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Do 5-Month-Old Infants Possess an Evolved Detection Mechanism for Snakes, Sharks, and Rodents?

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Abstract

The four experiments reported here used the preferential looking and habituation paradigms to examine whether 5-month-olds possess a perceptual template for snakes, sharks, and rodents. It was predicted that if infants possess such a template then they would attend preferentially to schematic images of these non-human animal stimuli relative to scrambled versions of the same stimuli. The results reveal that infants look longer at a schematic snake than at two scrambled versions of that image and generalize from real snakes to the schematic image. The experiments also demonstrate that 5-month-olds show no preferential looking for schematic sharks or schematic rodents relative to scrambled versions of those images. These data add to the growing support for the view that humans, like many non-human animals, possess an evolved fear mechanism for detecting threats that were recurrent across evolutionary time.

Keywords

infancy; snakes; cognition; evolution; fear

All species face adaptive problems that need to be solved for an organism to survive and reproduce. The adaptations that have emerged to overcome these problems are designed by natural selection and are often specific to the environment in which they evolved. One adaptive problem that is critical to survival is avoiding dangerous non-human threats: those who failed to avoid such threats risked injury or death and would consequently be unable to reproduce. Despite a significant database concerning the presence of these mechanisms in non-human animals (e.g., Kats, Petranks & Sih, 1988; Kiesecker, Chivers, & Blaustein, 1996), only recently have researchers begun to examine how they might operate in humans.

There are currently three main models of fear acquisition. According to one view—labeled the *general learning model*—fear is acquired through domain-general mechanisms such as classical conditioning and indirect learning, observation, and socially transmitted information (Rachman, 1977). Although there is considerable evidence for this model (for a review, see LoBue & Rakison, 2013), it fails to account for why humans' fears are commonly of recurrent evolutionary threats such as heights, spiders, and enclosed spaces. According to a second view—labeled the *non-associative model*—in addition to the three

Resources

Data for these experiments can be found at Open Science Framework (OSF): DOI [10.17605/OSF.IO/EKV2D](https://doi.org/10.17605/OSF.IO/EKV2D)

pathways outlined by the domain-general view fear is also acquired through domain-specific mechanisms such that fear develops early in life and potentially without experience of the fear-invoking stimulus (Poulton & Menzies, 2002). There is empirical research to support this model but it mostly relies on retrospective reports (e.g., Menzies & Clarke, 1993) and it has focused on direct conditioning experience while overlooking the role of indirect pathways through which fear is acquired.

According to a third view, which combines aspects of both the general learning and non-associative models, humans and non-human primates are “prepared” (Seligman, 1971) to learn fear for evolutionary recurrent threats. As a result, it has been proposed that the ability to acquire fears for these threats is privileged and, consequently, rapid (LoBue, Rakison, & DeLoache, 2010; Öhman & Mineka, 2001; Rakison, 2005, 2009; for a review see LoBue & Rakison, 2013). According to Rakison (2009; Rakison & Derringer, 2008; LoBue & Rakison, 2013), this mechanism has two components: the first causes individuals rapidly to attend to fear-relevant stimuli when they are in the surrounding environment; the second facilitates learning of an association of the threat with the appropriate response—avoidance, for example—which is typically acquired as a result of personal negative experience or through social learning via observation of the reaction of a conspecific (Barrett & Broesch, 2012; Barrett, Peterson, & Frankenhuys, 2016). In conjunction, these two components of the specialized fear mechanism means that humans are “prepared” rapidly to learn appropriate behavioral and emotional responses for evolutionarily relevant stimuli (Öhman & Mineka, 2003; Rakison, 2009; Seligman, 1971). There is now growing evidence from work with adults and infants to support the existence of both of these components. For example, human adults and 3-year-old children detect snakes and spiders against a background of non-fear relevant stimuli (e.g., flowers and mushrooms) more quickly than fear-irrelevant stimuli against a background of snakes and spiders (LoBue & DeLoache, 2008; Öhman, Flykt, & Esteves, 2001). These findings were supported by a recent study by New and German (2015) who found that adults in an inattention blindness paradigm detect, localize, and identify iconic spiders and are less likely to perceive stimuli with different configurations of the same features, modern threatening stimuli such as hypodermic needle, or fear-irrelevant non-human animals like houseflies. Finally, infants at 7 to 9 as well as 11 months of age show evidence that they readily associate fearful facial and auditory cues with recurrent threats but do not do so for fear-irrelevant stimuli (DeLoache & LoBue, 2009; Rakison, 2009).

One explanation for infants’ selective attention for recurrent threats—the first component of the fear mechanism—is that they possess an evolved perceptual template that specifies these threats’ basic shape and configuration (Rakison, 2005, Rakison & Derringer, 2008). A mechanism that biases infants to attend to recurrent threats must include a basic mental representation that corresponds with the images of those threats in the real world. Although there is evidence that newborns possess such a mental representation—or *perceptual template*—for faces (Johnson, Dziurawiec, Ellis, & Morton, 1991; Johnson & Morton, 1991), to date only one series of studies with infants has tested this explanation for infants’ preferential attention to recurrent evolutionary threats. In one experiment, Rakison and Derringer (2008) presented 5-month-old infants with three schematic images of spiders that moved horizontally back and forth across a computer screen. One image was a schematic spider, a second was the same schematic spider except that it had reconfigured features, and

a third was a linear image of the spider that was completely scrambled. It was predicted that if 5-month-olds possess a perceptual template for spiders they would look longer at the schematic spider stimulus than the other two reconfigured stimuli; this was the pattern of looking generated by infants in the experiment.

Subsequent experiments revealed that infants do not show the same effect for non-threatening stimuli such as flowers or for square rather than curvilinear schematic spiders. A final experiment tested whether 5-month-olds' perceptual template generalizes to spiders in the real world. Infants were habituated to color photos of spiders and then shown the three schematic images of spiders from the first experiment. Results revealed that infants showed a reversal of the pattern of looking in the first experiment; that is, they looked longer at the two reconfigured images than the schematic spider, which suggests that they generalized from the real images of spiders and found the schematic image familiar. These results suggest that infants may possess a perceptual template for spiders that specifies their shape and the location of their features (e.g., legs).

It remains to be seen, however, whether human infants possess a perceptual template for other recurrent evolutionary threats. This issue is important to address because, to date, there exists evidence only to support the view that infants possess a perceptual template for faces and spiders (Johnson & Morton, 1991, Rakison & Derringer, 2008). However, implicit in the theory that there exists a two-part fear learning mechanism is the notion that infants should possess a perceptual template for a number of recurrent evolutionary threats. However, it is difficult to identify for which recurrent threats humans may have evolved a perceptual template because this requires assumptions to be made about which non-human animals were particularly dangerous to ancestral humans. One approach in this regard is to determine which non-human recurrent threats are overly represented in clinical fears and phobias because one implication of the prepared learning perspective is that fear of these stimuli should develop quickly and will be long-lasting (LoBue & Rakison, 2013). A second approach is to analyze the number of fatalities that occur currently from non-human recurrent threats, although this method assumes that current fatalities from non-human recurrent threats is analogous to fatalities for ancestral humans.

Based on these two criteria, one likely candidate for a perceptual template is snakes. Fear of snakes is among the most common to be found in adults and children and occurs in approximately 5.5% of the population (compared to 3.5% for spiders) (Fredrikson, Annas, Rischer, & Wik, 1996), and venomous snake bites cause a relatively high number of deaths per year (up to 94,000; Kasturiratne et al, 2008). Indeed, a 2001 Gallup poll of 1016 Americans indicated that snakes (53%) were the feared more than anything including public speaking (40%) and heights (36%) (Brewer, 2001). Isbell (2009) has argued that venomous snakes—a critical predator on many non-human animals throughout their evolution—were a driving force in developing the vision of advanced primates. In other words, because primates were recurrently the prey of snakes there would have been strong selection pressures that favored the ability to detect snakes quickly (Isbell, 2009). This is perhaps why vervet monkeys learn predator alarm calls and behaviors from conspecifics to avoid snakes (as well as martial eagles and leopards) (Seyfarth & Cheney, 1986), why a variety of non-human primates have demonstrated fearful reactions to snakes (e.g. Rumbaugh, 1968;

Yerkes, 1943), and why captive rhesus monkeys can rapidly be taught to fear snakes but not flowers through social referencing (Cook & Mineka, 1990). Thus, fear of snakes may have its origins in mammalian evolution when such threats were a prevalent and recurrent threats to survival. In line with this idea, recent evidence suggests the existence in human adults of neurons in the primate medial and dorsolateral pulvinar that respond selectively to visual images of snakes (Van Le et al., 2013). Thus, if human possess a perceptual template for spiders it is possible that they also possess such a template for snakes.

It is less clear whether human infants possess a similar perceptual template for other non-human animals that are potentially threatening to humans. Two such candidates are sharks and rodents such as rats and mice. These animals have the potential to cause human fatalities and are often portrayed in the media as fear inducing (e.g., Burgess, 1991). The incidence of clinical fears and phobias for rodents and sharks is relatively low (Fredrikson et al., 1996), although the 2001 Gallup poll listed mice as the 7th most feared stimuli (20% of adults; sharks were not listed in the top 13 fears). Thus, there is currently no basis to determine whether humans possess a specialized perceptual template for rodents or sharks or whether fears for these non-human animals are acquired through other pathways.

With this in mind, the current experiments were designed to test whether 5-month-olds show evidence of an orienting response to schematic snakes, rodents (rats and mice), and sharks by using a similar design to Rakison and Derringer (2008). It was predicted that if infants possess a perceptual template for snakes, rodents, or sharks, they would be expected to demonstrate a visual preference for the schematic version of those stimuli relative to the scrambled versions of those stimuli. If infants show no preference for the schematic stimulus for snakes, rodents, or sharks, this may imply that they have no perceptual template for those non-human animals, although such a pattern cannot eliminate the possibility that infants have other specialized mechanisms to acquire fear for these potential threats.

Infants were tested at 5 months of age for three reasons: first, this age group was used by Rakison and Derringer (2008) and consequently the results of the current work can be compared directly to these previous findings; second, infants at 5 months of age were able to complete the potentially long procedure used here (which could last a maximum of 12 m); third, infants at 5 months of age rarely exhibit specific fears for objects or animals (Thrasher & LoBue, 2016), and because the current work was not designed to examine fear or fear learning such a response on older infants could have contaminated looking behavior.

In Experiment 1, infants were shown three horizontally moving schematic snakes and their looking times to each one were compared. Experiments 2 and 3 used the same basic design to test whether infants possess a perceptual template for sharks and rodents. Across these experiments, it was predicted that if infants possess a perceptual template for any of these non-human animals then they would look longer at a schematic image of them than the scrambled versions of the same image. Note that although the snake, shark, and rodent stimuli moved back and forth across the screen, that these stimuli moved in reverse for half of each event should not have interfered with infants' ability to preferentially attend to them via a perceptual template; that is, a perceptual template should be applied to recognize recurrent threats regardless of their orientation or movement because it would be

maladaptive if it only operated for such threats when presented in a canonical orientation or movement pattern. Finally, in Experiment 4 infants were habituated to real images of snakes and then tested with the schematic images used in Experiment 1. The goal of this final study was to determine whether infants perceived the schematic snake as equivalent to images of real snakes. Note that the present studies did not examine whether infants possess fear of snakes, sharks, or rodents: Rather, they investigated whether infants demonstrate a visual preference for schematic versions of these non-human animals. Indeed, recent research by Thrasher and LoBue (2016) demonstrated that 6- and 9-month-olds show no physiological cues of fear (e.g., accelerated heart rate or a large startle magnitude) when presented with snakes.

Experiment 1

Experiment 1 used a version of the preferential looking paradigm (Fantz, 1963) to compare infants' visual fixation to stimuli that were presented individually on a computer screen. As in Rakison and Derringer (2008), 5-month-old infants were presented with three stimuli but in the current experiment they were variations of a snake-like figure. One stimulus was an image of a schematic snake, a second stimulus was the same schematic snake but with reconfigured features, and the third stimulus was a completely scrambled version of the schematic snake. The rationale for the design of the two scrambled stimuli used here—and those in Experiments 2 and 3—were that they were akin to those implemented by Johnson and Morton (1991) and Rakison and Derringer (2008). Consistent with previous research that has posited that infants possess a perceptual template (e.g., Johnson & Morton, 1991; Rakison & Derringer, 2008), it was predicted that 5-month-olds would look longer at the schematic snake stimulus than the two reconfigured images if they possess such a template.

Methods

Participants.—Eighteen full-term infants with a mean age of 4 months 30 days (range: 4 months, 2 days to 5 months, 18 days) were participants in this experiment. There were an equal number of boys and girls. An additional 11 infants were excluded from the final analysis because of fussiness (6), parental interference (1), experimenter error (3), or looking for the maximum amount to all of the trials (1). The rationale for excluding infants who looked for the maximum amount of time to each trial in this and the subsequent experiments was that these infants may not have discriminated the stimuli or actively encoded them. Experiments 1, 2, and 3 used 18 participants for two reasons. First, a statistical power analysis was performed for sample size estimation, based on data from Rakison and Derringer (2008). With an $\alpha = .05$ and power = 0.80, the projected sample size needed with the effect size in Rakison and Derringer (2008) is approximately $N = 16$ for within group comparison. Second, 18 participants were used because this allowed for complete counterbalancing of the presentation of the stimuli across infant participants.

Materials.—Infants were shown three geometric images (see Figure 1) moving back and forth across a computer screen. Each stimulus took five seconds to cross the screen and return to its original position. The *schematic snake* stimulus was a geometric representation of a snake with a clearly defined head (with protruding tongue) and tail; the *reconfigured*

features stimulus had the same features but the head and tail were moved to a different location; the *completely scrambled* stimulus had the same object features but arranged in a nonsensical geometric formation. All images were black on a grey background. To assess the similarity of the reconfigured features stimulus and completely scrambled stimulus to the schematic stimulus, I used computer software (imageDIFF, <http://www.softpedia.com/get/Multimedia/Graphic/Graphic-Others/ImageDiff.shtml>) to determine the percentage of overlap between each image. The schematic snake and reconfigured features snake were different by 11.00%, and the schematic snake and the totally scrambled snake were different by 16.26%. These percentages are comparable to those for the shark stimuli in Experiment 2 (11.85% and 17.65% respectively) and the rodent images in Experiment 3 (11.35% and 18.35% respectively), which suggests that the manipulation of the snake, shark, and rodent images were relatively similar across the experiments. Each stimulus was presented twice and the order of stimulus presentation was counterbalanced across infants. Although it is possible to present infants at 5 months of age with more than six presentations of a stimulus (e.g., see LoBue et al., 2017; Oakes, 2017), the rationale for this design was twofold: first, this was the same design used in a comparable experiment with spiders (Rakison & Derringer, 2008); second, the maximum potential total time of stimulus presentation under the current design with six trials was 12 minutes, and it is possible an increase in the number of trials may have caused infants to become bored or fatigued.

Procedure.—Each infant sat on its parent's lap in front of a computer screen, and the parent was instructed to look above the screen. The screen was a 14 in. x 24 in. (35.6 cm x 61 cm) computer monitor that was approximately 24 in. (61 cm) from the infant's face. As in Rakison and Derringer (2008), each stimulus appeared on the monitor for a maximum of two minutes or until the infant looked away from the monitor for five consecutive seconds. Prior to the first trial, and in between each subsequent trial, a green expanding and contracting circle on a dark background and a synchronous bell sound was presented to capture the infant's attention. The experimenter observed the infant via a video feed from a camera placed directly behind the computer monitor and coded the looking time behavior online by pressing and releasing a preset keyboard key. After the original testing session, a second judge who was blind to which trial was presented recoded the looking times from 25% of the participants from a videotape of the session. Interrater reliability in all of the experiments reported here was >97%.

Results

Infants' looking times were averaged across the two trials of the same stimulus (Figure 2). The data were initially analyzed with a mixed-design analysis of variance (ANOVA) with test trial (schematic snake vs. reconfigured features vs. completely scrambled) as the within-participants factor and sex (boy vs. girl) as the between-participants factor. The sex of the infant was included because one previous study has found that infant girls and boys may process recurrent threats differently (Rakison, 2009). The analysis indicated that infants' looking times to the three stimuli were significantly different, $F(2,32)=9.86$, $p=.0001$, partial $\eta^2=.38$. There was no main effect of sex, $F(1,16)=.122$, $p=.73$, partial $\eta^2=.01$, and no significant interaction between test trial and the sex of the infant, $F(2,32)=.29$, $p=.75$, partial $\eta^2=.02$. Planned comparisons indicated that infants looked longer at the schematic snake (M

= 46.93; $SD = 29.46$) than at the reconfigured features snake ($M = 23.89$; $SD = 16.68$), $F(1,17)=9.13$, $p=.008$, partial $\eta^2=.35$, and the completely scrambled snake ($M = 20.30$; $SD = 18.57$, $F(1,17)=20.71$, $p=.001$, partial $\eta^2=.549$). Infants looked equally long at the reconfigured features snake and the totally scrambled snake, $F(1,17)=.32$, $p=.32$, partial $\eta^2=.02$.

The previous analyses suggest that 5-month-old infants looked significantly longer at the schematic snake than the two scrambled versions of the snake, and that they looked equally long at the two scrambled versions of the snake. In regard to the latter finding, the analyses indicate only that there was no support for the hypothesis that infants looked longer at one of the scrambled trials than the other. Consequently, I used a Bayes factor analysis to assess the strength of the evidence for the null hypothesis relative to the alternative hypothesis (i.e., infants looked longer at one of the scrambled test events than the other) (Dienes, 2014). The Bayes factors was computed with an on-line calculator (Dienes, 2008; http://www.lifesci.sussex.ac.uk/home/Zoltan_Dienes/inference/Bayes.htm), and the alternative hypothesis (H1) was calculated with the corresponding mean difference scores and effect sizes from Rakison and Derringer (2008, Expt. 1) using the standard error correction for small sample sizes (Dienes, 2008). I used a half-normal distribution with a mean of 0 and a two-tailed parameter because the prediction for all conditions was bidirectional. The Bayes factor values (BF) were interpreted with the standards outlined by Dienes (2014) such that a BF of 3 or higher indicated substantial evidence for the alternative hypothesis relative to the null hypothesis and a BF of 1/3 or below indicated substantial evidence for the null hypothesis relative to the alternative hypothesis. Both the schematic snake versus partially scrambled snake comparison, $B_{H(0, 8.6)} = 5.12$, and the schematic snake versus completely scrambled comparison, $B_{H(0, 6.8)} = 4.60$, produced Bayes Factors that indicated substantial support for the alternative hypothesis. However, the resulting Bayes Factor, $B_{H(0, 1.8)} = 0.97$, for the partially scrambled snake versus completely scrambled snake indicated that the data were indeterminate.

Discussion

The findings of the current experiment are consistent with those found with 5-month-olds for schematic and scrambled spiders (Rakison & Derringer, 2008). Here, infants' pattern of looking suggests that they may possess a perceptual template for snakes; that is, 5-month-olds looked longer at the schematic snake than at two different scrambled versions of the same image. This finding is somewhat impressive given the overall perceptual similarity between the schematic snake and the reconfigured features snake. Put another way, it is currently unknown to what extent perceptual templates specify the appearance of recurrent threats. The finding that infants do not preferentially attend to rectilinear spider images relative to scrambled versions of those images (Rakison & Derringer, 2008) suggests that the perceptual template for spiders includes curvilinear features. The current study adds to this finding because it demonstrates that infants' perceptual template for snakes may specify the location of important object parts such as facial features. Moreover, it is unlikely that the observed pattern of infant looking was because the schematic snake was more coherent or continuous rather than fragmented and biologically plausible than the other two images. This

is because 5-month-olds look equally long at a schematic flower and scrambled versions of the same flower (Rakison & Derringer, 2008; and see Experiments 2 and 3 reported here).

Experiment 2

Experiment 1 demonstrated that 5-month-old infants looked significantly longer at a schematic image of a snake than at scrambled versions of a snake. It currently remains unknown whether infants would demonstrate the same pattern of behavior for other non-human animals that have the potential to kill humans but for which it is unknown whether they were recurrent threats throughout evolutionary history. One such candidate is sharks. Although data are not available for ancestral humans' fatalities from sharks, of the 370 known species of sharks only 32 have been documented to attack humans, and sharks kill relatively few humans each year (an average of 5 to 15 deaths) (Burgess, 1991; Caldicott, Mahajani, & Kuhn, 2001). Indeed, statistically one is more likely to die driving to the beach than by a shark attack (Caldicott et al., 2001). Moreover, sharks are rarely, if ever, listed among the most feared stimuli by human adults (Brewer, 2001; Fredrikson et al., 1996). Thus, it remains an open question whether sharks posed a recurrent evolutionary threat to humans. With this in mind, Experiment 2 tested whether 5-month-old infants respond to schematic sharks in the same way as they do schematic snakes and spiders. As with Experiment 1, it was predicted that if infants have a perceptual template for sharks then they would look longer at a schematic shark than at scrambled versions of a shark.

Methods

Participants.—There were 18 healthy full-term infants in the experiment with a mean age of 4 months 26 days (range: 4 months, 15 days to 5 months, 12 days). There were 10 boys and 8 girls. An additional 3 infants were excluded from the final analysis, 2 because of equipment malfunction and one because of fussiness.

Materials and procedure.—As in Experiment 1, infants were shown three geometric images (see Figure 3) moving back and forth across a computer screen. The schematic shark stimulus was a geometric representation of a shark with a clearly defined shape, fins, head, and tail; the reconfigured features stimulus had the same features but the fins and tail were rotated or moved to a different location; the completely scrambled stimulus had the same object features but arranged in a nonsensical geometric formation. The two scrambled images maintained the same linear shape as the schematic stimulus. To assess whether the schematic stimulus was perceived as a shark, 15 adult participants ($M_{age} = 20.4$) were shown the image and asked whether it was a shark or a fish. All 15 participants judged the schematic image to be a shark. The same adults were also asked to rate how similar the reconfigured shark and completely scrambled shark were relative to the schematic shark (from 1 to 7 where 1 was “not at all similar”: and 7 was “completely similar”). Ratings from the same adults were also gathered for the snake stimuli in Experiment 1 and the rodent stimuli in Experiment 3. The question of interest was whether the reconfigured shark and completely scrambled shark were similarly different from the schematic shark as the reconfigured snake and completely scrambled snake were from the schematic snake in Experiment 1. Analyses revealed that adults judged the reconfigured shark ($M = 3.87$, $SD =$

99) as similarly different from the schematic shark as the reconfigured snake ($M = 4.07$, $SD = .88$) was from the schematic snake, $t(14) = .64$, $p = .53$. Similarly, the completely scrambled shark ($M = 2.40$, $SD = .91$) was judged as similarly different from the schematic shark as the completely scrambled snake ($M = 2.33$, $SD = .97$) was from the schematic snake, $t(14) = .19$, $p = .85$. This suggests that the manipulation of the two scrambled shark stimuli were equivalent to those of the two scrambled snake stimuli. All other aspects of the materials and procedure were identical to Experiment 1.

Results

Infants' looking times were averaged across the two trials of the same stimulus. The data were initially analyzed with a mixed-design ANOVA with test trial (schematic shark vs. reconfigured features vs. completely scrambled) as the within-participants factor and sex (boy vs. girl) as the between-participants factor. The analysis indicated no significant difference in the looking times to the three stimuli, $F(2,32) = 0.52$, $p = .60$, partial $\eta^2 = .03$. Infants looked equally long at the schematic shark ($M = 34.91$; $SD = 21.31$), the reconfigured features shark ($M = 28.97$; $SD = 17.81$), and the completely scrambled shark ($M = 34.03$; $SD = 21.79$). The analysis revealed a main effect of sex that indicated that overall boys ($M = 39.69$; $SD = 15.34$) looked longer than girls ($M = 23.85$; $SD = 21.78$) at the three stimuli, $F(1,16) = 5.99$, $p = .026$, partial $\eta^2 = 0.27$. However, there was no significant interaction between test trial and the sex of the infant, $F(2,32) = 1.27$, $p = .29$, partial $\eta^2 = 0.07$.

As in Experiment 1, Bayes Factor was computed for the three test trial comparisons to calculate the relative strength of the evidence for the null hypothesis versus the alternative hypothesis. According to the conventions described by Dienes (2014), all the resulting Bayes factors indicate that the data provided evidence that was indeterminate but approached evidence to support the null hypothesis. Thus, the schematic shark versus partially scrambled shark comparison, $B_{H(0, 8.6)} = 0.85$, the schematic shark versus the completely scrambled shark comparison, $B_{H(0, 6.8)} = 0.74$, and the partially scrambled shark versus completely scrambled shark comparison, $B_{H(0, 1.8)} = 0.98$, produced Bayes Factor values between 1/3 and 3.

Discussion

Experiment 2 detected no difference in infants' looking to different versions of a shark. This suggests that infants may not possess a perceptual template for sharks whereas they do for snakes (Experiment 1) and spiders (Rakison & Derringer, 2008). Although caution must be taken when interpreting null results, these findings imply that there was insufficient selection pressure for humans to have evolved a perceptual template that identifies the shape or features of sharks. This is perhaps not surprising given the low number of human fatalities from sharks each year (Caldicott et al., 2001) and the fact that a shark's overall shape underwater would have been difficult for our ancestors to discern. However, these findings do not eliminate the possibility that humans have an evolved specialized mechanism for fear acquisition for sharks that does not involve a perceptual template.

Experiment 3

Another category of animal that is often the target of fear is rodents such as mice and rats. Rats are often considered to be dangerous because their physical abilities—which could be potentially fatal to an infant—and rats and mice are also known to carry disease (e.g., Lyme disease through ticks, typhus, salmonella). However, although mice were listed as the 7th most feared stimulus in the Gallup 2001 poll (Brewer, 2001), there exist no statistics on rodent attacks on humans and a search of the literature (via Google Scholar) revealed no articles on human fatalities from rodent attacks. Thus, it remains an open question whether human infants possess a perceptual template for rodents like rats and mice. As with the previous experiments, it was predicted that if infants possess a perceptual template for rodents they should look longer at schematic rodent than scrambled versions of a rodent.

Methods

Participants.—The final sample consisted of 18 infants with a mean age of 5 months 5 days (range: 4 months, 17 days to 5 months, 14 days). There were 11 boys and 7 girls. An additional 5 infants were excluded from the final analysis, 2 because fussiness, 2 because of experimenter error, and 1 because of equipment malfunction.

Materials and procedure.—As in Experiment 1 and 2, infants were shown three geometric images (see Figure 4) moving back and forth across a computer screen. The schematic rodent stimulus was a geometric representation of a rodent with a clearly defined eyes, head, body shape, and tail; the reconfigured features stimulus had the same features but the head and tail were moved to a different location and the legs were revolved; the completely scrambled stimulus had the same object features but arranged in a geometric formation. The same 15 adult participants who rated the shark stimulus for Experiment 2 were asked whether the schematic rodent represented a rat or a mouse. Thirteen of the 15 participants judged the schematic rodent to be a rat and two judged it to be a mouse. As in Experiment 2, 15 adult participants evaluated the two scrambled stimuli for their similarity to the schematic rodent. Adults judged the reconfigured rodent ($M = 4.27$, $SD = .88$) as similarly different from the schematic rodent as the reconfigured snake ($M = 4.07$, $SD = .87$) was from the schematic snake, $t(14) = .56$, $p = .58$. Likewise, the completely scrambled rodent ($M = 2.40$, $SD = .91$) was judged as similarly different from the schematic rodent as the completely scrambled snake ($M = 2.33$, $SD = .97$) was from the schematic snake, $t(14) = .12$, $p = .86$. All other aspects of the materials and procedure were identical to Experiments 1 and 2.

Results and Discussion

Infants' looking times were averaged across the two trials of the same stimulus. The data were entered into a mixed-design ANOVA with test trial (schematic rodent vs. reconfigured features vs. completely scrambled) as the within-participants factor and sex (boy vs. girl) as the between-participants factor. The analysis indicated that infants looked equally long at the schematic rodent ($M = 22.67$; $SD = 14.27$), the reconfigured features rodent ($M = 21.78$; $SD = 20.70$), and the completely scrambled rodent ($M = 31.71$; $SD = 26.92$), $F(2,32) = 2.19$, $p = .13$, partial $\eta^2 = 0.12$. There was no main effect of sex, $F(1,16) = 1.16$, $p = .30$, partial $\eta^2 =$

0.07, and no significant interaction between test trial and the sex of the infant, $F(2,32) = 1.29$, $p > .2$, partial $\eta^2 = 0.08$.

As in Experiments 1 and 2, Bayes Factor was computed for the three test trial comparisons to calculate the relative strength of the evidence for the null hypothesis versus the alternative hypothesis. The Bayes Factor value for the schematic rodent versus partially scrambled rodent comparison, $B_{H(0, 8.6)} = 0.59$, was toward support of the null hypothesis but was indeterminate. The Bayes Factor values for the schematic rodent versus the completely scrambled rodent comparison, $B_{H(0, 6.8)} = 1.02$, and the partially scrambled rodent versus completely scrambled rodent comparison, $B_{H(0, 1.8)} = 1.01$, produced Bayes Factor values that were also indeterminate.

The results of the current experiment provided no evidence that infants have a preference for a schematic rodent image relative to two scrambled versions of the same image; that is, the experiment detected no difference in looking to different versions of the rodent. This finding, in conjunction with Experiments 1 and 2 and previous research (e.g., Rakison & Derringer, 2008) implies that human infants may possess a perceptual template for snakes and spiders but not for sharks or rats. However, as was the case for Experiment 2, this does not necessarily mean that infants do not have a specialized evolved mechanism for learning to fear rodents but only that this mechanism likely does not involve a perceptual template for rodents.

Comparison across experiments

The data presented here suggest that 5-month-old infants look longer at a schematic snake than scrambled versions of a snake, but they do not exhibit the same pattern for schematic rodents and sharks. One question that remains is whether infants' pattern of looking across Experiments 1, 2, and 3 was reliably different; that is, whether infants behaved significantly differently across the experiments for schematic stimuli, reconfigured features stimuli, and completely scrambled stimuli. The data from Experiments 1, 2, and 3 are presented as boxplots in Figure 5. This figure suggests that the findings of the first three experiments were not overly affected by one or two infants with extremely long or short looking times to the events. The data were analyzed with a mixed-design ANOVA with test trial (schematic stimulus vs. reconfigured features stimulus vs. completely scrambled stimulus) as the within-participants factor and experiment (1, 2, and 3) as the between-participants factor. The analyses revealed a significant effect for test trial, $F(2,102) = 4.29$, $p < .025$, partial $\eta^2 = 0.78$, which was mediated by a significant interaction between test trial and experiment, $F(4,102) = 4.79$, $p < .001$, partial $\eta^2 = .16$. Additional comparisons indicated that infants' looking times to the schematic images were significantly different across the experiments, $F(2, 51) = 5.21$, $p = .009$, partial $\eta^2 = .17$, but looking times to the reconfigured stimuli, $F(2, 51) = .742$, $p = .48$, partial $\eta^2 = .03$, and completely scrambled stimuli, $F(2, 51) = 1.89$, $p = .16$, partial $\eta^2 = .07$, were not reliably different. Planned comparisons revealed that infants looked significantly longer at the schematic snake than the schematic rodent, $t(34) = 3.14$, $p = .003$, and marginally longer at the schematic shark than the schematic rodent, $t(34) = 2.03$, $p = .051$. The looking times to the schematic snake and schematic shark were not reliably different, $t(34) = 1.40$, $p = .17$. Note, however, that these analyses across experiments fail to

take into account the fact that looking times within each experiment was affected by the relative difference between three stimuli that were presented to the infants within each experiment.

Experiment 4

Experiment 1 provided initial support for the notion that infants have a perceptual template for snakes. It is important to show, however, that infants' perceptual template facilitates learning about snakes in the real world. It is plausible, for example, that 5-month-olds prefer to look at continuous snake-like shapes but this it is unconnected to a specialized fear mechanism for learning about snakes. This question was addressed in the current experiment, which is analogous to that in Rakison and Derringer (2008, Experiment 3). Infants at 5 months of age were habituated to four static color images of different snakes and then shown the same schematic stimuli that were used in Experiment 1. The motivation for this design was that if a perceptual template for snakes is used to learn about real snakes in the world then the schematic image should be familiar (and therefore less interesting) following habituation to real images of snakes. Thus, it was predicted that if 5-month-old infants possess a perceptual template for snakes that helps them learn about snakes in the real world then they should look longer at the reconfigured and completely scrambled snake than at the schematic snake. In other words, infants should exhibit a shift from a preference to look at the schematic snake—as in Experiment 1—to a preference to look at the scrambled versions of the snake. It was also predicted that if infants do not have such a perceptual template for snakes then following habituation they should look longer at the schematic snake than the other two schematic images as they did in Experiment 1.

Methods

Participants.—Sixteen healthy and full term infants with a mean age of 4 months 18 days (range: 3 months, 18 days to 5 months, 6 days) acted as participants. There were an equal number of males and females. Ten additional infants were tested but excluded from the final analysis because of failure to habituate (7), fussiness (1), and looking for the maximum time to all test trials (2).¹

Materials and procedure.—The habituation stimuli were four different color images of snakes (see Figure 6). During habituation, each snake image was presented until the infant looked away from the monitor for over 1 s or made 30 s of continuous looking. The habituation phase ended when an infant's looking time for a block of three trials decreased to 50% of that in the first three trials or until 16 trials were presented. These parameters are the same as those used by Rakison and Derringer (2008, Exp. 3). The test trials were the same as those in Experiment 1. A green expanding and contracting circle on a dark background and a synchronous bell sound was presented on the screen prior to the first habituation trial and between each habituation and test trial.

¹Although the number of babies who failed to habituate was relatively high ($N = 7$) compared to the comparable study in Rakison and Derringer (2008, Exp. 4), their test trial data indicated the same general pattern of looking as the infants who habituated in the current study; schematic snake $M = 10.76$; partially scrambled snake $M = 14.2$; completely scrambled $M = 15.4$.

Results

As in Experiment 1, infants' looking times were averaged across the two presentations of the same stimulus. Infants' looking times are presented in Figure 7. The data were entered into a repeated-measures ANOVA to examine infants' visual fixation to the three test trials. The analysis revealed that looking times to the three test stimuli were significantly different, $F(2,28) = 4.02$, $p = .03$, partial $\eta^2 = .22$. There was no significant effect for sex of the infant, $F(1,14) = 0.75$, $p = .40$, partial $\eta^2 = .05$, and no significant interaction between sex of the infant and test trial, $F(2,28) = 0.91$, $p = .42$, partial $\eta^2 = .06$. Planned comparisons showed that infants looked significantly longer at the snake with reconfigured features ($M = 10.04$; $SD = 6.89$) than at the schematic snake ($M = 7.11$; $SD = 5.64$), $F(1,15) = 5.15$, $p = .04$, partial $\eta^2 = .26$. Likewise, infants looked significantly longer at the totally scrambled snake ($M = 11.94$; $SD = 9.96$), than at the schematic snake, $F(1,15) = 9.60$, $p = .007$, partial $\eta^2 = .39$. Infants looked equally long at the snake with reconfigured features and the totally scrambled snake, $F(1,15) = 0.95$, $p = .35$, partial $\eta^2 = .06$. As in the previous experiments, I used a Bayes factor analysis to assess the strength of the evidence for the null hypothesis relative to the alternative hypothesis (Dienes, 2014). In contrast the previous experiments, the mean difference score and effect sizes for these analyses were garnered from the habituation experiment in Rakison and Derringer (2008, Expt. 3). The analyses revealed that schematic snake versus the reconfigured features snake comparison, $B_{H(0, .5.3)} = 0.8$, the schematic snake versus completely scrambled comparison, $B_{H(0, 6.8)} = 1.35$, and the reconfigured features snake versus completely scrambled snake, $B_{H(0, 1.4)} = 0.95$, generated Bayes Factors values that were indeterminate.

Discussion

The parametric analysis for Experiment 4—but not the Bayes Factor—suggests that 5-month-old infants looked longer at the two scrambled images of snakes than the schematic snake following exposure to images of real snakes. This implies that infants generalized from the real snakes they saw during habituation to the schematic snake but not to the other two scrambled snakes that were presented in the test phase. That infants responded to the schematic snake as familiar after exposure to real snakes implies that the preference for the schematic snake in Experiment 1 resulted from their perception of it as a snake and not due to an unrelated preference for continuous shapes rather than discontinuous ones. However, given that the Bayes' factor analysis suggest that these data were indeterminate caution must be taken in interpreting the results of Experiment 4.

General Discussion

It has been theorized that humans possess a two-part specialized fear mechanism, the first of which orients infants to recurrent threats when they are in the immediate environment and the second of which allows infants rapidly to associate that threat with the appropriate emotional and behavioral response (LoBue, Rakison, & DeLoache, 2010; Öhman & Mineka, 2001; Rakison & Derringer, 2008; Rakison, 2009). Previous research has supported the notion that infants may preferentially attend—as a result of a perceptual template—to spider-like images relative to scrambled versions of those images but not to non-threatening images such as flowers relative to scrambled flowers (Rakison & Derringer, 2008).

The experiments reported here were designed to investigate the existence of other perceptual templates for potentially threatening non-human animals by examining whether 5-month-old infants preferentially look at images of schematic snakes, sharks, and rodents. The results of the experiments provide the first data in support of the notion that infants possess a mental perceptual template for snakes. Experiment 1 showed that 5-month-old infants look longer at a schematic image of a snake than scrambled versions of a snake, and the parametric analysis for Experiment 4 —although not the Bayes Factor—indicated that their perceptual template for snakes is related to real world images of snakes. Experiments 2 and 3 revealed that 5-month-olds detected no difference in infants' looking to different versions of a shark or rodent. This suggests that infants may not possess perceptual templates for non-human animals that are often perceived as dangerous to humans but were not recurrent evolutionary threats (Burgess, 1991). The results of Experiments 2 and 3 also imply that infants' longer looking to the schematic snake in Experiment 1 was not because it represented a better Gestalt image than the other two stimuli; if this were the case then infants would have also been expected to look longer at the schematic shark and rodent than the scrambled versions of those animals. The data also indicate that infants in Experiment 1 and in Rakison and Derringer (2008) did not preferentially orient to the schematic images merely because they represented animate agents (cf., New, Cosmides, & Tooby, 2007).

That infants looked longer at the schematic snake relative to the two other images would be predicted only if infants have an evolved bias—presumably via a mental template—to attend to snakes. In other words, no traditional theories of learning (e.g., Rescorla & Wagner, 1972) including the general learning model predict that infants without prior exposure to snakes would look longer at a snake-like image than scrambled versions of that image. It is also somewhat impressive that infants generalized from real snakes to the schematic snake but not to the reconfigured snake that maintained many of the configural properties of a snake. In other words, the reconfigured features snake had the same curvilinear body as the schematic snake and differed from it only in relation to the head and tail. This suggests that infants' perceptual template for snakes may include information about the shape and location of these features.

That infants may possess such a template for snakes—as well as spiders—but not sharks and rodents is consistent with the fact that snakes and spiders are among the top five phobias in men and women and that sharks and rodents rarely rank in the top 10 phobias in multiple polls (Brewer, 2001; Fredrikson et al., 1996). There is considerable evidence that non-human animals have evolved mechanisms that specify the identity of potential predators (Kats et al., 1988; Griffin, Evans, & Blumstein 2001): the present experiments—in conjunction with previous research (Rakison & Derringer, 2008)—demonstrate that infants may have perceptual templates for specific non-human animals that were recurrent threats over evolutionary time but not for other non-human animals. The goal of Experiments 2 and 3 were to determine whether infants possess such templates for sharks and rodents, both of which are currently viewed as dangerous (Burgess, 1991) but may not have represented recurrent evolutionary threats. As highlighted earlier, it is important to be cautious about the interpretation of the null results from Experiments 2 and 3. However, that the same pattern was found for snakes and spiders (Experiment 1; Rakison & Derringer, 2008) but not for rodents and sharks suggests that infants' failure to show a preference for the latter two non-

human animals may be because they do not possess a perceptual template for them. This does not exclude the possibility that infants have other specialized adaptations or mechanisms to learn about sharks or rodents—as predicted by the non-associative model—but the current experiments found no evidence for a perceptual template for these non-human animals. Thus, it remains to be seen whether humans possess a mental perceptual template for recurrent threats other than snakes or spiders.

The current data, in conjunction with previous work with infants' ability to detect and learn about recurrent threats (e.g., LoBue & DeLoache, 2008; Rakison, 2009; Rakison & Derringer, 2008), add to the growing support that human infants possess an evolved fear mechanism to learn about specific non-human threats. It has been suggested that this mechanism is comprised of two components. The first component is a perceptual template that directs attention to recurrent threats such as snakes and spiders when they are in the surrounding environment. The second component allows infants more readily to associate the recurrent threat with the appropriate emotional response exhibited by conspecifics during an encounter with the threat or from a personal negative experience. Although to date only a small handful of studies have tested this second component in infants (LoBue & DeLoache, 2008, 2010; Rakison, 2009), evidence from snake conditioning studies with adult humans and non-human primates provide additional support for its existence (Cook & Mineka, 1990).

That infants in the current experiments showed a preference for the schematic snake but that the data for the schematic rodent or shark provides important information that helps to inform and extend the current theory about humans' specialized two-part fear mechanism. First, the current data, in conjunction with previous work (Rakison & Derringer, 2008), suggests that selection pressure during evolution may have been particularly intense for specific non-human animals that were common threats to humans—namely, snakes and spiders—and that this may have led to the evolution of a perceptual template for these threats. Second, the present work—and that of Rakison and Derringer (2008, Exp. 2) in which infants did not look longer at a schematic rectangular spider than scrambled version of that spider—suggests that perceptual templates are initially highly specified in terms of their content. Put another way, infants showed a preference only for a schematic spider or snake when those images respectively were curvilinear and when their features were placed appropriately (e.g., the head and the tail of the snake in the correct orientation). In a similar vein, Morton and Johnson (1991; Johnson et al., 1991) found that newborn infants preferentially track face-like stimuli—with two upper “blobs” and one lower “blob”—relative to inverted versions of those stimuli. These findings, in conjunction with work of Rakison and Derringer (2008), provides converging evidence that perceptual templates for snakes and spiders (as well as faces) are relatively well specified and that object features and orientation are present in the initial representation. Moreover, that adults' and 3-year-olds children's rapidly attend to coiled items (that are not snakes) relative to frogs and flowers (LoBue & DeLoache, 2011) suggests that the initial perceptual template may act as a representational foundation that changes over developmental time following experience with real-world instances of snake and spiders. Alternatively, it may be that humans learn to react to input that merely closely resembles a recurrent threat because it is “better to be safe than sorry” (see Nesse's (1990) smoke-detector principle for a similar argument).

Although the current experiments tested only 5-month-olds, it is predicted that younger infants would exhibit the same pattern of looking found here and in Rakison and Derringer (2008). Morton and Johnson (1991; Johnson et al., 1991), for example, reported evidence to suggest that newborns possess a perceptual template for faces, and there is no reason why infants' perceptual template for recurrent threats would not also be on-line at birth or shortly thereafter. A more developmental approach to the study of fear mechanisms in infants was recently applied by LoBue et al. (2017, Exp. 1) who examined 4- to 24-month-olds' looking patterns to snakes relative to frogs. The study found that infants attended more to snakes than frogs but found no effect of age, which suggests that the attentional bias found here for schematic snakes likely does not change over the first years of life. Additional work could also use larger samples with additional trials, which would provide a greater chance to examine more complex relations using within-participants designs (see Oakes, 2017).

The increasing evidence in support of a two-part fear mechanism provides new insight into how phobias may be acquired during the lifespan. Although it is known that many phobias emerge through fear conditioning, such as in the classic case of Little Hans reported by Freud, the origin of other phobias remains unknown. For example, many people develop phobias for animals or places that they have not experienced directly (Öhman & Mineka, 2001, 2003). The current studies go some way to explaining such phobic responses by positing that humans and non-human animals are particularly susceptible—or prepared (Seligman, 1971)—to orient to, and presumably develop fear responses for, non-human animals that were potentially harmful during our evolutionary history. This explanation is presumably why many of the most common phobias among humans in the modern world are for evolutionarily relevant threats such as people, open spaces, heights, snakes, and spiders (Buss, 2008).

In sum, the current experiments extend previous work on humans' evolved fear mechanism by showing that 5-month-old infants possess a perceptual template for snakes but not for rodents or sharks. This template causes infants to orient to snakes when they are in the surrounding environment and, presumably, facilitates the process by which the appropriate response is learned for these recurrent threats (Rakison, 2009). These data, in combination with previous research, suggests that evolution has prepared human infants to learn about the appropriate response for specific threat-relevant stimuli such as snakes and spiders. The growing focus on evolutionary developmental (see e.g., Bjorkland & Ellis, 2005) suggests that it is only a matter of time before researchers start to discover the full range of threat related adaptations that emerged during human evolutionary history.

References

- Barrett HC, & Broesch J (2012). Prepared social learning about dangerous animals in children. *Evolution and Human Behavior*, 33, 499–508. doi:10.1016/j.evolhumbehav.2012.01.003.
- Barrett H, Peterson CD, & Frankenhuys WE (2016). Mapping the Cultural Learnability Landscape of Danger. *Child Development*, 87: 770–781. doi:10.1111/cdev.12495 [PubMed: 27189404]
- Brewer G (2001). Snakes Top List of Americans' Fears. <http://news.gallup.com/poll/1891/snakes-toplist-americansfears.aspx>
- Burgess GH (1991). Shark attack and the international shark Attack File In Gruber SH (Ed.). *Discovering Sharks*, pp. 101–105, American Littoral Society, Highlands, New Jersey.

- Buss DM (2008). *Evolutionary psychology: The new science of the mind* (3rd Ed.). Boston, MA: Allyn & Bacon.
- Caldicott DG, Mahajani R, & Kuhn M (2001). The anatomy of a shark attack: a case report and review of the literature. *Injury*, 32(6), 445–453. [PubMed: 11476808]
- Cook M, & Mineka S (1990) Selective associations in the observational conditioning of fear in rhesus monkeys. *Journal of Experimental Psychology: Animal Behavior Processes*, 16, 372–389. 10.1037/0097-7403.16.4.372. [PubMed: 2230660]
- Crockett (2016, 1 29th). The tragic data behind selfie fatalities. Retrieved from <http://priceonomics.com/the-tragic-data-behind-selfie-fatalities/>.
- Csibra G, Hernik M, Mascaro O, Tatone D, & Lengyel M (2016). Statistical Treatment of Looking-Time Data. *Developmental Psychology*, 52(4), 521–536. [PubMed: 26845505]
- DeLoache J, & LoBue V (2009). The narrow fellow in the grass: Human infants associate snakes and fear. *Developmental Science*, 12, 201–207. 10.1111/j.1467-7687.2008.00753.x [PubMed: 19120429]
- Dienes Z (2008). *Understanding Psychology as a Science: An Introduction to Scientific and Statistical Inference*. Palgrave Macmillan
- Dienes Z (2014). Using Bayes to get the most out of non-significant results. *Frontiers in Psychology*, 5: 781. doi: 10.3389/fpsyg.2014.00781 [PubMed: 25120503]
- Ellis BJ, & Bjorklund DF (Eds.) (2005). *Origins of the social mind: Evolutionary psychology and child development*. New York: Guilford Press.
- Fantz R (1963). Pattern vision in newborn infants. *Science*, 140, 296–297. [PubMed: 17788054]
- Fredrikson M, Annas P, Fischer H & Wik G (1996). Gender and age differences in the prevalence of specific fears and phobias. *Behaviour Research and Therapy*, 34, 33–39. 10.1016/0005-7967(95)00048-3 [PubMed: 8561762]
- Griffin AS, Evans CS & Blumstein DT (2001). Learning specificity in acquired predator recognition. *Animal Behavior*, 62, 577–589. 10.1006/anbe.2001.1781
- Johnson MH, & Morton J (1991). *Biology and cognitive development: The case of face recognition*. Oxford: Blackwell.
- Johnson MH, Dziurawiec S, Ellis HD, & Morton J (1991). Newborns' preferential tracking of face-like stimuli and its subsequent decline. *Cognition*, 40, 1–19. 10.1016/0010-0277(91)90045-6 [PubMed: 1786670]
- Isbell LA (2009). *The Fruit, the Tree, and the Serpent*. Harvard University Press.
- Kats LB, Petranks JW, & Sih A (1988). Antipredator defenses and the persistence of amphibian larvae with fishes. *Ecology*, 69, 1865–1870. 10.2307/1941163.
- Kiesecker JM, Chivers DP, & Blaustein AR (1996). The use of chemical cues in predator recognition by western toad tadpoles. *Animal Behavior*, 52, 1237–1245. 10.1006/anbe.1996.0271
- Kasturiratne A, Wickremasinghe AR, de Silva N, Gunawardena NK, Pathmeswaran A, Premaratna R, et al. (2008). The global burden of snakebite: A literature analysis and modeling based on regional estimates of envenoming and deaths. *PLoS Medicine*, 5(11), 1591–1604 (article no. e218).
- LoBue V & DeLoache JS (2008). Detecting the snake in the grass: Attention to fear-relevant stimuli by adults and young children. *Psychological Science*, 19, 284–289. 10.1111/j.1467-9280.2008.02081.x. [PubMed: 18315802]
- LoBue V, & DeLoache JS (2011). What so special about slithering serpents? Children and adults rapidly detect snakes based on their simple features. *Visual Cognition*, 19, 129–143.
- LoBue V & Rakison DH (2013). What we fear most: A developmental advantage for threat-relevant stimuli. *Developmental Review*, 33, 285–303. 10.1177/0963721410388801
- LoBue V, Rakison DH, & DeLoache JS (2010). Threat perception across the lifespan: Evidence for multiple converging pathways. *Current Directions in Psychological Science*, 19, 375–379
- LoBue V, Buss KA, Taber-Thomas BC, & Pérez-Edgar K (2017). Developmental differences in infants' attention to social and non-social threats. *Infancy*, 22, 403–415 [PubMed: 28936127]
- Menzies RG, & Clarke JC (1993). The etiology of childhood water phobia. *Behaviour Research and Therapy*, 31, 499–501. [PubMed: 8333825]

- Nesse RM (1990). Evolutionary explanations of emotions. *Human Nature*, 1, 261–289 [PubMed: 24222085]
- New J, Cosmides L & Tooby J (2007). Category-specific attention for animals reflects ancestral priorities, not expertise. *Proceedings of the National Academy of Sciences*, 104 (42), 16593–16603. 10.1073/pnas.0703913104.
- New J, & German TC (2015). Spiders at the cocktail party: An ancestral threat that surmounts inattention blindness. *Evolution and Human Behavior*, 36, 165–173. 10.1016/j.evolhumbehav.2014.08.004.
- Oakes LM (2017). Sample Size, Statistical Power, and False Conclusions in Infant Looking-Time Research. *Infancy*, 22(4), 436–469. [PubMed: 28966558]
- Öhman A, & Mineka S (2001). Fear, phobias and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review*, 108, 483–522. 10.1037/0033-295X.108.3.483. [PubMed: 11488376]
- Öhman A, Mineka S (2003). The malicious serpent: Snakes as a prototypical stimulus for an evolved module of fear. *Current Directions in Psychological Science*, 12, 5–8. 10.1111/1467-8721.01211.
- Öhman A, Flykt A, & Esteves F (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General*, 130, 466–478. 10.1037/0096-3445.130.3.466. [PubMed: 11561921]
- Poulton R, & Menzies RG (2002). Non-associative fear-acquisition: A review of the evidence from retrospective and longitudinal research. *Behaviour Research and Therapy*, 40, 127–149. [PubMed: 11814178]
- Rachman SJ (1977). The conditioning theory of fear acquisition: A critical examination. *Behaviour Research and Therapy*, 15, 375–387. [PubMed: 612338]
- Rakison DH (2005). *Infant Perception and Cognition: An Evolutionary Perspective on Early Learning*. In Bjorkland D, & Ellis B (Eds.), *Origins of the Social Mind: Evolutionary Psychology and Child Development*. New York: Wiley.
- Rakison DH (2009). Does women's greater fear of snakes and spiders originate in infancy? *Evolution and Human Behavior*, 30, 438–444. 10.1016/j.evolhumbehav.2009.06.002.
- Rakison DH, & Derringer JL (2008). Do infants possess an evolved spider-detection mechanism? *Cognition*, 107, 381–393. 10.1016/j.cognition.2007.07.022 [PubMed: 17825812]
- Rescorla RA, & Wagner AR (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement In Black AH & Prokasy WF (Eds.), *Classical conditioning II: Current research and theory* (pp. 64–99). New York: Appleton-Century-Crofts.
- Rumbaugh DM (1968). The learning and sensory capacities of the squirrel monkey in phylogenetic perspective In Rosenblum LA & Cooper RW (Eds.), *The squirrel monkey* (pp. 256–317). New York: Academic Press.
- Seligman MEP (1971). Phobias and preparedness. *Behavior Therapy*, 2, 307–320.
- Seyfarth RM, & Cheney DL (1986). Vocal development in vervet monkeys. *Animal Behavior*, 34, 1640–1658.
- Thrasher C & LoBue V (2016). Do infants find snakes aversive? Infants' physiological responses to "fear-relevant" stimuli. *Journal of Experimental Child Psychology*, 142, 382–390. 10.1016/j.jecp.2015.09.013 [PubMed: 26483161]
- Van Le Q, Isbell LA, Matsumoto J, Ngyuen M, Hori E, Maior RS, Tomas C, Tran AH, Ono T, & Nishijo H (2013). Pulvinar neurons reveal neurobiological evidence of past selection for rapid detection of snakes. *Proceeding of the National Academy of Science*, 110, 19000–19005. 10.1073/pnas.1312648110
- Yerkes Robert M. (1943). *Chimpanzees: A laboratory colony*. New Haven, CT: Yale University Press

Figure 1.
Schematic images of snakes used as test stimuli in Experiments 1 and 4

Figure 2.

Infant looking times to the three snake-like images in Experiment 1. Five-month-olds looked significantly longer at the schematic snake than the two scrambled versions of the same image. Visual fixation to the snake with reconfigured features and the totally scrambled snake was not significantly different. Error bars represent standard error.

Figure 3.
Schematic images of sharks used as stimuli in Experiment 2

Figure 4.
Schematic images of rats/mice used as stimuli in Experiment 3

Figure 5.
Boxplots of the data from Experiments 1-3

Experiment 1: Snakes

Experiment 2: Sharks

Experiment 3: Rodents

Figure 6.
Real images of snakes used as habituation stimuli used in Experiment 4

Figure 7.

Infant looking times to the three snake-like images following habituation to real images of snake. Infants' visual fixation to the snake with reconfigured features and the totally scrambled snake were longer than to the schematic snake. Infants' visual fixations to the snake with reconfigured features and the totally scrambled snake were not significantly different. Error bars represent standard error.