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Brief Report

And along came a spider: An attentional bias for the detection of spiders in young children and adults

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ABSTRACT

Spiders are among the most common targets of fears and phobias in the world. In visual search tasks, adults detect their presence more rapidly than other kinds of stimuli. Reported here is an investigation of whether young children share this attentional bias for the detection of spiders. In a series of experiments, preschoolers and adults were asked to find the single spider picture among an array of eight mushrooms or cockroaches or the reverse. Both children and adults detected the presence of spiders more rapidly than both categories of distracter stimuli. Furthermore, there was no difference between the detection of two neutral stimuli (cockroaches vs. mushrooms). These results provide the first evidence of enhanced visual detection of spiders in young children.

Introduction

Little Miss Muffet is not the only one ever to have been frightened away by a spider. Fear of spiders is very common, and spider phobia is one of the most common phobias in the world, shared by 3.5% of the population in the United States (Fredrikson, Annas, Rischer, & Wik, 1996). The high incidence of spider fear and phobia persists in spite of the fact that spiders are not actually very threatening to humans in modern industrialized societies. According to a recent report by the Centers for Disease Control and Prevention (CDC), spider bites caused only 99 deaths in the United States during the 20 years between 1979 and 1999 (Forrester & Stanley, 2004). This is an extremely small number compared with the incidence of other non-disease-related deaths in the United States. Guns, for example, were responsible for more than 30,000 deaths in the year 2002 alone (Centers for Disease Control & Prevention, 2006). Why, then, is fear of spiders more common than fear of guns?

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Although spiders might not pose a very common threat to humans in modern societies, they did constitute a recurrent and widespread threat throughout the course of human evolution (Öhman, 1993; Seligman, 1970). Accordingly, evolutionary theorists have suggested that humans who quickly learned to fear spiders (and other threat-relevant stimuli such as poisonous snakes) would have been more likely to survive and reproduce. More specifically, the prepared learning view proposes that through evolution, humans developed a predisposition to quickly perceive the presence of threats (e.g., spiders, snakes) that were recurrent and widespread throughout evolutionary history (Öhman, 1993; Öhman & Mineka, 2001, 2003; Seligman, 1970). Thus, proponents of this view would make two predictions about human behavior: (a) that fear of evolutionarily relevant stimuli would be learned more quickly than fear of neutral stimuli (Öhman & Mineka, 2001, 2003; Seligman, 1970) and (b) that humans would detect the presence of evolutionary threats particularly quickly in visual perception (Öhman, 1993; Öhman, Flykt, & Esteves, 2001; Öhman & Mineka, 2001, 2003). To explain these behaviors, Öhman and Mineka (2001, 2003) proposed an evolved fear module that functions solely to aid humans in defending against threat.

Evidence of a predisposition to learn to fear evolutionary threats comes from experiments with rhesus monkeys and human adults. Research with laboratory-reared rhesus monkeys has shown that they selectively learn to fear stimuli such as snakes from observing a conspecific after very few trials. Furthermore, research with human adults has shown superior conditioning of skin conductance responses when participants are conditioned to associate an electric shock with spider and snake stimuli compared with neutral stimuli (see Öhman & Mineka, 2001, for a review). Together, this research provides evidence supporting the idea that both human adults and non-human primates learn more quickly to fear evolutionary threats than neutral stimuli.

Similarly, there is also evidence that both rhesus monkeys and human adults quickly detect threat-relevant stimuli. Using a visual search task, Öhman, Flykt et al. (2001) presented human adults with 3×3 matrices of photographs of two categories of stimuli: threat-relevant spiders and snakes and neutral mushrooms and flowers. Each trial consisted of either (a) nine pictures from one of the categories or (b) eight pictures from one of the categories and one picture from the other category. Participants needed to decide as quickly as possible whether a discrepant picture was present in each matrix. The presence of a single spider or snake target was detected reliably more quickly than the presence of a mushroom or flower target. Several researchers have since replicated this finding (Blanchette, 2006; Brosch & Sharma, 2005; Flykt, 2005; Lipp, Derakshan, Waters, & Logies, 2004; Waters, Lipp, & Spence, 2004).

This research demonstrates that adults visually detect threat-relevant stimuli particularly quickly in visual attention. However, the adult participants in these studies had extensive knowledge and experience with stimuli such as snakes and spiders. If humans are predisposed to detect such stimuli particularly rapidly, this bias should be observable regardless of age and experience. Thus, strong support for a bias to detect spiders would come from child participants, who have had relatively little experience with snakes and spiders. Recent research has examined this important issue and shown that even preschoolers detect the presence of snakes particularly quickly in visual attention. LoBue and DeLoache (2008) presented 3-, 4-, and 5-year-olds and adults with 3×3 matrices of colorful photographs on a touch-screen monitor. Participants either saw one snake target among eight non-snake distracters or saw one non-snake target among eight snakes. They were instructed to touch the target on the screen as quickly as possible. Consistent with adult research, snake targets were detected significantly faster than flowers, frogs, and caterpillars by all age groups. This research was the first to demonstrate that, like adults, children demonstrate a propensity for the rapid detection of snakes.

One important question that follows from this research is whether children and adults detect snakes particularly quickly or threat-relevant stimuli particularly quickly in general. Thus, the goal of the current research was to investigate whether, like adults, young children demonstrate an attentional bias for spiders.

General method

Adopting the touch-screen paradigm used by LoBue and DeLoache (2008), both preschoolers and adults were presented with 3×3 matrices of color photographs showing one target and eight distracters. The participants were asked to touch the target as quickly as possible. In three experiments, the question of interest was whether preschoolers and adults would detect spiders more quickly than various neutral stimuli.

Materials

The stimuli consisted of three sets of 24 photographs arranged in 3 × 3 matrices, with one target picture from one category and eight distracter pictures from another category. The stimulus categories were spiders, cockroaches, and mushrooms. The photographs were scanned from nature books and adjusted to 325 × 245-pixel images. A coder blind to the purpose of the research rated the brightness of all pictures on a scale from 1 (*very bright*) to 5 (*very dull*). The pictures were not rated as significantly different from each other.

A MultiSync LCD 2010X color touch-screen monitor was used to present each picture matrix on a 61-cm (24-inch) screen. The overall matrix was 39.4 × 39.4 cm, with 1.27 cm between rows and 0.64 cm between columns. The individual projected pictures measured 11.47 × 8.64 cm. Each of the 24 pictures in the target category served as the target once, appearing in each of the 9 positions in the matrix two or three times. The 24 pictures from the distracter category appeared approximately the same number of times across trials. One stimulus order was created by randomly arranging matrices, and the second order was the reverse of the first order. An outline of a child's handprints was located on the table immediately in front of the monitor.

Procedure

The child was seated in front of the touch-screen monitor (approximately 40 cm from the base of the screen) and told to place his or her hands on the handprints. This ensured that the child's hands were in the same place at the start of each trial, making it possible to collect reliable latency data. The experimenter stood alongside to monitor and instruct the child throughout the procedure.

First, a set of 7 practice trials was given to teach the child how to use the touch-screen monitor. On the first 2 trials, a single picture appeared on the screen, and the child was asked to touch it. The first picture was from the target category, and the second picture was from the distracter category. (All pictures used in the practice trials were chosen randomly from the original sets of 24 pictures.) Next, the child was presented with 2 trials with one target picture and one distracter picture and was asked to touch only the target picture. This was followed by 3 practice trials, each involving a different nine-picture matrix. The child was told that for each trial, his or her task was to find the "X" (target) among "Y" (distracters) as quickly as possible, touch it on the screen, and then return his or her hands to the handprints. All of the children readily learned the procedure.

This was followed by a series of 24 test trials, each with a different picture matrix containing one target and eight distracters presented on each trial. In between trials, a large smiley face appeared on the screen. To ensure that the child's full attention was on the screen before each matrix appeared, the experimenter pressed the face when she judged that the child was looking at it, causing the next matrix to appear. Latency was automatically recorded from the onset of the matrix to when the child touched one of the pictures on the screen.

After the child had completed all 24 test trials, his or her parent was tested in exactly the same manner. The parent had not been told about the experimental hypothesis and had not been present while the child was tested.

Participants

The participants were 72 3-year-olds (mean age = 41.7 months, range = 36.0–47.4) and their 72 accompanying parents (all but 4 were female). In each experiment, 24 children and parents were tested. An additional 3 3-year-olds were excluded for failure to follow directions. The participants in all experiments presented here were recruited from records of birth announcements in the local community and were predominantly Caucasian and middle class. There were equal numbers of boys and girls in the child group, and each child was randomly assigned to one of two target conditions and one of two stimulus orders. For convenience, the parent was assigned to the same conditions as the child. The parent was not present in the room while the child was being tested.

Analyses

The analyses for all of the experiments reported here were 2 (Target) × 2 (Age) analyses of variance (ANOVAs) on the latency to touch the target. Following standard procedures for visual search tasks, only trials in which the correct target was selected were counted. In Experiment 1, 9 children made a total of 24 errors (approximately 4% of the data), and 1 adult made 4 errors (less than 1% of the data). In Experiment 2, 12 children made a total of 62 errors (approximately 10% of the data), and 2 adults made a total of 2 errors (less than 1% of the data). In Experiment 3, 12 children made a total of 26 errors (approximately 5% of the data), and no adults made any errors. It is likely that more errors were made in Experiment 2 than in Experiments 1 and 3 because the stimuli in the second experiment (spiders vs. cockroaches) were perceptually more similar than those in the other two experiments. Errors did not vary by target.

Experiment 1

In Experiment 1, 3-year-olds and adults were asked to locate either a single spider target among eight mushroom distracters or the lone mushroom target among spiders. Mushrooms were used as the neutral comparison stimulus both because of their similarity in color to spiders and because they have been used in previous visual search studies with spider targets (Blanchette, 2006; Brosch & Sharma, 2005; Flykt, 2005; Lipp et al., 2004; Öhman, Flykt et al., 2001; Waters et al., 2004). Based on findings from previous research, the adults were expected to detect spider targets more quickly than mushrooms. The question of interest was whether the young children would show the same pattern of performance.

Results and discussion

Results for Experiments 1 to 3 are presented in Fig. 1. Both adults and children detected the spiders more quickly than the mushrooms. In the ANOVA on latency to locate the target, there were significant main effects of age, $F(1, 44) = 237.13$, $p < .05$, and target, $F(1, 44) = 11.80$, $p < .01$, with no interaction. The overall R^2 was .85. The main effect of age indicated that the adults detected the targets significantly more quickly than did the children. The main effect of target revealed that both the adults and children detected the presence of the spider targets more quickly than the mushrooms. The absence of an interaction indicated a similar effect in both age groups. The adult data replicated previous findings with adults, indicating that our touch-screen procedure produced the same pattern of results as the standard visual search task. Of most importance, the child data offer the first evidence that superior detection of spiders is not limited to adults but rather also occurs in young children.

Experiment 2

In Experiment 1, both the adults and young children detected spiders more rapidly than mushrooms, thereby replicating and extending the results reported previously by Öhman, Flykt et al. (2001). However, if humans are biased for the rapid detection of evolutionarily relevant threat stimuli, that bias should be apparent with a wide range of neutral stimuli. Mushrooms, which were the only non-threat stimulus category used by Öhman, Flykt et al. (2001), differ from spiders in many ways, the most important of which is animacy (spiders are animate and mushrooms are not). A much stronger test of a bias for the detection of threat-relevant stimuli would be a comparison between spiders and other animals of similar physical appearance. Accordingly, in Experiment 2, spiders were compared with cockroaches.

Results and discussion

In the ANOVA on latency to locate the target, there were significant main effects of target, $F(1, 44) = 7.93$, $p < .01$, and age, $F(1, 44) = 133.98$, $p < .01$, with a Target × Age interaction,

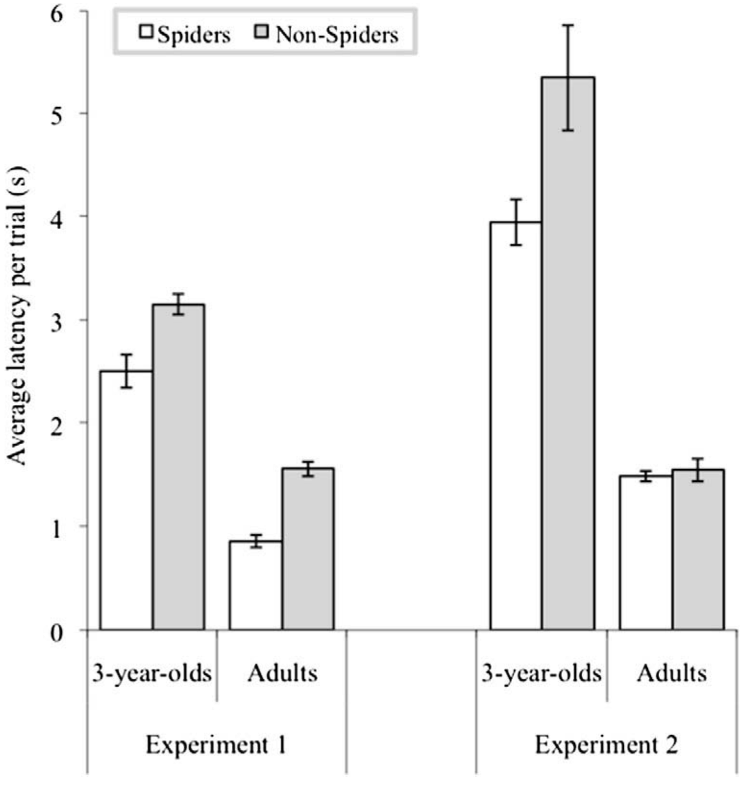

Fig. 1. Average latencies to detect the target stimulus for adult and child participants in Experiments 1 and 2. As predicted, spiders were detected more rapidly than mushrooms (Experiment 1) and cockroaches (Experiment 2).

$F(1, 44) = 5.55$, $p < .05$. The overall R^2 was .79. As expected, the adults detected the target stimuli more quickly than did the children. The interaction reflected a larger difference between the detection of spiders and the detection of cockroaches for the children than for the adults, and post hoc *t* tests indicated that the effect of target was significant only in children ($t = 2.52$, $p < .02$). Although adults also detected the spiders more quickly than the cockroaches, this effect was not statistically significant ($t = 0.51$, *ns*).

The null results with adults are likely due to the small sample size. As mentioned previously, only 24 adults were tested in this experiment, with only 12 in each experimental group. Although previous research has shown that this sample size is sufficient to obtain a significant result in children for threat detection, adults detect the targets very quickly and so a larger sample size might be necessary to obtain a significant result in all experiments (LoBue & DeLoache, 2008). In fact, a similar result was obtained previously by LoBue and DeLoache (2008) when examining the detection of snakes versus caterpillars; although both age groups detected the snakes more quickly than the caterpillars, the result was significant only in children. Because the focus in the current study was on children, the author believed that a sample size of 24 was appropriate in that this has been the typical sample size used with this method in previous research (LoBue, 2009; LoBue & DeLoache, 2008). However, the result with adults is in the predicted direction (adults detected the spiders more quickly than the cockroaches as well), and it is predicted that with more adult participants, a significant effect would also be obtained.

Overall, the results of Experiment 2 were consistent with those of Experiment 1 in that young children detected the presence of threat-relevant stimuli more quickly than non-threat stimuli. Considering that the stimuli were so similar, these results provide particularly strong support for a detection bias for spiders in young children.

Experiment 3

Results from the preceding two experiments revealed that children, like adults, detect the presence of spiders more rapidly than two different types of neutral stimuli. In Experiment 3, we took a different tack, comparing the detection of two categories of non-threat-relevant stimuli: cockroaches and mushrooms. The claim of priority for processing threat-relevant stimuli has no implications for the relative speed of detecting different fear-irrelevant stimuli. Hence, there is no theory-based reason to predict a bias for one over the other even for stimuli of distinctly different appearance. Although we are predicting the null hypothesis here, it is well motivated in the context of the general theory and the pattern of results in the first two experiments.

Results and discussion

In the ANOVA, there was a significant main effect of age, $F(1, 44) = 137.94$, $p < .01$, with adults responding more rapidly than children. As expected, there was no effect of target, $F(1, 44) = 3.60$, *ns*, and no interaction. The overall R^2 was .77. Although there was a tendency for both the children and adults to detect the mushrooms slightly faster than the cockroaches, this difference was not significant in either age group (mushrooms: *M*s = 1.00 and 2.93 s, respectively; cockroaches: *M*s = 1.14 and 3.48 s, respectively).

This predicted null result was informative in the context of the other experiments reported here. In the two cases where a theory-based prediction could be made about differences in speed of detection, the predicted difference in performance was found both times. In the one case where there was no theory-based reason to expect a difference, no difference was found even though the perceptual similarity between the two categories of non-threat stimuli was at least as great as the perceptual similarity between the threat-relevant and non-threat-relevant stimuli in the preceding experiments. Thus, the results of Experiment 3 offer important support for the existence of a detection bias for threat-relevant stimuli early in life.

General discussion

The research presented here establishes the existence in young children of a bias for the detection of spiders. The study replicates previous findings with adults and extends them to children, who have had relatively little and certainly much less experience with spiders than older individuals have had. Furthermore, the fact that young children detected the spider targets more quickly than the other stimuli provides especially strong support for the existence of an evolved attentional bias for spiders in humans.

This research, in combination with previous work, presents strong evidence that humans possess a bias for the detection of threat. As mentioned previously, several researchers have found that adults and preschoolers detect snakes faster than various other stimuli (Lipp et al., 2004; Öhman, Flykt et al., 2001; Tipples, Young, Quinlan, Broks, & Ellis, 2002), and LoBue and DeLoache (2008) showed the same pattern of results in 3- to 5-year-olds. The current research adds to these previous findings, demonstrating that adults and children detect spiders particularly quickly as well. Furthermore, recent research has also shown that adults and children also detect threatening facial expressions, such as angry and fearful faces, particularly quickly. In a series of experiments, both 5-year-olds and adults generally detected all negative faces (sad, angry, or fearful) more quickly than positive ones (happy). Most important, they detected threat-relevant negative faces (fearful or angry) more quickly than all other faces (sad, happy, or neutral) (LoBue, 2009). Similar findings have been reported in previous work with adults (Hansen & Hansen, 1988; Öhman, Lundqvist, & Esteves, 2001). Together, these findings present strong evidence that humans have a predisposition to quickly detect the presence of threatening stimuli in visual attention.

A question of substantial theoretical importance is the nature of the mechanism that underlies humans' rapid detection of spiders. Rakison and Derringer (2008) suggested that infants may have an innate ‘‘perceptual template" for evolutionarily threat-relevant stimuli, including spiders. As a result, infants may have an inborn preference for representations that have the basic configuration of spiders, a factor that would lead to an advantage in the visual detection of spiders versus other stimuli. To test this view, they examined infants' perceptual preference for schematic representations of spiders versus reconfigured and distorted spiders. The 5-month-olds looked longer at pictures of schematic spiders than at representations of spiders with their features scrambled. By comparison, the infants did not show a preference for schematic pictures of neutral stimuli such as flowers. These results suggest that infants may have an innate perceptual representation of spiders that causes infants to preferentially orient to them. Consistent with the findings presented here, such a mechanism might allow facilitated detection of spiders (Rakison & Derringer, 2008).

Regardless of the mechanism by which humans detect threatening stimuli, such an ability is shared by many other animals. However, whereas humans use the visual system to quickly detect the presence of dangerous predators, most reptiles and mammals use their olfactory systems (Miller & Gutzke, 1999). Wall lizards, for example, use chemical cues from snakes to detect their presence and seek shelter (Amo, Lopez, & Martin, 2004). Similarly, many types of amphibians, including tadpoles and small-mouthed salamanders, use chemical cues to detect the presence of predatory fish (Kats, 1988; Kats, Petranka, & Sih, 1988; Kiesecker, Chivers, & Blaustein, 1996). Even predatory snakes use olfactory cues to detect other types of threatening snakes; North American pit vipers use their vomeronasal organ to detect the presence of kingsnakes (Miller & Gutzke, 1999).

One question for future research is whether even infants, like young children and adults, would detect the presence of spiders and other threat-relevant stimuli particularly quickly. Recent research has shown that when presented with two images side by side, infants turn more quickly to look at the image of a snake than at the image of a flower (LoBue & DeLoache, 2010) or at the images of other animals (DeLoache & LoBue, 2009). Research examining detection of spiders with infants would provide the strongest test of an inborn bias to detect threat-relevant stimuli in humans.

In conclusion, preschoolers share the propensity of adults for the particularly rapid visual detection of spiders. The presence of this tendency in such young children lends important support for theories positing the existence of an evolved bias for the detection of evolutionarily relevant threat stimuli in humans.

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