paired marsupials, snakes, or worms ($r = .19, .22, \text{ and } .11$ respectively) was found.

Insert Figure 7

DISCUSSION

Three experiments replicated Askew and Field's (2007; Askew et al., 2008) finding that children's self-reported fear beliefs increase for stimuli they see with scared faces: observing someone respond fearfully to a stimulus is sufficient to increase children's fear cognitions for it. Children also preferred to avoid these scared-paired stimuli compared to unpaired stimuli. This second finding suggests that behavioural avoidance of scared-paired animals demonstrated by Askew and Field (2007) is preceded and/or accompanied by cognitions about avoidance intentions. Most striking was that vicarious fear learning was generally independent of stimulus fear-relevance: children's learning was similar for flowers, marsupials, caterpillars, and snakes. Only learning for worm stimuli differed from marsupials and only on some measures: increases in fear beliefs, fear-related cognitions, and self-reported approach-avoidance were greater for marsupial and snake stimuli than for worms, which showed no vicarious learning on these measures. However, significant increases in self-reported physiological responses and avoidance preferences were observed for scared-paired worms that were no less than for scared-paired marsupials and snakes.

Of course, interpreting non-significance as evidence that vicarious learning is not affected by the type of CS can be problematic because there could be other reasons for the lack of significance (e.g., insufficient power). However, the effect sizes for the key pairing type \times CS type interactions were consistently close to zero. Although the precision of these effect size estimates will be affected by sample size, with N s of around 50-60 the estimates are precise enough to interpret confidently. The estimates clearly indicate that any differences in

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conditioned responses across different stimuli were close to zero, and should be considered trivial at best.

These results mirror those from toddlers (Dubi et al., 2008), but are inconsistent with evidence from conditioning procedures with adults using direct aversive USs (see Davey, 1995; McNally, 1987; Mineka & Öhman, 2002; Öhman & Mineka, 2001) and vicarious learning in monkeys (Cook & Mineka, 1989, 1990), which show selective associations for fear-relevant stimuli. The most straight forward explanation for this is that unlike adults or monkeys, young children do not show enhanced vicarious learning for fear-relevant stimuli compared to other stimuli. This might, for example, be the case if fear-relevance and selective associations in fact reflect common life experiences rather than biological preparedness. In this scenario, laboratory demonstrations of selective associations may not be due to evolutionary pressures but participants' previous experience with a stimulus and its personal relevance (Davey, 1992, 1995; Purkis, Lester, & Field, 2011; Purkis & Lipp, 2007, 2009). Davey (1992, 1995) has argued that the uneven distribution of fears can be explained by expectancy evaluations about a learning event. A CR is mediated by the strength of association between the CS and US (Rescorla, 1980). This association is in turn influenced by the degree to which an individual believes the CS predicts the US (Alloy & Tabachnik, 1984). So an individual's prior beliefs or 'expectancies' about the relationship between a stimulus and a negative outcome could create selective learning effects in the laboratory. But we would not expect to find selective associations for *novel* stimuli such as those used in the current study unless they are biologically prepared.

Evidence of selective associations for familiar fear-relevant stimuli could be due then either to biological preparedness or past learning experiences. Little evidence for selective associations in vicarious learning was found for fear-relevant stimuli in the current study. Hence the findings contradict a preparedness explanation for selective association but not an experiential explanation. However, there are two possible alternative explanations for the current findings that should also be discussed. These are: i) the measures used were not sensitive enough to detect differences in learning for the stimuli; and ii) the CSs were not

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sufficiently fear-relevant. The first of these seems an unlikely interpretation for two reasons. As has already been noted, effect sizes for comparisons of fear beliefs ($r = .07$ and $.02$) and avoidance ($r = .02$ and $.03$) for the CSs in Experiments 1 and 2 were extremely small; and much smaller than comparisons between scared-paired and unpaired conditions using these same measures (fear beliefs: $r = .37$ and $.28$; avoidance: $r = .66$ and $.37$). Furthermore, there was no evidence of ceiling effects: there was ample room on both ends of the fear beliefs and avoidance scales for mean responses to increase or decrease further. Lang (1968) conceptualised anxiety as three response systems: language behaviour (subjective report), overt behaviour (avoidance), and physiological responses. These systems are relatively independent from each other and there is often little correlation between measures of each index. The current study used self-report measures, whereas monkey (Cook & Mineka, 1989, 1990) and toddler (Dubi et al., 2008) studies have usually observed fear-related behaviour, and human conditioning studies have typically used physiological responses or self-report (e.g. Öhman & Soares, 1998). As a result, differences in findings between these studies might in part reflect differences in measures.

The second alternative explanation for the results could be that the stimuli used were not sufficiently fear-relevant. The caterpillars were chosen for the current study on the basis that they were fear-relevant and novel (i.e. unusual in the UK and unknown to children). The fear-relevance of a stimulus is usually defined retrospectively though - a stimulus is typically considered fear-relevant if it is feared more often than other stimuli - and is therefore difficult to determine for less well-known stimuli. The caterpillars were chosen because they share perceptual characteristics - i.e. they are slimy like mucus or faeces - with some commonly feared animals, e.g. slugs, snakes, eels, and worms (Bennett-Levy & Marteau, 1984; Davey, 1994). As such, they were believed to be both novel and fear-relevant. However, due to the circular nature of the definition of fear-relevance, it is not possible to simultaneously demonstrate the fear-relevance of a stimulus and that selective associations do not occur for it, because selective associations are assumed to be a feature of fear-relevance: a stimulus is fear-

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relevant if selective associations are observed; if they are not observed the stimulus is not fear-relevant. Nevertheless findings from Experiment 2 suggest that a novel stimulus can share perceptual characteristics with fear-relevant stimuli but not form selective associations.

Because the fear-relevance of caterpillars is not established, Experiment 3 compared learning for marsupials to snakes and worms: snakes are well-established fear-relevant stimuli (e.g. Cook & Mineka, 1989) and worms share some perceptual similarities with snakes. Children's fear-related learning for snakes was no different to learning for marsupials, supporting the findings from Experiments 1 and 2. Increases in fear beliefs, fear cognitions, and self-reported avoidance were greater for marsupials and snakes than for worms. However, there could be many reasons for this and it highlights the problems associated with making a priori assumptions about what evolution selects for to define stimuli as fear-relevant in experimental procedures. There may have been less learning for worms because, for example, 6 to 9-year-olds already have stable beliefs about how unthreatening worms are compared to snakes and marsupials. Alternatively, fear learning may be more evolutionarily prepared for marsupials and snakes than for worms because, for example, they are larger, have teeth, and move faster; and evolution is more likely to select for general features such as these than for say a specific snake or marsupial fearing system. Or there may be different reasons for snakes and marsupials why fear learning is superior compared to worms: for example, fear learning might be enhanced for marsupials because they are large and mobile, but enhanced for snakes due to socialisation. The problem is that there is no way of knowing which of many possible explanations is more accurate. The picture is further complicated here because children's avoidance preferences for scared-paired worms were no different to those for snakes and marsupials when measured using the nature reserve task. And when children were asked about their physiological responses to the animals, children believed their heart rate responses to all three animal stimuli had similarly increased following learning. Thus, although findings for worms are not as straightforward as for the other animals and flowers used, they do not entirely contradict the general finding that learning was no different for stimuli of seemingly greater and lesser fear-relevance.

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Aside from fear-relevance, other characteristics of the CS may affect comparisons with studies such as those with monkeys (Cook & Mineka, 1989, 1990). Fear for stimuli is associated with perceptions of speediness and suddenness of movement (Bennett-Levy & Marteau, 1984) and young children show a predisposition to associate frightened voices with films of moving snakes, but not with still images of snakes (DeLoache & LoBue, 2009). Still CS images were used here. Characteristics of the US also vary across studies. USs in the current experiments (still pictures of faces) were unlikely to be as aversive as USs used in monkey and human conditioning studies which involve moving frightened models. Mineka and Öhman (2002; Öhman & Mineka, 2001) have argued that controllability and intensity of the US influence whether emotional (mediated by the amygdala) or cognitive (mediated by the hippocampus) fear learning occurs. Fear-relevant stimuli are believed to trigger what they call the ‘evolutionary module’ and produce emotional fear learning, whereas fear-irrelevant stimuli produce less robust cognitive learning. According to Mineka and Öhman, intense USs may also lead to emotional (fear-relevant-like) learning. In line with Mineka and Öhman’s theory, Dubi et al. (2008) speculated that they found no evidence of selective vicarious learning for fear-relevant stimuli because their procedure may tap into general cognitive learning about danger, rather than learning of irrational phobias. This now appears less likely given the replication here and that, together with the current procedure, vicariously acquired changes in two of Lang’s fear systems, avoidance behaviour (Askew & Field, 2007; Dubi et al., 2008; Egliston & Rapee, 2007; Gerull & Rapee, 2002) and subjective report (Askew & Field, 2007; Askew et al., 2008), have been demonstrated in children.

Summary

Three experiments confirm that fear-related vicarious learning experiences increase children’s fear and avoidance cognitions for a stimulus. In contradiction to preparedness theory, this learning was similar for flowers, marsupials, caterpillars, snakes, and in some cases worms and therefore may be unrelated to stimulus fear-relevance in children of this age. The study also highlights issues around defining and explaining fear-relevance in this kind of research.

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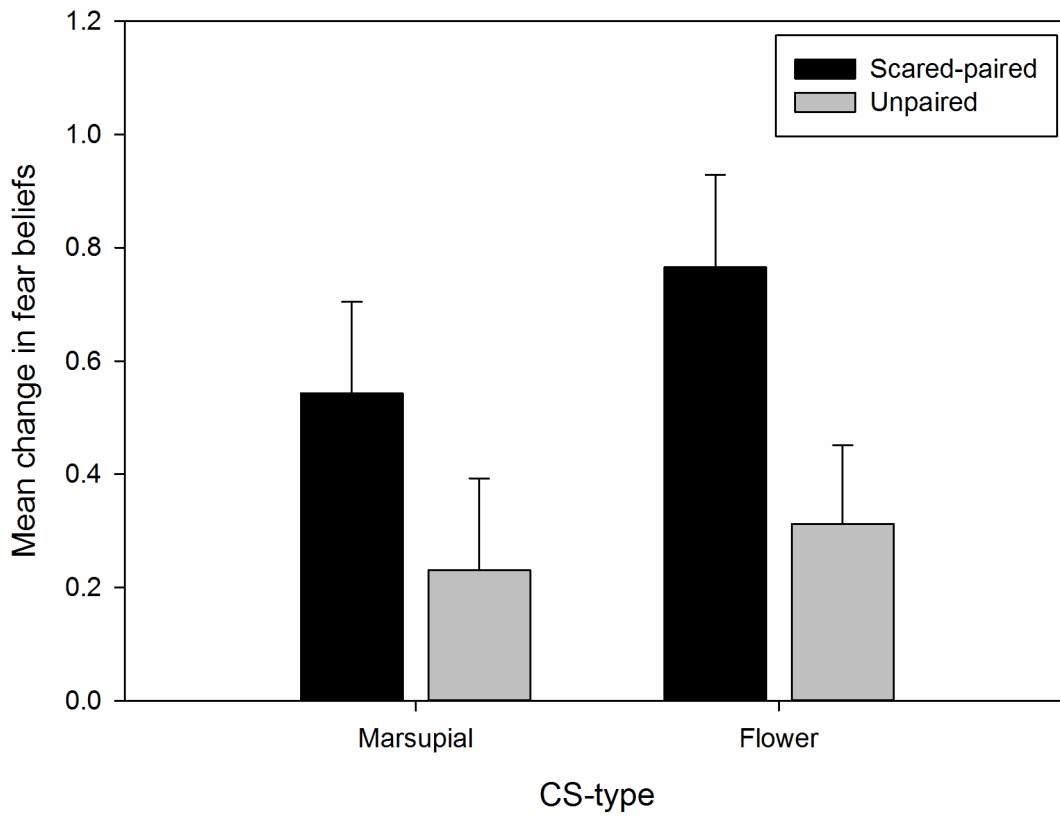


Figure 1. Graph showing mean change in fear beliefs (and SE) for each CS and pairing type in Experiment 1.

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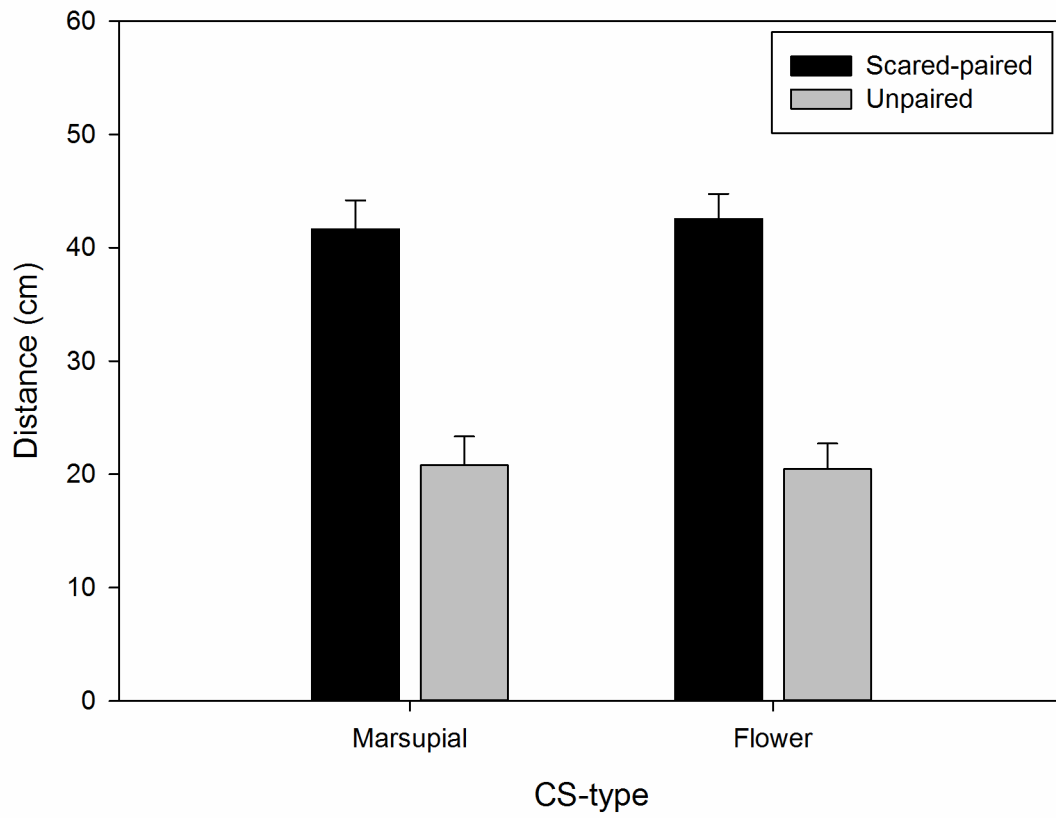


Figure 2. Graph showing mean distances (and SE) from children's figures to marsupial and flower CSs in Experiment 1.

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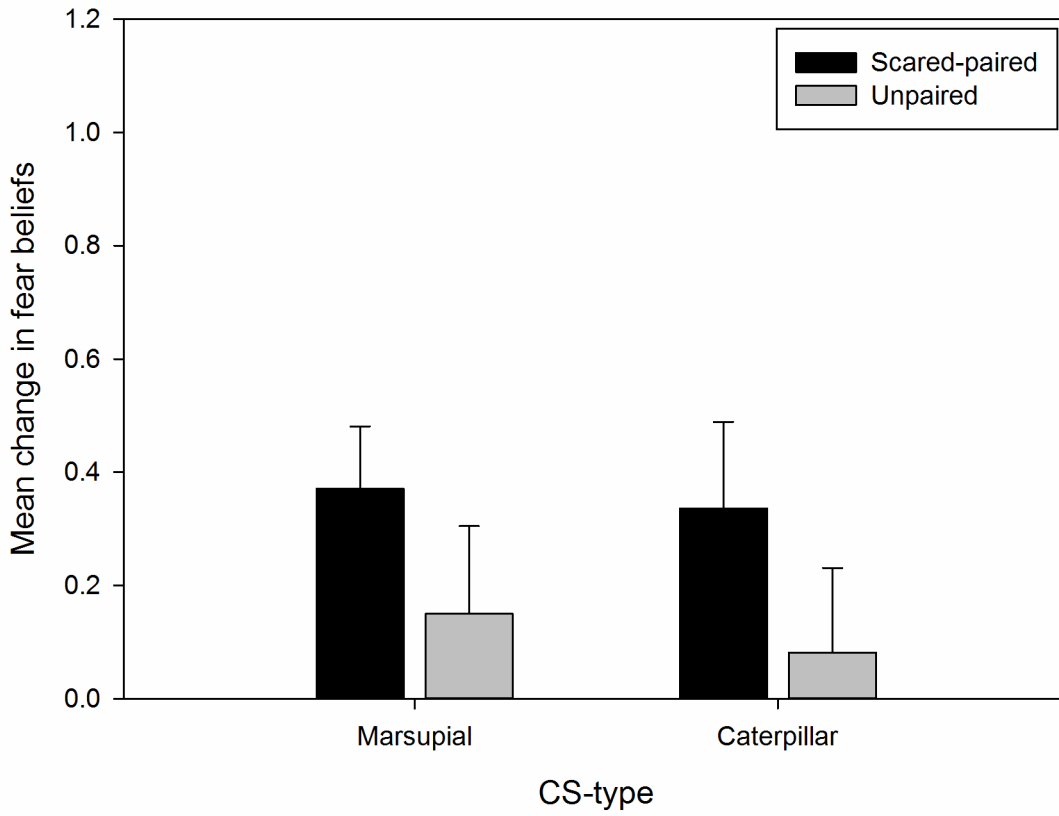


Figure 3. Graph showing mean change in fear beliefs (and SE) for each CS and pairing type in Experiment 2.

VICARIOUS LEARNING OF FEAR IN CHILDHOOD

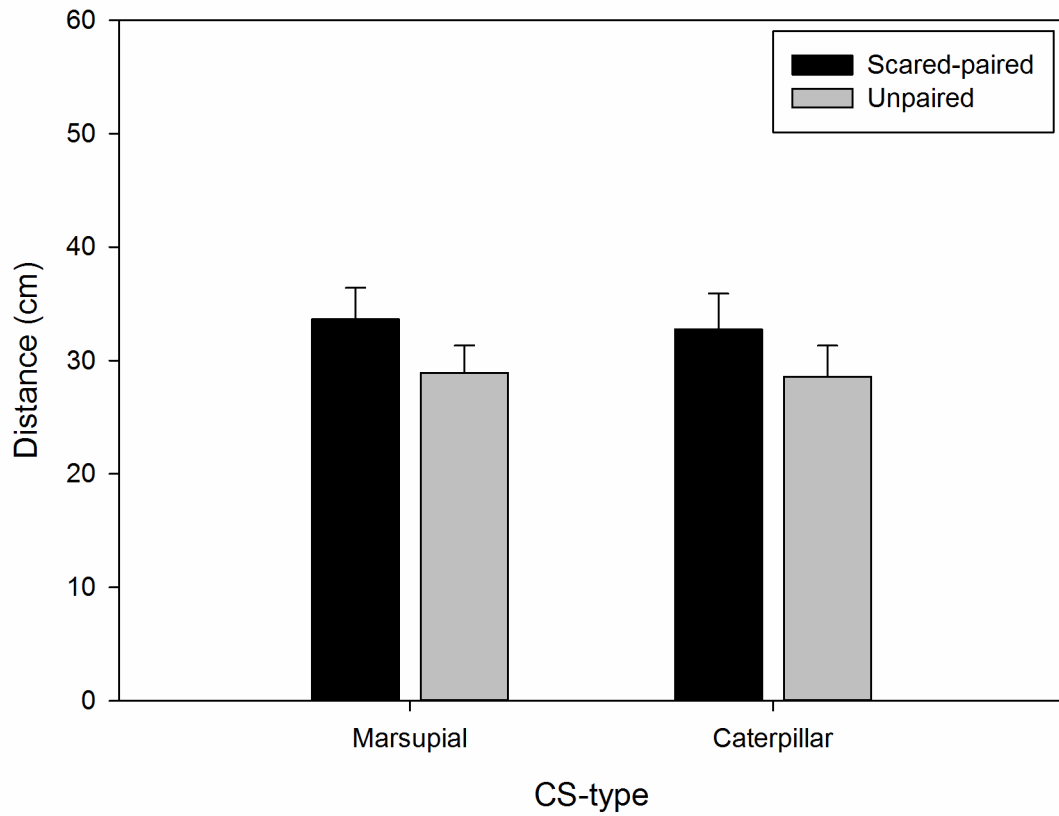


Figure 4. Graph showing mean distances (and SE) from children's figures to marsupial and caterpillar CSs in Experiment 2.

VICARIOUS LEARNING OF FEAR IN CHILDHOOD

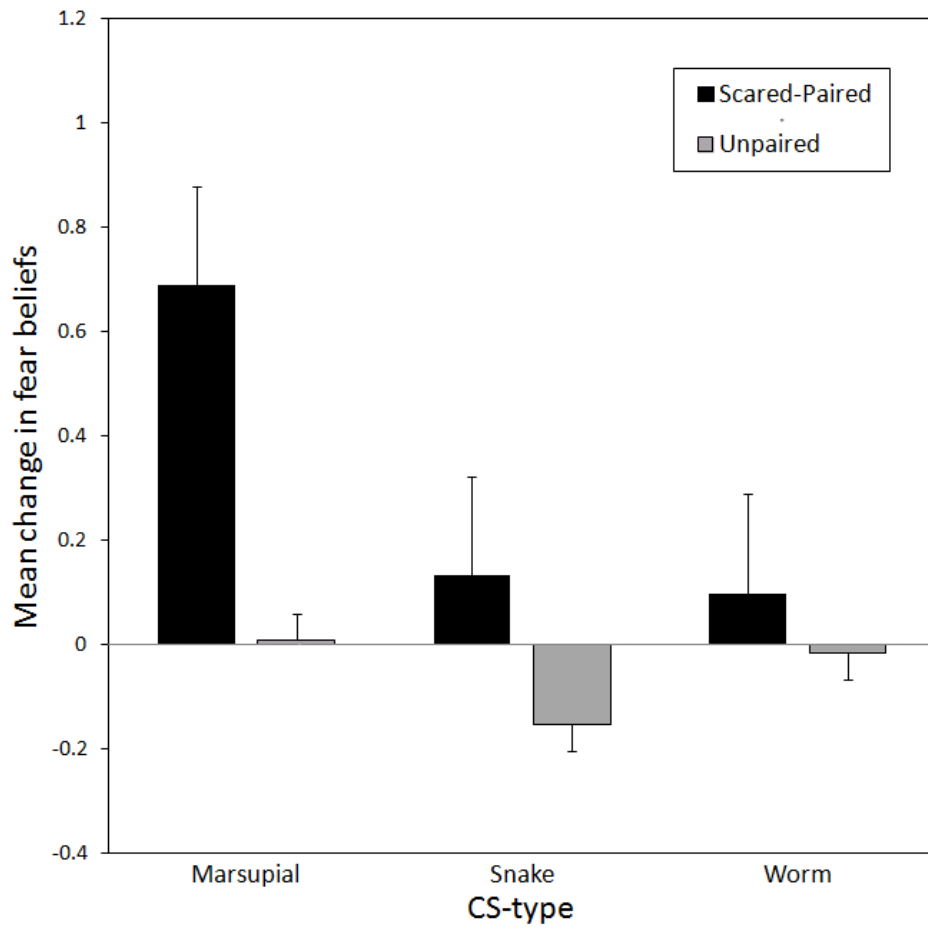


Figure 5. Graph showing mean change in fear beliefs (and SE) for each CS and pairing type in Experiment 3.

VICARIOUS LEARNING OF FEAR IN CHILDHOOD

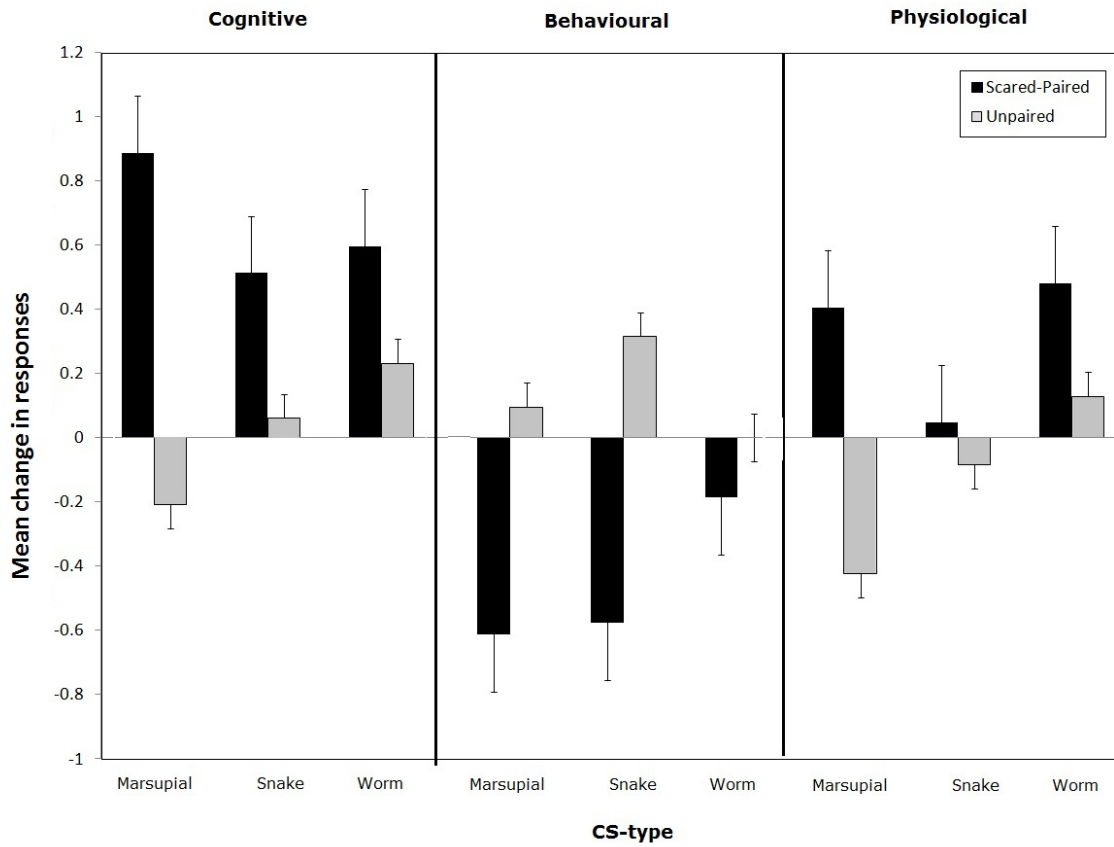


Figure 6. Graph showing mean change in self-reported fear cognitions, approach-avoidance behaviour, and physiological responses (and SE) for each CS and pairing type in Experiment 3.

VICARIOUS LEARNING OF FEAR IN CHILDHOOD

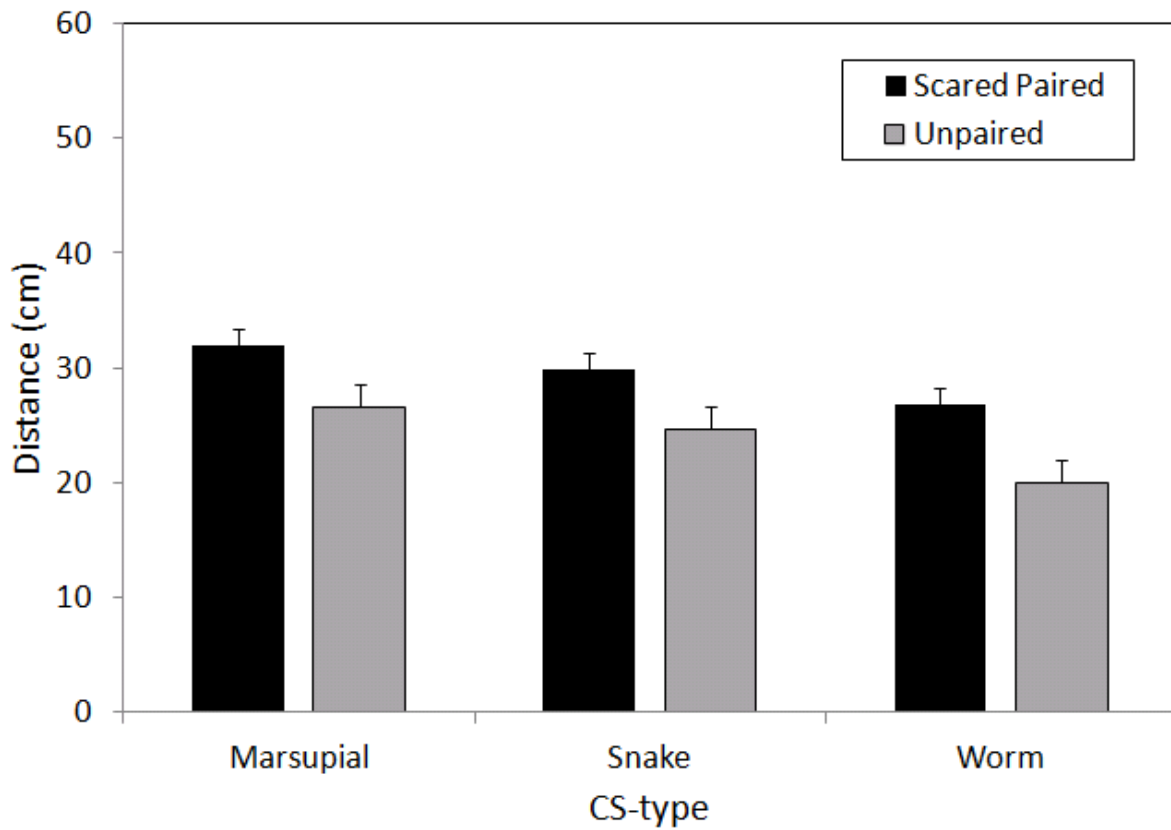


Figure 7. Graph showing mean distances (and SE) from children's figures to marsupial, snake and worm CSs in Experiment 3.