aps ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

Current Directions in Psychological Science
19(6) 375-379

DOI: 10.1177/0963721410388801
http://cdps.sagepub.com
SAGE

Threat Perception Across the Life Span: Evidence for Multiple Converging Pathways

Vanessa LoBue[1], David H. Rakison[2], and Judy S. DeLoache[3]
[1] Rutgers University, [2] Carnegie Mellon University, and [3] University of Virginia

Abstract
Snakes and spiders are the objects of two of the most common fears and phobias throughout the world. In the lab, researchers have documented two interesting phenomena in adult humans and nonhuman primates: A propensity for the rapid association of snakes and spiders with fear, and a propensity for the rapid detection of these threatening stimuli. Here, we describe these perceptual biases for threat and highlight new work supporting their existence in infants and young children.

Keywords
threat perception, detection, snakes, spiders, fear

Snakes and spiders are potent symbols of evil and fear—from the evil serpent in the Garden of Eden to modern-day movies like *Arachnophobia* and *Snakes on a Plane*. Part of the reason that these depictions are so powerful is the fact that snakes and spiders are two of the most common objects of human fears and phobias throughout the world, even in highly industrialized countries in which direct contact with these animals is relatively rare. Why, then, are we so afraid of them? One prominent theory is that because snakes and spiders constituted a significant threat to humans and other mammals throughout evolution, there would have been a reproductive advantage to learn to fear them very quickly (Seligman, 1971).

Consistent with this view, two robust phenomena have been observed in the laboratory. First, both humans and monkeys learn to fear snakes and spiders more readily than they learn to fear neutral stimuli; second, human adults and monkeys visually detect snakes and spiders more rapidly than a variety of other stimuli (Öhman & Mineka, 2001, 2003). To explain these and related phenomena, Öhman and Mineka (2001, 2003) proposed the existence of an evolved fear module, a specialized neural system that is activated automatically by certain types of stimuli that posed recurrent threats to survival throughout primate evolution and results ultimately in a defensive response (e.g., fear). We propose a more conservative view, that humans possess low-level visual biases for the perception of evolutionarily relevant threats that function only to draw attention to important stimuli in the environment. Our view and the modular view are not mutually exclusive. However, our view is more conservative from previous formulations because, among other things, we do not describe any specialized neural circuitry to explain the studied behaviors. Although others have proposed that the amygdala plays a role in threat perception (Öhman & Mineka, 2001, 2003), the available developmental evidence on this issue is insufficient for us to make such claims.

Similar perceptual biases have been described in various domains of infant development. For example, researchers have proposed that infants have perceptual biases that draw their attention to human speech sounds (Vouloumanos & Werker, 2007) and to configurations that resemble human faces (Macchi Cassia, Turati, & Simion, 2004). In the same vein, we propose that humans have a perceptual bias for the rapid detection of evolutionarily relevant threats and a bias for the rapid association of these threats with fear. It is unclear at this point whether they are distinct biases or manifestations of a single underlying perceptual bias.

We first briefly describe the original research with human adults and nonhuman primates supporting the existence of these biases. Then we highlight new research from our laboratories examining these biases from a developmental perspective in infants and young children. Finally, we propose that there are multiple converging pathways by which humans can quickly detect threat: (a) perceptual biases for evolutionary

Corresponding Author:
Vanessa LoBue, Rutgers University, Department of Psychology, 101 Warren Street, Newark, NJ, 07102
E-mail: vlobue@psychology.rutgers.edu

threats and (b) the ability to learn to detect threats that are environmentally specific.

Biases for Threat Perception in Human Adults and Monkeys

Several studies have shown that both humans and monkeys more readily associate fear with evolutionarily threatening stimuli than with nonthreatening displays (for a review, see Öhman & Mineka, 2001, 2003). For example, when human adults are conditioned to associate an electric shock with photographs of either snakes and spiders or with flowers and mushrooms, extinction takes longer for snakes and spiders. The same effects have been documented for other evolutionarily relevant stimuli such as threatening facial expressions, such as angry faces (Öhman & Mineka, 2001). Similarly, lab-reared rhesus monkeys are quickly conditioned to fear snakes after watching a wild-reared conspecific react fearfully toward one. This conditioning is selective: Monkeys do not learn the same fear responses with respect to flowers or rabbits (Öhman & Mineka, 2001, 2003). This research provides especially strong support for a bias to readily associate snakes with fear, as these rhesus monkeys had no prior exposure to snakes.

Humans and monkeys are also faster at detecting threatening stimuli than neutral stimuli. In a standard visual search paradigm, human adults are faster to detect snakes and spiders than other stimuli (Öhman, Flykt, & Esteves, 2001), and they are faster to detect angry faces than happy and neutral ones (e.g., Öhman, Lundqvist, & Esteves, 2001). Japanese monkeys behave similarly: They more rapidly detect a single snake than a single flower on a computer display (Shibasaki & Kawai, 2009).

Biases for Threat Perception in Infants and Young Children

Although this seminal work with human adults was the first to document these interesting phenomena, it is limited in that human adults have years of experience with and knowledge about threat-relevant stimuli. If humans have perceptual biases for threat, these biases should be present across ages and varying levels of experience. Thus, research with infants and young children could provide particularly strong tests for perceptual biases for threat, as children have little to no experience with the relevant stimuli. Additionally, investigating these phenomena from infancy to adulthood can allow us to examine the role of experience and learning in their development and to ask how they may lead to the most common phobias that we experience today.

Infants associate threat with fear

We propose that infants—most of whom have no experience with threatening stimuli—readily associate specific threats with fear. In an experiment employing an audio-visual matching procedure (DeLoache & LoBue, 2009), 7- to 9-month-old and 14- to 16-month-old infants watched two videos simultaneously—one of a snake and one of a nonsnake (elephant, giraffe, hippo, etc.)—while listening to either a happy voice or a fearful voice. Infants looked longer at the snake videos when listening to fearful voices than when listening to happy voices. There was no differential responding to nonsnakes as a function of the auditory stimuli. It is important to note that these infants demonstrated no signs of fear, as they did not cry or show distress—they merely made a perceptual match between seeing a snake and hearing a fearful voice.

Rakison (2009) has also shown that infants associate threatening stimuli like snakes and spiders with fearful *faces*. Infants at 11 months of age were habituated to photographs of a recurrent threat (snake or spider) paired side by side with a facial emoticon (a fearful or happy face) and then tested to see if they had learned this association by being presented with a novel exemplar (e.g., a snake if habituated to snakes) along with a different facial emotion (e.g., a happy face if habituated to a fearful face). Infants' pattern of looking revealed that 11-month-old girls—but not boys of the same age—associated recurrent threats with fearful faces. However, there was no such difference for learning about nonthreatening stimuli (e.g., mushrooms or flowers) or for learning associations between happy faces and recurrent threats. These data suggest that infants (at least females) associate the occurrence of a threatening stimulus with a fearful face.

Infants and young children rapidly detect threat

We also propose that, like human adults and monkeys, infants and young children quickly detect the presence of threat. In a modified visual search procedure, LoBue and DeLoache (2008) presented 3-year-olds and adults with 3-by-3 matrices of photographs, each containing eight photographs from a particular category and one photograph from a different target category. The participants were instructed to find and touch the target photograph on the screen. Both the children and adults detected snakes more quickly than flowers and detected snakes more quickly than other animals that closely resemble snakes, such as frogs and caterpillars. The same result was obtained with other categories of threat-relevant stimuli—spiders (LoBue, 2010a) and angry faces (LoBue, 2009). Importantly, there were no differences in detection among participants who were afraid of snakes and spiders and those who were not.

Analogous results have been reported for infants. When presented with pairs of images, one snake and one flower or one happy face and one angry face, 8- to 14-month-old infants turned more quickly to look at threatening stimuli (snakes and angry faces) than at nonthreatening stimuli (flowers and happy faces; LoBue & DeLoache, 2010).

Infants' perceptual template for threat

Rakison and Derringer (2008) suggest that one of the factors that contribute to the rapid visual detection of threat is that infants have a perceptual template that gives preference to

stimuli that have the basic configuration of threatening stimuli. This template incorporates a low-level schematic of the basic features and form of the recurrent threat; for example, a spider perceptual template is a central body with curvilinear features extending from it, and a snake perceptual template is a continuous curvilinear contour that has a larger mass at one end. Rakison and Derringer (2008) suggest that this perceptual template is present at birth or shortly thereafter, though they are cautious to make claims about its neural basis because of the lack of research on this issue. This suggestion is akin to the proposal that there is a perceptual template for face recognition that results in infants' longer visual tracking of schematic human faces than of scrambled stimuli (e.g., Johnson & Morton, 1991). Analogous results have been found with threatening stimuli: 5-month-old infants look longer at schematic drawings of snakes and spiders than they do at scrambled versions of the same stimuli. By comparison, infants do not show a preference for schematic pictures of neutral stimuli, like flowers (Rakison, 2010; Rakison & Derringer, 2008).

Together, the results discussed so far indicate that, like human adults and nonhuman primates, infants and young children demonstrate perceptual biases relevant to the visual detection of evolutionarily relevant threats. This research is the first to demonstrate that infants readily associate the occurrence of threat with both fearful voices and fearful faces and that infants, children, and adults all have the propensity to detect quickly the presence of various categories of threat, including snakes, spiders, and angry faces.

The Role of Learning in Threat Perception

Learning to be afraid

In the current research, we have observed two biases for threat perception in the absence of any observable fearful or defensive response on the part of our participants. For example, while infants associated fear-relevant stimuli with snakes and spiders, they did not demonstrate any sort of behavioral fearful response themselves, they were simply making a perceptual match. Thus, this associative bias functions to bring together fear-relevant stimuli and threat with great ease. However, to develop an actual fear of snakes or of spiders, learning is required. As previous research has demonstrated, monkeys do not have an innate fear of snakes but instead learn this fear through observation (Öhman & Mineka, 2001, 2003). However, because they have a perceptual bias to match the occurrence of a snake with fear, they more readily learn to fear snakes than other stimuli, such as flowers and rabbits. Thus, learning, via observation or conditioning, plays a vital role in the development of actual fears and phobias. Perceptual biases facilitate this learning.

In the same way, fear is not required for the rapid visual detection of snakes and spiders: Snakes, spiders, and angry faces are detected particularly quickly regardless of whether or not participants are afraid of them. However, learning to be afraid of snakes and spiders can enhance visual detection of these stimuli. For example, individuals with snake and spider phobias detect the object of their phobias more quickly than nonphobic participants do (Öhman, Flykt et al., 2001), and individuals with social anxiety detect angry faces even more quickly than do those without such fears (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). Thus, intense fears can tune up the biases for threat that we already have.

Learning to detect modern threats

Although there are various studies that show that adults detect snakes and spiders particularly quickly, adults have been shown to detect modern threats, like guns, knives, and syringes, particularly quickly as well (e.g., Blanchette, 2006). This result could be problematic for the idea that humans possess a bias for the detection of evolutionarily relevant threats, because adults could not possibly have evolved a bias for modern-day threats. Alternatively, there may be multiple pathways by which humans detect threat: We may have a bias to rapidly detect evolutionarily relevant threats *and* the ability to learn to quickly detect other types of threat-relevant stimuli (Blanchette, 2006). We suggest that the former reflects evolutionary biases for the detection of ancient threats whereas the latter occurs through all-purpose learning mechanisms such as association and conditioning.

Although it is impossible to account fully for individual differences in experience, research with infants and young children can be valuable in clarifying this issue because they have far less experience with threatening stimuli than do adults. It is not ethical to give children negative experiences with threatening stimuli like guns and knives in an experimental context, but most children will already have had negative experiences with other threatening stimuli such as syringes. LoBue (2010b) examined the detection of two categories of modern threatening stimuli—syringes and knives—with which children were familiar. Every participant in this research was reported to have had experience with syringes through painful injections, and most were reported to dislike syringes. In contrast, *none* of the children had ever had a negative experience with knives; each child could identify a knife but none was allowed to handle knives at home or had ever been hurt by a knife. In two visual detection tasks, LoBue (2010b) asked 3-year-olds to detect syringes versus pens and knives versus spoons, using the same photographic stimuli that were used by Blanchette (2006). Although Blanchette found that adults detected both syringes and knives more quickly than neutral comparison stimuli, the children only detected the syringes particularly quickly. These findings suggest that humans may learn to detect threatening stimuli (or possibly any stimuli) particularly quickly as a result of negative experiences.

Together, the research discussed above suggests that learning plays a vital role in threat perception and is required for the development of actual fears and phobias. Further, this research suggests that humans may have multiple pathways by which quickly to detect threat: We first have biases for the rapid

detection of ancient threats like snakes and spiders, and second, we have the flexibility to learn to detect new threats that are specific to our environments.

Directions for Future Research

There are several future directions for this new area of developmental research. One of the most important is to study how these biases for the detection of certain kinds of threat influence behavior. In all of the studies discussed here, the biases examined did not necessarily result in a fearful response or lead to any kind of defensive behavior. Such biases would be useful only if they actually aid humans in surviving threatening encounters. Thus, an important question for future research is whether the ability to detect threat-relevant stimuli particularly quickly means that humans can also *act* more quickly in response to their presence. For example, does the detection of a threatening stimulus lead to more rapid decision making and hence to a higher probability of escape? Similarly, does a bias for the rapid association between threat and fear actually lead to faster fear learning of evolutionary threats in humans? Öhman and his colleagues have found that human adults' associate snakes and spiders with something aversive, but they did not examine fear learning directly. We know that rhesus monkeys very quickly learn to fear snakes after seeing a conspecific respond fearfully to a snake. Presumably the same would be true for humans, but there is no research that actually examines this question directly.

Conclusion

The research reviewed here indicates that some ancient threats are privileged in human perception and that we have perceptual biases that enable us to respond to them very rapidly. Further, this work also demonstrates that humans have the ability to *learn* to respond quickly to specific kinds of threat-relevant stimuli. These findings suggest that visual perception and learning are supported by mechanisms that give priority to processing certain kinds of stimuli. Our recent research with infants and young children who have had little to no experience with or knowledge about evolutionarily relevant threat stimuli provides especially strong support for the existence of perceptual biases for threat very early in life.

Recommended Reading

DeLoache, J., & LoBue, V. (2009). The narrow fellow in the grass: Human infants associate snakes and fear. *Developmental Science, 12,* 201–207. The first evidence that infants are more likely to associate threat with fear-relevant than with neutral stimuli.

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. The first article to report that like adults, children detect the presence of threat particularly quickly in visual attention.

Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review, 108,* 483–522. A comprehensive review of previous research on perceptual biases for threat in human adults and nonhuman primates.

Öhman, A., & Mineka, S. (2003). The malicious serpent: Snakes as a prototypical stimulus for an evolved module of fear. *Current Directions in Psychological Science, 12*, 5–8. A brief review of previous research on perceptual biases for threat in human adults and nonhuman primates.

Rakison, D. H., & Derringer, J. L. (2008). Do infants possess an evolved spider-detection mechanism? *Cognition, 107*, 381–393. The first study to show that infants may have a perceptual template for threat-relevant stimuli.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

References

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M.J., & van Ijzendoorn, M.H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, *133*, 1–24.

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

DeLoache, J., & LoBue, V. (2009). The narrow fellow in the grass: Human infants associate snakes and fear. *Developmental Science*, *12*, 201–207.

Johnson, M.H., & Morton, J. (1991). *Biology and cognitive development: The case of face recognition*. Oxford, England: Blackwell.

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

LoBue, V. (2010b). What's so scary about needles and knives? Examining the role of experience in threat detection. *Cognition and Emotion*, *24*, 80–87.

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.

Macchi Cassia, V., Turati, C., & Simion, F. (2004). Can a nonspecific bias toward top-heavy patterns explain newborns' face preference? *Psychological Science*, *15*, 379–383.

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

Öhman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: An anger superiority effect with schematic faces. *Journal of Personality and Social Psychology*, *80*, 381–396.

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

Öhman, A., & Mineka, S. (2003). The malicious serpent: Snakes as a prototypical stimulus for an evolved fear module. *Current Directions in Psychological Science*, *12*, 5–9.

Rakison, D.H. (2009). Does women's greater fear of snakes and spiders originate in infancy? *Evolution and Human Behavior*, *30*, 438–444.

Rakison, D.H. (2010). *Do infants possess an evolved mechanism for snake detection?* Manuscript submitted for publication.

Rakison, D.H., & Derringer, J.L. (2008). Do infants possess an evolved spider-detection mechanism? *Cognition*, *107*, 381–393.

Seligman, M. (1971). Phobias and preparedness. *Behavior Therapy*, *2*, 307–320.

Shibasaki, M., & Kawai, N. (2009). Rapid detection of snakes by Japanese Monkeys (*Macaca fuscata*): An evolutionarily predisposed visual system. *Journal of Comparative Psychology*, *123*, 131–135.

Vouloumanos, A., & Werker, J.F. (2007). Listening to language at birth: Evidence for a bias for speech in neonates. *Developmental Science*, *10*, 159–171.