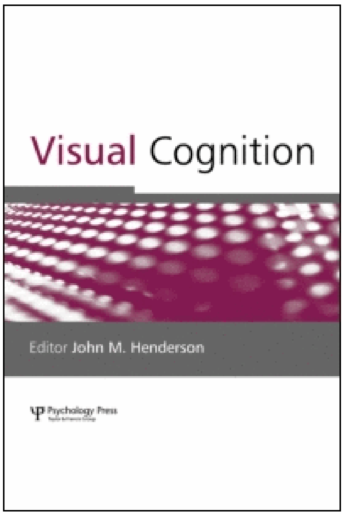

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What's so special about slithering serpents? Children and adults rapidly detect snakes based on their simple features

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What's so special about slithering serpents? Children and adults rapidly detect snakes based on their simple features

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Snakes are among the most common targets of fears and phobias around the world. In visual search tasks, both adults and young children have repeatedly been found to visually detect snakes more rapidly than other kinds of stimuli. An important question that remains unstudied is what accounts for humans' rapid response to snakes? Here we suggest that specific features of snakes themselves lead to their rapid detection. The results of five experiments suggest that a snake's shape is the crucial factor in their rapid detection.

Keywords: Attention; Detection; Threat.

Several researchers have documented that human adults show enhanced visual detection of threat-relevant stimuli, particularly snakes. The general idea behind this research is that throughout the course of evolutionary history, mammals, including humans, that quickly detected the presence of widespread threat-relevant stimuli, like poisonous snakes, would have been more likely to survive and reproduce (Ohman, 1993; Ohman, Flykt, & Esteves, 2001; Ohman & Mineka, 2001, 2003). Thus, the claim is that humans evolved an attentional bias supporting the exceptionally rapid visual detection of snakes and certain other threat-relevant stimuli.

The idea that humans visually detect snakes more rapidly than other stimuli has been substantiated in several experiments using a standard visual search paradigm, in which participants try to detect target stimuli as rapidly as

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possible. On some trials, the adult participants are presented with 3×3 matrices of pictures of two categories of stimuli, each matrix consisting of colour photographs of snakes and flowers, with eight pictures from one category and one picture from the other. On other trials they are shown nine pictures from one of the categories. Participants are asked to indicate as quickly as possible whether a discrepant picture is present in the display. Researchers have consistently found that the presence of a single snake is detected more quickly than the presence of a single flower (Blanchette, 2006; Brosch & Sharma, 2005; Flykt, 2005; Lipp, Derakshan, Waters, & Logies, 2004; LoBue & DeLoache, 2008; Ohman et al., 2001; Waters, Lipp, & Spence, 2004).

LoBue and DeLoache (2008) recently reported the same result for 3-, 4-, and 5-year-old children. Using a touchscreen procedure, they established that even very young children, who have had relatively little experience with snakes and possess relatively little knowledge about them, are nevertheless like adults in detecting snakes more rapidly than flowers. Further, a bias for faster detection of snakes versus other nonthreat-relevant animals, including frogs and caterpillars, was also reported.

An important question raised by this research that has not yet been examined is what accounts for humans' particularly rapid response to snakes? More specifically, we ask what it is about snakes that attracts the visual attention of humans from the first years of life on. One suggestion is that because snakes usually carry a negative valence, humans learn to detect them particularly quickly. This would mean that as humans gain knowledge about the threatening nature of snakes, they learn to quickly visually detect snakes' features (Cave & Batty, 2006). However, recent research has shown that even 8-month-old infants, who had never seen a live snake, detect snakes particularly quickly as well (LoBue & DeLoache, 2010). It is highly unlikely that by 8 months, infants have learned to associate a negative valence with snakes. Thus, an alternative possibility is that some low-level perceptual feature(s) of snakes visually attract attention (Cave & Batty, 2006). The focus of the current research is to identify what feature(s) of snakes is guiding attention to them.

There are several features of snakes that could drive their fast detection. One possibility is that it is not any specific feature about snakes per se that is causing their rapid detection, but, instead, some feature of their presentation that is causing the reported effects. For example, in many of the previous studies reported in this area, when participants are asked to detect nonsnake targets, snakes are used as the *distractor* stimuli. Thus, instead of attracting attention as the target stimuli, it is possible that snakes actually divert attention, thereby disrupting performance when they are not the target stimuli.

A second possibility is that actual physical attributes of snakes are drawing participants' attention to them particularly quickly. One distinctive characteristic of snakes is their surface appearance. Although some snakes have quite dull colouration, many have brightly coloured scales, often creating distinctive patterns. These bright colours and distinctive patterns can easily cause snakes to attract attention visually. In fact, some researchers have suggested that these bright colours might act as a memory cue for animals that have survived nondeadly snake bites to remember to flee from dangerous snakes in future encounters (Brattstrom, 1955). Another attribute that distinguishes snakes from other animals is their elongated and limbless body, which makes possible not only snakes' unique movement pattern, but also their unique ability to coil themselves. The existence of various asymmetries in basic visual attention hints that coiling might play an important role in snake detection. For example, researchers have shown that a curved target among rectilinear stimuli visually "pops out" more than a rectilinear target among curves (Treisman & Gormican, 1988). Thus, it is conceivable that coiling contributes to the rapid detection of snakes.

In the studies reported here, we examine the properties that account for the rapid detection of snakes in visual attention. In Experiments 1 and 2, we replicate previous studies on the detection of snakes and examine the role that background and distractor stimuli play in detection. In Experiments 3 and 4, we examine the specific features of snakes that might drive their rapid detection, such as body shape and bright colouration. Both preschool children and adults were tested. Although most of the previous research has involved adults only, research with young children can be important for the current research question. Preschool children, 3-year-olds in particular, are likely to have had minimal experience with snakes, particularly in a threatening context. Thus, if adults learn to detect the features of snakes because of knowledge about their threat relevance, one would expect that adults would detect snakes particularly quickly, but 3-year-old children would not. However, since previous research has already demonstrated that 3-year-olds do indeed detect snakes particularly quickly, we suggest alternatively that certain perceptual features likely drive the detection of snakes, and we expect that both adults and children would detect stimuli with these features particularly quickly.

GENERAL METHOD

Adopting the touchscreen paradigm used by LoBue and DeLoache (2008), both preschool children and adults were presented with 3×3 matrices of colour photographs and asked to touch a target on the screen as quickly as possible. Two procedural changes to the standard visual-search task were instituted to make the procedure appropriate for young children. First, to make it possible to obtain reliable reaction time data from 3-year-olds, we presented the stimuli on a touchscreen monitor, asking each participant to touch the target on the screen as quickly as possible. Second, only target-present matrices were presented, because the touchscreen procedure precluded the inclusion of no-target matrices. Despite these differences, previous results using this paradigm with adults have replicated previous findings using a standard visual search paradigm (LoBue, 2009; LoBue & DeLoache, 2008).

Based on previous research, parallel results were expected for the adult and the preschool participants; that is, we expected that the adults would respond much more rapidly than the children, but that the two age groups would display the same pattern of performance.

Materials

The stimuli for each experiment consisted of photographs scanned from nature books and adjusted to 325×245 pixel images. Each stimulus category contained 24 colour photographs that were arranged in 3×3 matrices, with one target picture from one category and eight distractor pictures from another category. The specific photographs used for each experiment are described later.

A MultiSync LCD 2010X colour touchscreen monitor was used to present each picture matrix on a 61 cm (24 inch) screen. The overall matrix was 39.4 cm $\times$ 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 nine positions in the matrix two or three times. The 24 pictures from the distractor 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. 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 touchscreen 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 reaction time data. The experimenter stood alongside to monitor and instruct the child throughout the procedure.

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

A series of 24 test trials followed. A different picture matrix containing one target and eight distractors was 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 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. After both the parent and child were tested in one experiment, they were tested in exactly the same manner for the second.

Analyses

The analyses of the experiments reported here were 2 (target: Snakes vs. comparison) $\times$ 2 (age: Children vs. adults) ANOVAs on the latency to touch the target. All factors were between-subjects. Preliminary analyses revealed no effects in any of the experiments of gender or presentation order, so these variables were not included in the analyses. Following standard procedures for visual search tasks, only trials in which the correct target was selected were counted. In all experiments, participants rarely erred, and errors did not vary by target.

EXPERIMENT 1: REPLICATION AND EXTENSION

The primary goal of Experiment 1 was to replicate the basic finding reported in previous research showing that snakes are detected more rapidly than neutral stimuli. Further, all previous research examining the detection of snakes presents participants with detailed photographs of snakes and other stimuli against various natural backgrounds. It is possible that there was something about the backgrounds of the snake images that aided participants in their detection. The secondary goal of Experiment 1 was to ensure that background stimuli did not play a role in the detection of snakes in previous research. Thus, instead of using photographs of snakes and neutral stimuli presented against rich and full backgrounds, the stimuli in Experiment 1 were all presented alone with plain white backgrounds.

Both adults and preschool children were asked to find either a single snake among eight frogs or a single frog among eight snakes. Based on previous research, we expect that snakes will be detected more quickly than frogs by both age groups.

Participants

The participants were 24 3-year-old children ($M = 40.3$ months, range = 36.2–46.3 months) and their accompanying parent. All but four parents were female. One additional child was eliminated for failure to follow instructions.

In all of the experiments reported here, there were an equal numbers of boys and girls. The children and parents were recruited from records of birth announcements in the local community and were predominantly Caucasian and middle class. The children were randomly assigned to one of two target conditions and to one of two stimulus orders. For convenience, the parent was assigned to the same condition as the child. Neither the parent nor the child was in the room while the other was being tested.

Results and discussion

Figure 1 shows the speed with which the adults and children located the target stimuli for Experiments 1–4. An ANOVA on the latency to touch the target picture yielded significant main effects of age, $F(1, 44) = 153.89$, $p < .01$, and target, $F(1, 44) = 6.12$, $p < .02$, with no interaction. Not surprisingly, the adults located the targets significantly faster than the children did. Most importantly, both age groups detected snakes more rapidly than frogs. Thus, these findings replicate those of previous research, demonstrating that snakes are detected more quickly than neutral stimuli, like frogs (LoBue & DeLoache, 2008). Further, the snakes were detected more quickly than the frogs by both age groups even though the snake and frog stimuli were depicted alone, against plain white backgrounds. These results replicate previous findings and extend them, suggesting that the background of the stimuli does not play a crucial role in our rapid detection of snakes.

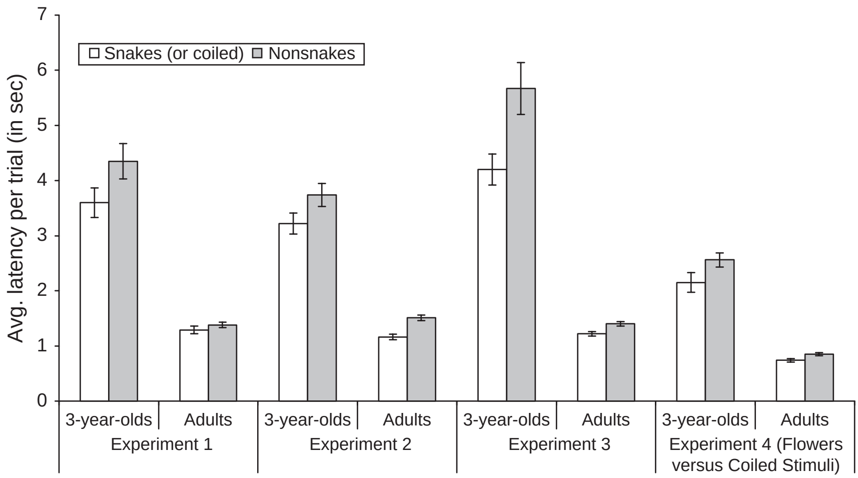

Figure 1. Average latencies to detect the target stimulus for adult and child participants in Experiments 1– 4. For Experiment 4, results for only the flowers versus coiled stimuli are pictured, since comparing the snakes versus coiled stimuli produced a null result. Across all four experiments, snakes and similarly coiled stimuli were detected more quickly than nonsnake stimuli by both adults and children.

EXPERIMENT 2: THE ROLE OF DISTRACTOR STIMULI

A second aspect of the stimulus presentation that could drive the rapid detection of snakes is the nature of the distractor stimuli. Experiment 2 is concerned with whether snakes actually attract attention in visual search research, or whether they merely distract from nonsnake targets. For example, in LoBue and DeLoache (2008), when the target stimuli were nonthreatening, the distractors were always snakes. It is possible that a single threat-relevant snake target does not attract a substantial amount of attention to drive the findings reported previously, but instead, when eight snakes are presented as the distractor stimuli, they function to divert attention, thereby disrupting performance for nonsnake target stimuli. In order to examine whether a single snake target attracts attention, the detection of snakes and frogs was compared using the same uniform distractor stimuli. The same snake and frog pictures that were used in LoBue and DeLoache were used for the two target conditions, but each of these target categories was presented with the same distractor stimuli—a variety of nonthreat-relevant animals, such as a horse, deer, rabbit, etc. The distractors were thus identical for both the snake and frog target conditions. If snakes attract attention, they should be detected more quickly than frogs when presented with the same distractor stimuli.

Participants

A larger sample size was used in this study than in the previous studies—twice as many participants were tested. In previous studies if snakes both *attracted* attention as the target stimuli *and distracted* from nonthreat-relevant targets as the distractor stimuli, here, with uniform distractor stimuli, snakes will be detected more quickly than frogs, but with a smaller effect size. Thus, 48 children were tested instead of 24. The participants were thus 48 3-year-old children ($M = 41.7$ months, range = 37.2–47.6 months) and their accompanying parent. All but six parents were female. Six additional children were eliminated for failure to follow instructions.

Results and discussion

An ANOVA on the latency to touch the target picture yielded significant main effects of age, $F(1, 92) = 211.13$, $p < .01$, and target, $F(1, 92) = 6.14$, $p < .02$, with no interaction. Adults located the targets significantly faster than the children did, but both age groups detected snakes more rapidly than the frogs. Thus, even though the snake and frog stimuli were presented with the same background stimuli, the snakes were detected more quickly than the frogs by both age groups. This result presents very strong evidence that snakes attract attention in visual search paradigms. It is still possible that they also distract from nonthreat-relevant targets as well—if snakes attract attention, they should do so as both the target and distractor stimuli. However, the results of the current study indicate that snakes attract enough attention as targets to result in an advantage in detection: When holding the distractor stimuli constant, snakes are still detected more quickly than frogs.

EXPERIMENT 3: THE ROLE OF BRIGHT COLOURATION

The results of Experiments 1 and 2 suggest that features of the stimulus presentation are not responsible for the rapid detection of snakes in visual search research. The aim of Experiments 3 and 4 was to examine what specific features of snakes themselves might drive their rapid detection. Experiment 3 investigates the extent to which the rapid visual detection of snakes is based on *bright colouration*. In previous research, snakes and nonsnake targets were presented in colour, highlighting the bright colours and patterns of snakes. In the current study, adults and children were asked to detect snakes versus frogs, the same pictures used in LoBue and Deloache (2008), but instead of presenting the pictures in colour, they were all presented in black and white. If the rapid detection of snakes is based on snakes' colouration and surface appearance, the snake stimuli should not be detected more rapidly than the frogs. However, if bright colours are not critical, snakes should still be detected more quickly than frogs by both age groups.

Participants

The participants were 24 3-year-old children ($M = 40.6$ months, range = 36.7–47.3 months) and their accompanying parent. All but one parent was female.

Results and discussion

An ANOVA on the latency to touch the target picture yielded significant main effects of age, $F(1, 44) = 174.75$, $p < .01$, and target, $F(1, 44) = 9.20$ $p < .01$, with a Target × Age interaction, $F(1, 44) = 5.56$, $p < .05$. Not surprisingly, the adults located the targets significantly faster than the children did. Most importantly, both age groups detected snakes more rapidly than frogs. The interaction indicates a larger effect in the adults than in children, but the effect of target was significant in both age groups: Adults, $F(1, 22) = 11.50$, $p < .05$; children, $F(1, 22) = 7.29$, $p < .05$. Thus, even though the snake and frog stimuli were in black and white, the snakes were detected more quickly than the frogs by both preschool children and by adults. These results suggest that colour does not play a crucial role in our rapid detection of snakes.

EXPERIMENT 4: THE ROLE OF SHAPE

The results of Experiment 3 suggest that colour is not the effective stimulus for the rapid detection of snakes. A second characteristic of snakes that might distinguish them from other animals is *shape*—their elongated, limbless body, which results in their ability to coil themselves. In Experiment 4, we examine the role of coiling in the detection of snakes. The most direct way of testing whether snakes' coiled shape is crucial in detection is to compare the detection of coiled snakes to the detection of uncoiled snakes. However, pilot data suggest that both adult and child participants have great difficulty distinguishing between coiled and uncoiled snakes because they are within the same category. Thus, in Experiment 4, we instead control for shape by comparing the detection of snakes and flowers to various coiled objects.

The snake and flower stimuli were the same as those used in LoBue and DeLoache (2008), with all of the stimuli depicted against a grassy background.

Because no other terrestrial animal is shaped like a snake or able to coil its body, the comparison stimuli were photographs of coiled wires. The pictures of these objects were matched with those of the snakes and flowers with respect to colouration, and they were also depicted against grassy backgrounds. In this study, one group of adults and children were asked to detect a single coiled snake among an assortment of eight coiled nonsnake stimuli or a single coiled stimulus among eight snakes. A second group of adults and children were asked to detect a single flower among the same assortment of coiled stimuli, or the reverse. To the extent that the rapid detection of snakes is based on a snake's coiled shape, the coiled stimuli should be detected more quickly than the flowers, but snake stimuli should not be detected more rapidly than the coiled stimuli. However, if shape is not critical, there should be no differences in the detection of coiled stimuli versus flowers, but the snakes should be detected more quickly than the coiled stimuli.

Participants

The participants were 48 3-year-old children ($M = 40.5$ months, range = 36.2–47.3 months), 24 in each study, and their accompanying parent. All but three parents were female. One additional child was eliminated for failure to follow instructions.

Results and discussion

For the flowers versus coiled stimuli conditions, an ANOVA on the latency to touch the target picture yielded significant main effects of age, $F(1, 44) = 202.43$, $p < .01$, and target, $F(1, 44) = 6.65$, $p < .02$, with no interaction. The adults located the targets significantly faster than the children did. Further, both age groups detected coiled objects more rapidly than flowers.

For the snakes versus coiled stimuli conditions, a second ANOVA on the latency to touch the target yielded a significant main effect of age, $F(1, 44) = 102.20$, $p < .01$, but no effect of stimulus condition, $F(1, 44) = 1.85$, *ns*, and no interaction. As usual, the adults detected the targets significantly faster than the children did. Most importantly, neither the adults nor the children detected the snakes significantly more rapidly than the coiled objects.

Thus, the results of Experiment 4 demonstrate that coiled objects are detected more rapidly than flowers, with no difference between the detection of coiled wires and coiled snakes. Together, these results suggest that coiling is a crucial factor in the rapid detection of snakes. Although a null result was obtained in these experiments, it is meaningful in the context of our predictions: If snakes' coiled body shape is the effective stimulus in their rapid detection, then the snakes should have been detected more quickly than the coiled stimuli. However, despite the fact that past research has continually found an advantage for the visual detection of snakes, this advantage was not found when snakes were compared to stimuli that were also coiled, such as ropes, wires, and hoses. Thus, these findings suggest that the unique shape of snakes is critical to their rapid detection by both adults and children.

EXPERIMENT 5: MORE ON SHAPE

Two follow-up studies support the results of Experiment 4. They will be discussed here only briefly, as they both produced null results. Another way to examine the role of a snake's coiled shape in detection is to eliminate coiling altogether. In both experiments, we eliminated coiling by using noncoiled snake stimuli. In Experiment 5a, detection of snakes in a noncoiled position was compared to the detection of flowers. In Experiment 5b, photographs of the faces of snakes versus the faces of frogs were examined. Again, if the ability of snakes to coil themselves is the effective stimulus in their rapid detection, there should be no difference in the detection of snake versus frog faces, or noncoiled snakes versus flowers. As predicted, both experiments produced null results, providing further evidence that without a snake's coiled body, they are not detected particularly quickly.

Experiment 5a: Noncoiled snakes versus flower

In Experiment 5a, participants were asked to detect a single noncoiled snake among eight flowers (the same ones used in LoBue & DeLoache, 2008), or the reverse. The participants were 24 3-year-old children ($M = 39.8$ months, range = 36.0–46.5 months) and their accompanying parent, with equal numbers of boys and girls. All but one parent was female.

An ANOVA on the latency to touch the target yielded a significant main effect of age, $F(1, 44) = 78.83$, $p < .01$, but no effect of stimulus condition, $F(1, 44) = 0.89$, *ns*, and no interaction. As usual, the adults detected the targets significantly faster than the children did. However, neither the adults nor the children detected the elongated snakes significantly more rapidly than the flowers. These results support and strengthen the results of Experiment 4: When snakes were presented in a noncoiled position, they were not detected more quickly than flowers.

Experiment 5b: Snake versus frog faces

In a second follow-up to Experiment 4, snakes' bodies were removed from the stimuli in order to further probe the importance of coiling in eliciting a detection advantage for snakes. In Experiment 5b, photographs of the faces of snakes versus the faces of frogs were examined. Again, if the ability of snakes to coil themselves is the effective stimulus in their rapid detection, there should be no difference in the detection of snake versus frog faces. The participants were 24 3-year-old children ($M = 41.0$ months, range = 36.8–47.9 months) and their accompanying parent, with equal numbers of boys and girls. All but four parents were female.

An ANOVA on the latency to touch the target yielded a significant main effect of age, $F(1, 44) = 62.60$, $p < .01$, but no effect of stimulus condition, $F(1, 44) = 0.12$, *ns*, and no interaction. As usual, the adults detected the targets significantly faster than the children did. Most importantly, neither the adults nor the children detected the snake faces significantly more rapidly than the frog faces. These results again support and strengthen the results of Experiments 4 and 5a: When only snakes' faces were presented without their coiled bodies, they were not detected more quickly than frogs.

GENERAL DISCUSSION

The research presented here examines the specific properties that account for humans' rapid detection of snakes. Experiments 1 and 2 examined the role of the stimulus background and of the distractor stimuli, and demonstrated that these features are not responsible for the rapid detection of snakes. Experiments 3–5 examined two features of snakes themselves that could drive the effects reported in the literature—their brightly coloured skin and their ability to coil their elongated bodies. The results suggest that it is not snakes' brightly coloured skin that attracts the human visual system, as they are detected more rapidly than frogs even when depicted in black and white. Experiment 4 suggests that rather than its bright colour, it is a snake's coiled body shape that leads to their rapid detection: Although LoBue and DeLoache (2008) demonstrated that snakes are detected more rapidly than flowers, Experiment 4 demonstrated that coiled wires are also detected more quickly than flowers, with no differences between the detection of snakes and coiled wires. The two follow-up studies support this finding.

Taken together, these results suggest that snakes' coiled body shapes play an important role in their rapid detection. These results are not surprising when considering the universality of the colour versus shape of snakes. Although many snakes are brightly coloured, many are not. However, all snakes share the feature of an elongated, legless body shape that affords coiling. Further, as mentioned earlier, past research has shown that a curved target among rectilinear stimuli visually "pops out" more than a rectilinear target among curves (Treisman & Gormican, 1988). Thus, the current findings are consistent with previous work.

This research thus demonstrates that snake-like shapes are detected particularly quickly regardless of whether these shapes are presented within the context or category of a snake. One question that remains involves the mechanism that drives the rapid detection of these snake-like shapes. There are two possibilities. As mentioned previously, one possibility is that as we learn about the threatening nature of snakes, we learn to detect their features particularly quickly. Support for this idea comes from previous research that shows that both children and adults detect other categories of threatening stimuli such as spiders and threatening faces (LoBue, 2009, 2010) particularly quickly as well. As humans learn about the threatening nature of any stimulus, it is possible that they learn to be wary of them in visual attention. However, it is unlikely that the 3-year-olds examined here have had enough experience with snakes to be knowledgeable about their threatening nature. Further, 8-month-old infants who have certainly not had experience with snakes have also been shown to quickly detect them (LoBue & DeLoache, 2009).

An alternative possibility that is supported by the current research is that humans have low-level biases for shapes that resemble snakes. Many have suggested that such a bias has evolutionary origins (Isbell, 2006). Ohman et al. (2001), for example, argued that since snakes constituted a recurrent and widespread threat for humans throughout evolutionary history, there would have a reproductive advantage for humans who responded to snakes very quickly. They go on to suggest that detection of snakes should be preattentive or automatic—without conscious, effortful processing. To support this claim, they found that the speed of detecting a snake or spider was not affected by the number of distractors in a matrix: Latencies for detecting a snake or spider did not differ for 2×2 versus 3×3 matrices. In contrast, the speed of detecting neutral stimuli (flowers or mushrooms) was significantly slowed by the presence of more distractors. Further, they found that the position of the target in a matrix did not affect detection of snakes or spiders, whereas flower or mushroom targets were located more rapidly when they appeared in the middle row.

Other researchers have failed to replicate Ohman et al.'s (2001) findings with respect to automaticity (Batty, Cave, & Pauli, 2005; Cave & Batty, 2006). Thus, it is also possible that humans have low-level perceptual biases for snake-like shapes, but these biases are not automatic, and not necessarily related to any sort of threat response. In other words, there may be other, still unknown, reasons for why curvy shapes are detected particularly quickly, and these reasons may have nothing to do with snakes. Unfortunately, although we can further examine whether the perceptual features of threatening stimuli are privileged in perception, the evolutionary question cannot be examined directly in future work.

Although our data suggest that low-level features of threatening stimuli could underlie the advantage in threat detection, cognition (knowing that a stimulus is threatening) and emotion (being afraid of the threatening stimuli) still may contribute to their rapid detection. Fear, for example, has been shown to can enhance visual detection of threat. Ohman et al. (2001) found that participants with snake and spider phobia detect the object of their fear more quickly than nonphobic participants. Participants who are afraid of snakes and spiders may be more motivated to detect these targets than nonphobic participants, or they may have more practice being vigilant of snakes and spiders (Cave & Batty, 2006). Future research examining the interacting role of low-level perceptual features, emotion, and cognition in threat detection would be an important next step to further investigating these important questions.

The current research also presents important findings regarding snakes' ability to both attract attention and distract from nonthreatening targets. Experiment 2 demonstrates that both children and adults detect snakes more quickly than frogs, even when presented with the same distractor stimuli. This experiment provides very strong evidence for a perceptual bias for the detection of snakes: With identical distractor stimuli across conditions, snakes are still detected more quickly than nonthreat-relevant stimuli by both preschool children and adults. Further, this experiment provides definitive evidence that previous visual search results discussed previously were obtained because snakes attract attention and not merely because they distract from nonsnake targets.

In conclusion, the current set of experiments suggest that the rapid detection of snakes is likely driven by some low-level stimulus features of snakes, revealing that the elongated body shape common to snakes is a crucial factor for detecting the presence of an immobile snake. Further, these experiments confirm that children and adults share the propensity for the particularly rapid visual detection of snakes, regardless of the presence of specific external distractor stimuli.

REFERENCES

Batty, M. J., Cave, K. R., & Pauli, P. (2005). Abstract stimuli associated with threat through conditioning cannot be detected preattentively. *Emotion*, *5*, 418–430.

Blanchette, I. (2006). Snakes, spiders, guns, and syringes: How specific are evolutionary constraints on the detection of threatening stimuli? *Quarterly Journal of Experimental Psychology*, *59*, 1484–1504.

Brattstrom, B. H. (1955). The coral snake "mimic" problem and protective coloration. *Evolution*, *9*, 217–219.

Brosch, T., & Sharma, D. (2005). The role of fear-relevant stimuli in visual search: A comparison of phylogenetic and ontogenetic stimuli. *Emotion*, *5*, 360–364.

Cave, K. R., & Batty, M. J. (2006). From searching for features to searching for threat: Drawing the boundary between preattentive and attentive vision. *Visual Cognition*, *14*, 629–646.

Flykt, A. (2005). Visual search with biological threat stimuli: Accuracy, reactions times, and heart rate changes. *Emotion*, *5*, 349–353.

Isbell, L. (2006). Snakes as agents of evolutionary change in primate brains. *Journal of Human Evolution*, *51*, 1–35.

Lipp, O., Derakshan, N., Waters, A. M., & Logies, S. (2004). Snakes and cats in the flower bed: Fast detection is not specific to pictures of fear-relevant animals. *Emotion*, *4*, 233–250.

LoBue, V. (2009). More than just a face in the crowd: Detection of emotional facial expressions in young children and adults. *Developmental Science*, *12*, 305–313.

LoBue, V. (2010). And along came a spider: Superior detection of spiders in children and adults. *Journal of Experimental Child Psychology, 107*, 59–66.

LoBue, V., & DeLoache, J. S. (2008). Detecting the snake in the grass: Attention to fear-relevant stimuli by adults and young children. *Psychological Science*, *19*, 284–289.

LoBue, V., & DeLoache, J. S. (2010). Superior detection of threat-relevant stimuli in infancy. *Developmental Science*, *13*, 221–228.

Ohman, A. (1993). Fear and anxiety as emotional phenomena: Clinical phenomenology, evolutionary perspectives, and information-processing mechanisms. In M. Lewis & J. Haviland (Eds.), *Handbook of emotions* (pp. 511–536). New York, NY: Guilford Press.

Ohman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General*, *130*, 466–478.

Ohman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review*, *108*, 483–522.

Ohman, 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.

Treisman, A., & Gormican, S. (1988). Feature analysis in early vision: Evidence from search asymmetries. *Psychological Review*, *95*, 15–48.

Waters, A. M., Lipp, O. V., & Spence, S. H. (2004). Attentional bias toward fear-related stimuli: An investigation with nonselected children and adults and children with anxiety disorders. *Journal of Experimental Child Psychology*, *89*, 320–337.

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