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PAPER

The narrow fellow in the grass: human infants associate snakes and fear

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Abstract

Why are snakes such a common target of fear? One current view is that snake fear is one of several innate fears that emerge spontaneously. Another is that humans have an evolved predisposition to learn to fear snakes. In the first study reported here, 9- to 10-month-old infants showed no differential spontaneous reaction to films of snakes versus other animals. In the second study, 7- to 18-month-old infants associated snakes with fear. As predicted, they looked longer at films of snakes while listening to a frightened human voice than while listening to a happy voice. In the third study, infants did not look differentially to still photos of snakes and other animals, indicating that movement is crucial to infants' association of snakes with fear. These results offer support for the view that humans have a natural tendency to selectively associate snakes with fear.

Introduction

Snakes have long served as representations of danger and evil, from paintings of Eve with the Serpent in the Garden of Eden to Emily Dickinson's poem in which the sight of a 'narrow fellow in the grass' causes 'a tighter breathing and zero at the bone'. The ubiquity of such images is not surprising, given the fact that snakes constitute one of the most common objects of intense fears and phobias (Agras, Sylvester & Oliveau, 1969; Fredrikson, Annas, Rischer & Wik, 1996; King, 1997). Fearful reactions to snakes have also been reported for a variety of non-human primates (e.g. Joslin, Fletcher & Emlin, 1964; Rumbaugh, 1968; Schiller, 1952; Yerkes, 1943).

In the research reported here, we probe the origins of snake fear in humans by examining infants' response to snakes and other unfamiliar animals. The goal was to provide evidence relevant to evaluating two influential accounts of the prevalence of snake fear in humans. Both theories propose that snake fear originated in early mammalian evolution when reptiles constituted a wide-spread, recurrent threat to survival. Fear of snakes would have led to avoidance of these potentially dangerous animals, thereby reducing mortality risks and enhancing the likelihood of survival and reproduction. Where the two accounts differ is with respect to whether humans have an *innate fear* of snakes (Menzies & Clarke, 1995; Poulton & Menzies, 2002) or an *evolved tendency to associate snakes with fear* (Marks, 1987; Ohman & Mineka, 2001, 2003; Seligman, 1970).

According to what we refer to as the *non-associative view* (Menzies & Clarke, 1995; Poulton & Menzies, 2002), snake fear is one of several innate, universal fears, including fear of heights, water, spiders, and strangers. Learning is not required for the emergence of these fears: Rather, 'most members of a species will show fear to a set of biologically relevant stimuli from early encounters . . . without any relevant associative learning experiences' (Poulton & Menzies, 2002, pp. 127–128).

Consistent with this view, individuals with snake fear or phobia often cannot identify any learning experiences that might account for the origin of their fear (Menzies & Clarke, 1995; Poulton & Menzies, 2002). The explanation offered for the fact that snake fear (and other purportedly innate fears) is not present in everyone is that people 'learn to *not fear*'. Through non-traumatic encounters with live snakes or representations of snakes, snake fear is gradually extinguished (Menzies & Clarke, 1995; Poulton & Menzies, 2002; Rachman & Seligman, 1976; Rachman, 2002). 'The . . . role of the environment is to abate biologically relevant fears, rather than account for their emergence' (Menzies & Clarke, 2005, p. 128).

According to prepared learning theory, originally formulated by Seligman (1970), and what we will refer to as the *associative-bias account* of Ohman and Mineka (2001, 2003), the prevalence of snake fear reflects an innate predisposition to associate snakes with fear. One form of empirical support for this perspective comes from Pavlovian fear-conditioning studies with adult humans (see Ohman & Mineka, 2001, for a review). For one thing, conditioned skin conductance responses (SCR) – a measure of emotional activation – are more resistant to extinction when evolutionarily fear-relevant stimuli, including snakes and spiders, serve as the CS

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than when the CS is not fear-relevant (e.g. flowers and mushrooms). For another, fear-relevant responses (e.g. skin conductance, heart rate acceleration) are more readily conditioned to fear-relevant stimuli, including snakes, than to non-fear-relevant stimuli.

Further, there is evidence for *non-conscious* SCR conditioning to snake stimuli (Ohman & Soares, 1998). When pictures of snakes and non-threat stimuli were presented very briefly and followed immediately by a masking stimulus (making participants unaware of seeing the pictures), conditioning occurred to the snakes, but not to the non-threat stimuli. According to Ohman and Mineka (2003), these findings are consistent with the idea that 'responses to snakes are organized by a specifically evolved primitive neural circuit' (p. 7).

There is also evidence of enhanced *detection* of snakes. Adults find a single snake picture among a set of neutral distracters (e.g. flowers) more rapidly than a single neutral stimulus among an array of snakes (Ohman, Flykt & Esteves, 2001).

The strongest evidence in favor of the associative-bias account of snake fear comes from research with non-human primates (Cook & Mineka, 1987, 1989). Monkeys that grow up in the wild are afraid of snakes, but laboratory-reared monkeys are not, suggesting that wild monkeys acquired their fear.

In a test of this learning account, lab-reared rhesus monkeys (adults and adolescents) observed a wild-reared monkey react with fear to a snake. Simply from observing a con-specific's fearful behavior, the monkeys very rapidly developed an intense, long-lasting fear of snakes themselves (Cook & Mineka, 1987). Even viewing a video of another monkey reacting fearfully to a snake instilled a fear of snakes (Cook & Mineka, 1989). A crucial finding in this research is that the vicarious acquisition of fear is *selective*: When shown a video of a monkey reacting fearfully to a rabbit, a new group of monkeys did not acquire a fear of rabbits (Cook & Mineka, 1989).

In the research reported here, we introduce empirical evidence with infants relevant to the debate on the origins and nature of human snake fear. In the first experiment, we simply ask whether infants respond differently to films of snakes versus other animals. In the second, we ask whether infants show any tendency to associate snakes with a fearful stimulus. Specifically, do infants associate the sight of a snake with the sound of a frightened human voice? (Ethical considerations precluded replicating with human infants the observational fear-learning studies done with monkeys.) The third study is a replication of the second, except that still photographs are substituted for the snake and animal films used in the second.

Three outcomes were possible in these studies. If humans do have an *innate fear of snakes*, infants might display some kind of spontaneous negative reaction to them. Instead, if there is no innate fear but an *associative bias*, there should be no initial fearfulness of snakes, but a tendency to associate snakes with fear-relevant stimuli should be observed. Further, if humans have a bias to detect the presence of snakes, differences in orienting to snakes versus other animals should occur. Finally, if snakes have no special status, contrary to both accounts described above, then infants should not respond differentially to snakes compared to other animals.

Experiment 1

To see if human infants would react differently to snakes versus other animals, we presented 9- to 10-month-olds with silent films of snakes and exotic non-snake animals. We used films rather than photographs on the assumption that snakes' unique pattern of motion might be critical in humans' reactions to them.

One dependent measure was looking time to the two types of stimuli. If snake fear is innate in humans, infants might look differentially at snakes and other animals. For example, they might avoid looking at snakes and look longer at the non-snakes, or they might show hyper-vigilance toward snakes, looking longer at them than at other animals. The second measure was the infants' manual exploration of the images on the video screen. Previous research has shown that 9-month-olds occasionally feel, pat, rub, and even attempt to grasp at kinetic video images (Pierroutsakos & Troseth, 2003). It seemed reasonable to expect that this measure might be particularly sensitive to any tendency to react differentially to snakes versus other animals. If infants are in fact afraid of snakes, they might be reluctant to reach towards and grasp the image of a moving snake on a television screen.

Method

Participants

The 16 participants were 9- to 10-month-old infants, nine males and seven females (M = 9.8 mos, r = 9.3–10.5 mos). This age group was selected because of the prior research demonstrating manual exploration of video images by 9-month-olds (Pierroutsakos & Troseth, 2003). The infants were randomly assigned to two stimulus orders. The participants in this and the second experiment reported here were recruited from birth announcements in the local community and were from predominantly middle-class Caucasian families. Three additional participants were excluded from the study (two for fussiness, and one for experimenter error).

Stimuli

The stimuli were 10 8-sec color film clips from nature programs in which a snake slithered or an animal walked at approximately the same slow rate across the screen. Each of the four snake films showed a different snake. The six animal films were of wild animals (giraffe, rhinoceros, polar bear, hippopotamus, elephant, and large bird[1]). (Although some of these are dangerous animals, only snakes and spiders are considered to be evolutionarily relevant threat stimuli.)

Apparatus

The films were presented on a 50.8 cm monitor that was 25 cm from the infant's eyes. One video camera behind and a second to the left of the participant recorded looking at the films and manual exploration of the images.

Procedure

The session started with a warm-up trial of a toy moving across the screen. At the beginning of each of the 10 trials, a 3-sec attention-getter attracted the infant's attention to the screen. The snake and animal clips were presented in two pseudo-random orders, one the reverse of the other, with no two snake videos appearing in succession. Twice during each clip, a female voice prompted the infant to look at the screen (i.e. 'Look at that!').

Results

The results were straightforward. One-way Mixed-Effects ANOVAs revealed no significant differences in the infants' behavior toward the two types of stimuli on either of the two measures (Looking time: Animals – 5.74 sec, Snakes – 5.62 sec, $F(1, 15) = 0.05$, *ns*; Manual Exploration: Animals – 0.76, Snakes – 0.61, $F(1, 15) = 0.18$, *ns*). (Preliminary analyses had revealed no differences for age group or gender, so these variables were not included in the analysis.) Power analyses indicated 95% percent power for both measures.

Discussion

The infants in Experiment 1 did not react differentially to the snakes and other animals either in terms of how long they looked at them or how frequently they manually explored them. The results thus provide no support for the non-associative account, that is, no evidence of an innate fear of snakes. Any differential responding of any sort could have offered support for this view: The infants might have looked longer at the snakes, indicating this category of stimulus was prepotent, or they might have avoided looking at snakes, suggesting that these stimuli were aversive. However, it is important to point out that the absence of differential responding is not definitive: It has been suggested that an innate fear of snakes might be manifested only after infants have begun walking and moving around in the environment (Marks, 1987). The results of Experiment 2 speak to this possibility.

The lack of differential responding in Experiment 1 is consistent with the associative-bias account. According to this view, no negative reactions would be expected to the snake images in the absence of any fearful stimuli with which to associate them. This null result does not, however, provide strong support for this account.

Experiment 2

Informed by the results of Experiment 1, the second study was designed to provide a *direct* test of the associative-bias hypothesis. If humans have an innate predisposition to learn to fear snakes, that predisposition should exist independent of experience with snakes. Hence, a *tendency to associate a fearful stimulus with snakes* might be observable even in infants. We reasoned that such a tendency might lead infants to pay more attention to snakes when they heard a frightened human voice than when they heard a happy voice.

To examine this possibility, we used an auditory-visual matching paradigm. This well-established procedure is based on the often-replicated tendency of infants (and adults) to look selectively at a visual display that matches an auditory stimulus (e.g. Golinkoff, Hirsh-Pasek, Cauley & Gordon, 1987; Spelke & Cortelyou, 1981; Walker-Andrews, Bahrick, Raglioni & Diaz, 1991). Of particular relevance here, infants match the *emotional valence* of voices and visual stimuli. For example, infants as young as 5 months of age who are presented with pairs of faces displaying different emotional expressions look longer at a smiling face when they hear a happy voice and longer at an angry face when listening to an angry voice (Walker-Andrews, 1986).

Further, infants use another person's vocal emotion as a source of information for evaluating situations (Mumme, Fernald & Herrera, 1986; Sorce, Emde, Campos & Klinnert, 1985; Tamis-LeMonda, Adolph, Dimitropoulou & Zack, 2006). They rely on emotional tone even when a message is delivered in an unfamiliar language (Fernald, 1992).

As Figure 1 depicts, the infants in Experiment 2 were simultaneously presented with two films – one of a snake and the other of an exotic animal – accompanied by a recording of either a very frightened or a very happy human voice speaking in a nonsense language (Banse & Scherer, 1996). If infants have a predisposition to associate snakes with fear, as proposed by prepared-learning theory (e.g. Ohman & Mineka, 2001; Seligman, 1970), they should look longer at snakes when they hear a frightened voice than when they hear a happy voice. Note: we did not expect the infants to react fearfully to the snakes, only to look more at them in the presence of a fearful voice.

There is no basis for making any prediction regarding how long the infants would look at the non-snake animals

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[1] Fewer snake than animal films were used out of concern that the infants might habituate more rapidly to the snakes than to the animals, which differed more in terms of appearance and pattern of movement. A comparison of the eight infants who had received equal numbers of snakes and non-snake animals in their first six trials revealed no differences in either dependent variable for the two types of stimuli.

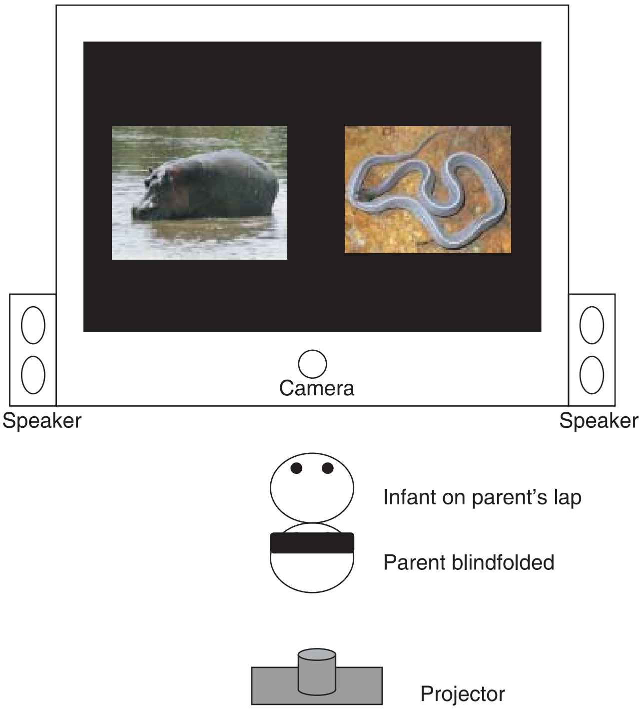

Figure 1 *The infant sat on the blindfolded parent's lap. On each trial, a pair of films of a snake and another animal was presented, accompanied by a tape of either a frightened or happy voice.*

as a function of emotional voice. Hence, the predicted result is an interaction of type of animal by vocal emotion, with significantly longer looking to snakes while hearing a frightened voice than a happy one.

This design also enabled us to examine whether, like adults in threat-detection tasks, infants more readily detect the presence of snakes than other animals. If snakes represent a threat-relevant category for infants, a bias should be apparent in terms of infants' orienting behavior to the snakes versus the other animals.

Method

Participants

Participants were 48 infants, half 7- to 9-month-olds ($M = 8.0$ mos, $r = 7.2–8.8$ mos) and half 16- to 18-month-olds ($M = 16.4$ mos, $r = 14.8–18.3$ mos). All but one of the infants in the older group were reported to be walking. An additional 15 infants failed to complete the experiment, most because of fussiness. Half the males and half the females at each age were randomly assigned to one of two stimulus orders.

Stimuli

Films. Twelve films (six snakes and six exotic animals) were used (including the 10 from Experiment 1 plus two additional snake clips).

Voices. The 12 professionally produced audio recordings were of the same two nonsense phrases ('Hat sundig pron you venzy. Fee gott laish jonkill gosterr') spoken by two men and two women. Most importantly, one recording made by each person was in a pleasant, happy-sounding tone of voice, and the other sounded distinctly frightened. (These recordings have been scaled for emotional content and used in many studies of adult perception of emotion; Banse & Scherer, 1996.)

Film–voice pairings. Twelve film–voice combinations were constituted by (a) randomly selecting one snake and one animal film to form each of six film pairs and (b) randomly assigning each film pair to one of the frightened voices and one of the happy voices. Each film–voice pair was converted to a single QuickTime video, with the two clips side by side. The snakes and non-snake animals appeared equally often on the right and left side. Both animals began moving simultaneously and at approximately the same speed. The voices came on 3 sec before the onset of the films and continued throughout the 10-sec films.

Stimulus presentation. As Figure 1 shows, the films were projected onto a 91.4 cm by 121.9 cm white screen approximately 91 cm from the infant. The projected films measured 48.3 × 30.5 cm with 30.4 cm between them. The voices came from two speakers located on either side of the screen. A video camera filmed the infant's head and eyes through a small hole in the screen. Each infant received 12 trials, each involving a different one of the 12 film–voice combinations.

The experimenter observed the infant's looking behavior on a monitor in the adjoining room in order to control the beginning of each trial. In between trials, the infant's attention was attracted by a blinking green dot appearing in the center of the screen accompanied by a 'dinging' sound. The blinking light automatically appeared at the end of each film, but the experimenter initiated the onset of the next trial on the computer controlling the presentation.

Procedure

Each infant was seated on a parent's lap in front of the screen. The parent was blindfolded to preclude any inadvertent cues. The experimenter manually began each trial as soon as the attention-getter attracted the infant's gaze to the screen. Everything else was controlled automatically.

Coding

The Supercoder program (Hollich, Rocroi, Hirsh-Pasek & Golinkoff, 1999) was used to code looking time for each infant. The coding of the digital tapes was done frame by frame at a rate of 30 frames per second, making the coding very sensitive. All coding was blind: Because the videos were silent and showed only the infants'

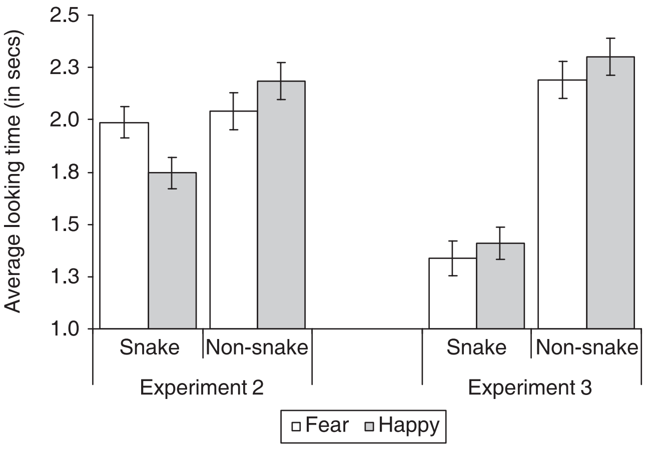

Figure 2 *As predicted, in Experiment 2, the infants looked significantly longer at the snakes when listening to a frightened-sounding voice than when listening to a happy voice. Looking times to the other animals did not differ significantly for the happy and frightened voices. In Experiment 3, looking times did not differ for either the snakes or the other animals for the happy and frightened voices. Error bars =* SE *of the mean.*

faces, the coders could not know which voice the infant was hearing or on which side of the screen the snakes and animals appeared. The coders recorded the latency from the onset of the films to the infant's first fixation of one of them, and the total amount of time the infant looked at each of the two visual stimuli. All of the tapes were coded by a primary coder, and one-fourth of the tapes were independently coded by a second coder. Agreement between coders was 80% for latency and 81% for looking time (an acceptable level of reliability in infant attention research). When coders disagreed, the primary coder's codes were used.[2]

Results

The looking-time data are shown in Figure 2. They reveal the predicted result – significantly longer looking at snakes while hearing a fearful voice than a happy one. As noted before, there is no basis for predicting differential looking at the non-snake animals as a function of vocal emotion, and no difference occurred.

The primary data analysis was a 2 (snake vs. animal) × 2 (frightened vs. happy voice) Mixed Effects analysis of variance (Bagiella, Sloan & Heitjan, 2000; Gueorguieva & Krystal, 2004). (Preliminary analyses had revealed no differences for age or gender, so these variables were not included in the analysis.) The only significant result was the predicted interaction between type of animal and type of vocal emotion, $F(1, 1077) = 4.56$, $p < .04$. Post-hoc comparison revealed that, as predicted, the infants looked longer at the snakes when listening to a frightened voice than when listening to a happy one, $F(1, 515) = 3.98$, $p < .05$. In contrast, the post-hoc comparison of looking times to the other animals as a function of vocal emotion was not significant. These results are consistent with the hypothesis that infants would associate the sound of a frightened voice with the sight of a snake.

Discussion

The overall pattern of results in Experiment 2 revealed important differences in infants' responses to snakes. Primarily, the looking-time data revealed a significant tendency to associate snakes with fearful stimuli: The infants looked longer at the snakes when listening to a frightened voice than a happy one. This result is consistent with the associative-bias view. Infants also turned somewhat more rapidly to look at the snakes than at the non-snakes.

Another aspect of the results of this study worth noting is the *absence* of a significant age difference in the two groups of infants (8- and 16-month-olds). This result indicates that the tendency to associate snakes with fear emerges well before the onset of walking. More importantly, the highly similar pattern of behavior for infants only slightly more than half a year old and those a full year older supports the idea of a predisposition that is independent of both maturational status and experience.

Experiment 3

The results of Experiment 2 raise an important question concerning what stimulus attributes of snakes underlie infants' tendency to associate them with a fearful stimulus. One likely candidate is their sinusoidal movement pattern; no other terrestrial animals move like snakes do. If the unique pattern of movement associated with snakes is a crucial determinant of humans' negative reactions to them, one would predict that infants would not associate *stationary* images of snakes with fearful voices. Accordingly, in Experiment 3, we replicated Experiment 2, except that the visual stimuli were still photographs of snakes and other exotic animals. The voices were the same as those used in Experiment 2.

Method

Participants

Participants were 48 infants, half 7- to 9-month-olds (M = 9.2 mos, r = 7.3–11.7 mos) and half 16- to 18-month-olds (M = 17.2 mos, r = 16.1–18.6 mos). An additional 13 infants failed to complete the experiment, most because of fussiness. Half the males and half the females

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[2] Any data points that were 3 times the interquartile range outside of the interquartile range and were more than three standard deviations above or below the mean (Cohen, Cohen, West & Aiken, 2003) were identified as outliers and eliminated from the data. A total of 8 and 10 outliers were identified for Experiments 2 and 3, respectively. The eliminated data points constituted 1.6% of the data.

at each age were randomly assigned to one of two stimulus orders.

Stimuli

The stimuli used in Experiment 3 were 12 still photographs of snakes and exotic animals taken from nature books. The projected images were the same size as the videos used in Experiment 2. The animal photographs matched the films in Experiment 2 in that they were of the same types of animals of the same colors and against generally the same types of background. The voices were identical to those of Experiment 2, and the stimulus pairings were constituted in the same way.

Procedure

The procedure for Experiment 3 was identical to that of Experiment 2. Coding was the same as that of Experiment 2, with agreement between coders of 80% for latency and 81% for looking time.

Results

The looking-time results are shown in Figure 2. As expected and in contrast to the interaction that was present in Experiment 2, the looking behavior of these infants did not differ for snakes versus other animals based on what voice they were hearing.

The looking-time data were analyzed in a 2 (snake vs. non-snake animal) × 2 (frightened vs. happy voice) Mixed Effects analysis of variance. (Preliminary analyses had revealed no differences for age or gender, so these variables were not included in the analysis.) The only significant result was a main effect of animal, $F(1, 1098) = 66.34$, $p < .01$. Consistent with the results of Experiment 2, the infants looked longer at the non-snakes than the snakes.

There was no interaction of animal by voice, $F(1, 1098) = 0.11$, *ns*. The infants did not look differentially at the non-moving snakes and other animals. Of most importance, they did not look longer at a still snake than at a still animal when they heard a frightened voice.

Additionally, examination of the infants' first looks revealed that they turned significantly more rapidly to the snakes ($M = 0.74$ s) than to the non-snakes ($M = 0.91$ s), $F(1, 511) = 3.82$, $p = .05$. There were no other significant effects. (The same pattern of behavior also occurred in Experiment 2, but the difference was not significant.)

General discussion

The three studies reported here provide evidence supporting the prepared-learning/associative-bias account of the prevalence of snake fear and phobia, specifically, the claim that humans are predisposed to learn to associate snakes with fear. The current results offer particularly strong support by virtue of the fact that such a predisposition was observed in infants. In the main study, Experiment 2, the prediction that infants in the first and second years of life would associate the sight of a moving snake with the sound of a fearful voice was confirmed.

In contrast to this predicted positive result, infants in Experiment 1 did not respond differentially when films of snakes and other unfamiliar animals were presented individually, unaccompanied by voices. Further, in Experiment 3, in which pairs of still photographs of snakes and other animals were accompanied by emotional voices, infants did not respond differentially. Thus, the overall pattern of the results reveals a natural tendency in human infants to associate the sight of an undulating snake with the sound of a frightened human voice.

The results of Experiments 2 and 3 also provided evidence of an attentional bias in infants' response to snakes versus other unfamiliar animals. Consistent with research with adults (Ohman *et al.*, 2001), the snakes more readily recruited the infants' attention than the other animals did, as shown by more rapid orienting to snakes when the stimulus pairs first appeared. This preferential orienting to snakes constitutes the first evidence that, like adults (Ohman *et al.*, 2001) and older children (LoBue & DeLoache, 2008), infants respond to the presence of a snake more rapidly than other kinds of animals. The more rapid turning to snakes suggests that when a snake is detected, infants are biased to respond to it very quickly.

The present studies raise several questions for future research. One is whether the same results as in the experiments reported here would be found with spiders – another fear-relevant class of stimuli. Like snakes, spiders are a very frequent target of fears and phobias, and there is substantial evidence with adults for conditioning and detection effects with spiders similar to those reported for snakes (Ohman & Mineka, 2001, 2003). Thus, infants might show a tendency to associate spiders with fearful voices.

Another important issue for further research concerns the role of the unique movement pattern of snakes in eliciting negative responses. In Experiment 3, we established that still photographs of snakes and other animals do not elicit differential responding, suggesting that movement may play an important role in humans' reactions to snakes. We are currently examining the importance of motion pattern *on its own* by replicating Experiment 2 using point light displays of snakes and other animals.

In summary, the research reported here provides the first evidence with infants relevant to the origins of one of the most common fears and phobias present in humans. The results offer support for the view that humans have a predisposition to associate snakes with fear. The results also indicate that the unique, anomalous movement pattern of snakes may underlie this association.

These findings suggest that it was the slithering motion of the 'narrow fellow in the grass' that aroused Emily Dickinson's fear.

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