Video Article

Measuring Attentional Biases for Threat in Children and Adults

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Abstract

Investigators have long been interested in the human propensity for the rapid detection of threatening stimuli. However, until recently, research in this domain has focused almost exclusively on adult participants, completely ignoring the topic of threat detection over the course of development. One of the biggest reasons for the lack of developmental work in this area is likely the absence of a reliable paradigm that can measure perceptual biases for threat in children. To address this issue, we recently designed a modified visual search paradigm similar to the standard adult paradigm that is appropriate for studying threat detection in preschool-aged participants. Here we describe this new procedure. In the general paradigm, we present participants with matrices of color photographs, and ask them to find and touch a target on the screen. Latency to touch the target is recorded. Using a touch-screen monitor makes the procedure simple and easy, allowing us to collect data in participants ranging from 3 years of age to adults. Thus far, the paradigm has consistently shown that both adults and children detect threatening stimuli (*e.g.,* snakes, spiders, angry/fearful faces) more quickly than neutral stimuli (*e.g.,* flowers, mushrooms, happy/neutral faces). Altogether, this procedure provides an important new tool for researchers interested in studying the development of attentional biases for threat.

Video Link

The video component of this article can be found at https://www.jove.com/video/52190/

Introduction

For decades researchers have been interested in humans' detection of various types of threatening stimuli. In the standard adult detection paradigm used in previous research, participants are generally presented with photographs arranged in 3 × 3 matrices or 2 × 2 matrices. The matrices are comprised of photos from a single stimulus category, or they contain one discrepant image from a second stimulus category. Adult participants are asked to press one button if all of the photos are from the same category, and a second button if there is a discrepant image present. Adults generally detect threatening stimuli including snakes, spiders, and angry faces more quickly than neutral stimuli including flowers, mushrooms, and happy or neutral faces[1,2].

Traditionally, the focus of most threat detection research has been on adult participants. In order to examine how attentional biases for threat develop, LoBue and DeLoache (2008) modified the standard adult visual detection paradigm so that it could be used with children as well[3]. They presented participants with 3 × 3 matrices of images on a touch-screen monitor, each matrix containing a single target among eight distracters. They told participants to find the target as quickly as possible and touch it on the screen. Various studies using the modified touch-screen paradigm have shown results parallel to those reported in previous research with the standard button-press procedure described above: Preschool children (ranging in age from 3 to 5) and adults detect images of snakes faster than images of flowers, frogs, and caterpillars; they detect spiders faster than mushrooms and cockroaches; and they detect angry and fearful facial expressions faster than happy, neutral, and sad faces[3-5].

There are a few important differences between the standard button-press procedure and the new touch-screen procedure that make the touch-screen paradigm easier and child-friendly. In the classic adult procedure, participants are presented with two types of matrices—some that are made up of photographs from a single category, and others that contain an image from a discrepant category. In this paradigm, participants' task is to press one key if they see a discrepant image, and a second key if all of the images in the matrix belong to the same category. In contrast, participants using the touch-screen procedure know that there will be a target in every matrix, and their task is to simply touch it. This makes the touch-screen task easier: Instead of having to detect whether a discrepant image is present *and* remember to press a specific button on a keyboard, participants in the touch-screen paradigm know that a target is present in every matrix, and their only task is to find it and touch it directly on the screen[5]. Further, the touch-screen procedure can be thought of as a forced choice task as opposed to a yes/no task like the standard button-press procedure; using a forced choice task eliminates any potential response bias. The touch-screen methodology can be used with children as young as three, with older children, and with adults. In fact, researchers have even used the touch-screen paradigm to examine threat detection in monkeys, reporting that they too detect a single snake among eight flowers more quickly than a single flower among eight snakes[6].

Here we present a detailed protocol for the child-friendly touch-screen detection paradigm, describing the relevant materials, equipment, procedure, and analyses required to use this procedure with both child and adult participants. We describe previous results using the standard adult button-press procedure and the modified touch-screen procedure within the same participants and discuss similarities and differences between the results for each paradigm. Finally, we discuss practical considerations for using the touch-screen procedure in future research on the study of threat detection.

Protocol

NOTE: The following protocol follows the guidelines of Rutgers University human research ethics committee.

1. Stimuli

1. Use sets of photographs that each belongs to the same category. Choose the number of stimuli that best fits the experimental question; much of the previous work with this procedure used 24 photographs per category;
2. For the study of the detection of social threats, use schematic drawings or photographs of angry faces as the threatening stimuli, such as the adult angry faces found in the NimStim face set[5, 7-9]. Alternatively, use fearful faces[5].
3. For the study of the detection of social threats in children, use adult face stimuli such as the ones described above, or use photographs of *child* angry faces, such as those in the Child Affective Facial Expression set (CAFE)[8, see note below].
   Note: LoBue, V., & Thrasher, C. *The Child Affective Facial Expression (CAFE) Set: Validity and reliability from untrained adults.* (2014).
4. For the study of the detection of threatening animals such as snakes and spiders, use photographs of animals from nature books or websites[3-4,7].
5. Choose a category of neutral comparison stimuli that is well matched to the threatening category. If studying threatening (angry/fearful) faces, use neutral or happy faces as the comparison stimuli. If studying threatening animals (*e.g.*, snakes/spiders), use a perceptually similar non-threatening animal (*e.g.,* frogs/cockroaches)[3-4].
6. Choose the distracter stimuli. Either interchange the targets and distracters (*e.g.,* snake targets among frog distracters, and frog targets among snake distracters), or use a uniform set of distracters for the threatening and non-threatening target conditions (*e.g.,* snake targets among flower distracters, and frog targets among flower distracters).
   NOTE: See Discussion for issues with choosing appropriate distracters.
7. When the stimuli are made up of photographs of faces, use an equal number of male and female faces, and vary the faces for race based on the availability of different races/ethnicities in each set.
8. When the stimuli are made up of photographs of animals or plants, match the categories for color and brightness, or use black and white photographs[3-4,7].

2. Equipment

1. Obtain a computer with a touch-screen monitor for the task. Use a stand-alone touch-screen monitor that connects to standard VGA ports for any PC, or use a tablet PC that functions as an all-in-one computer and touch-screen.
2. Choose the parameters of the study, including matrix size and number of trials.
   NOTE: Previous work has used 9-picture (3 by 3) matrices, or 4-picture (2 by 2) matrices, and 24 trials, but other parameters may be used.
3. Use either a customized program to present the matrices to participants, commercial presentation software such as EPrime, or access the Matrix program designed specifically for this methodology on the author's website.
   NOTE: The Matrix program allows for flexible study parameters. It gives researchers the option to choose matrix size, number of trials, and stimuli. It also randomly arranges the stimuli within each matrix, and presents them in a random order.
4. Arrange the touch-screen monitor/computer at a desk or table with an outline of handprints located on the table in front of the monitor. Use the handprints as a starting point so that the participants' hands are in the same place for the start of each trial.

3. Child Procedure

1. Ensure that vision impaired children are wearing their glasses or contact lenses throughout the procedure. Exclude vision impaired children who do not have a corrective device.
2. Seat participants at arm's length from the base of the touch-screen monitor before beginning the experiment.
3. Instruct children to place their hands on the handprints. Do this between every trial so that the participants' hands are in the same place at the beginning of every trial.
4. Stand alongside the monitor to instruct the participant throughout the procedure.
5. First explain the task to the child: "Are you ready to play a computer game with me? This is a special computer that you can touch! I'm going to show you a bunch of pictures on the screen and ask you to touch some of them. Are you ready?"
6. Next, teach the child participants how to use the touch-screen by giving them several practice trials. On the first practice trial, present participants with a single photograph from the target category, and ask them to touch it on the screen. Use the following language: "This is a (target). Can you touch the (target) on the screen?"
7. On the second practice trial, present participants with a single photograph from the distracter category, and ask them to touch it on the screen. Use the following language: "This is a (distracter). Can you touch the (distracter) on the screen?"
8. On the next three practice trials, present participants with full nine-picture matrices with one target among eight distracters. When the first nine-picture practice matrix appears on the screen, give the following instructions: "When you see the pictures come up on the screen, it's your job to find the (target) and touch it as *fast* as you can. Can you do that? Do you think you can find the (targets) really fast?"
   NOTE: The procedure can be modified for matrices of other sizes, such as 2 × 2, 1 × 1, *etc.*
9. Between each full-matrix trial, design the stimulus presentation program so that a smiley face icon appears. Explain to the child: "It's your job to touch the (targets), and it's my job to touch the smiley face." Reinforce these directions if the child attempts to touch the smiley face between subsequent trials.
10. Use the smiley face between each trial to ensure that the child's full attention is on the screen before the onset of the next trial. When the child's hands are on the handprints and he/she is looking at the screen, press the smiley face icon to continue. Do this between every trial.

11. Touch the smiley face and continue to the second and third practice trials. If the child does not touch the target on the screen, reiterate the instructions: "Remember, your job is to find the (target) as fast as you can and touch it on the screen!"
12. Next, present participants with the test trials.
13. Use a stimulus presentation program that automatically records latency to touch the screen from the onset of each matrix. Present matrices on the screen until the participants touch the target. Do not record latency when the smiley face icon is displayed; use this icon to redirect the child's attention to the screen, and to reiterate instructions if necessary.
14. Identify errors from your latency data. Errors are trials in which participants select one of the distracter stimuli instead of the target. Custom stimulus presentation software should be written so that errors are identified and marked in the output.
15. Calculate average latency to detect the target stimuli for each participant after eliminating errors. Use these data for the statistical analyses.

4. Adult Procedure

1. Ensure that vision impaired adults are wearing their glasses or contact lenses throughout the procedure. Exclude vision impaired adults who do not have a corrective device.
2. Seat participants at arm's length from the base of the touch-screen monitor.
3. Instruct the participant to place his/her hands on the handprints to ensure that the participants' hands are in the same place at the onset of every trial.
4. Stand alongside the monitor to instruct the participant throughout the procedure.
5. In order to teach participants how to use the touch-screen, give them several practice trials. In the first two practice trials, ask participants to touch a single picture from the target category on the screen, followed by a single picture from the distracter category.
6. On the next three practice trials, present participants with full nine-picture matrices with one target amid eight distracters.
7. Instruct participants to find the targets and touch them on the screen as quickly as possible. Then return his/her hands to the handprints. NOTE: The smiley face between each trial is not necessary for adult participants; you can choose whether to use it or eliminate it.
8. If using the smiley faces, instruct participants to touch the smiley face to move on to the next trial.
9. Following practice trials, present participants the test trials, each containing one target and eight distracters.
10. Use a stimulus presentation program that automatically records latency to touch the screen from the onset of each matrix.
11. Identify errors from your latency data, as specified in step 3.13.
12. Calculate average latency to detect the target stimuli for each participant after eliminating errors. Use these data for the statistical analyses.

Representative Results

Statistical Analyses

There are several possible statistical analyses that can be done with data produced by the touch-screen methodology. Use SPSS or other statistical software to analyze the data. The original studies using the touch-screen detection task utilized between-subjects designs where each participant was randomly assigned to one experimental condition[3,5]. If this is the case, investigators should calculate the average latency to detect the target stimuli on all usable trials (as directed in the Protocol). This produces a single data point for each participant. The data can then be entered as the dependent variable in a standard ANOVA with target category as the between-subjects factor.

Alternatively, researchers may choose to use a within-subjects design with participants receiving all of the experimental conditions. In this case, researchers should be careful to counterbalance/randomize the order of tasks, as participants tend to get faster over repeated trials. Researchers can use the same statistical methods described above for the between-subjects design using a repeated measures ANOVA. Alternatively, an advantage of a within-subjects design is that researchers can calculate a bias score, which is generally a difference score that represents a bias for certain kinds of stimuli. For example, a bias score for threatening faces can be calculated by subtracting the average latency to detect angry faces from average latency to detect happy faces[10]. In this case, positive scores indicate a bias for threats, and negative scores indicate a bias for non-threats.

In some cases, researchers might choose to use within-subjects designs where participants complete several experimental conditions in a single testing session. In these cases, researchers might choose to use Mixed Effects ANOVAs to analyze trial-level data instead of analyzing a single averaged data point for each participant. By using every data point instead of a single mean, Mixed Models take into account individual differences in a participants' behavior over the course of many trials, reducing the potential for error[12-14].

Finally, it is worth noting that head-mounted or desk-mounted eye-tracking technology can be used in combination with the touch-screen visual detection paradigm to capture exact fixations as participants search for target stimuli. Eye-tracking produces more than just latency to touch the screen—it also produces data on latency to first fixate the target, total fixations and fixation time to each distracter before first fixating the target, and latency from the first fixation to making a behavioral response[11]. By differentiating between these measures, researchers can disambiguate the potential mechanisms that drive rapid detection. For example, a *perceptual advantage* for target stimuli can be examined by analyzing latency to first fixate target stimuli. If there is a perceptual advantage for some stimuli over others, latency to first fixate those targets should be faster than for other targets. A*utomaticity of search,* or "pop out," can also be measured using an eye-tracker by examining the number of distracters each participant fixates before they reach the target. If search occurs automatically for certain target stimuli, participants should scan fewer distracters before reaching those targets. An eye-tracker can also be used to examine *efficiency of behavioral responding*, measuring latency to touch the screen from the time the participant first fixates the target. If there is an advantage in behavioral responding for certain target stimuli, participants should be faster to make a behavioral response (*e.g.*, touch a target on the screen) after first fixating those targets. Mixed Models can be used to analyze eye-tracking data so that each fixation can be used in the analyses.

Patterns of Detection in Preschool Children and Adults

Previous research using the touch-screen detection paradigm with both child and adult participants has consistently shown that participants of all ages detect threatening stimuli more quickly than non-threatening stimuli. In the original paper using the procedure, the authors examined detection of snakes versus various non-threatening stimuli (flowers, frogs, and caterpillars respectively). In the procedure for Experiment 1, participants either detected a single snake among 8 flowers or a single flower among 8 snakes on each subsequent trial. Participants detected snakes more quickly than flowers, and adults detected all of the stimuli more quickly than children. A second experiment compared snakes to an animal that closely resembles snakes—frogs. Again, participants detected the snakes significantly faster than the frogs, and the adults detected all targets more quickly than children. Finally, a third experiment compared detection of snakes to another animal that is shaped like a snake—caterpillars. Again, both age groups detected snakes more quickly than caterpillars, but the effect was only significant for children[3] (**Figure 1**).

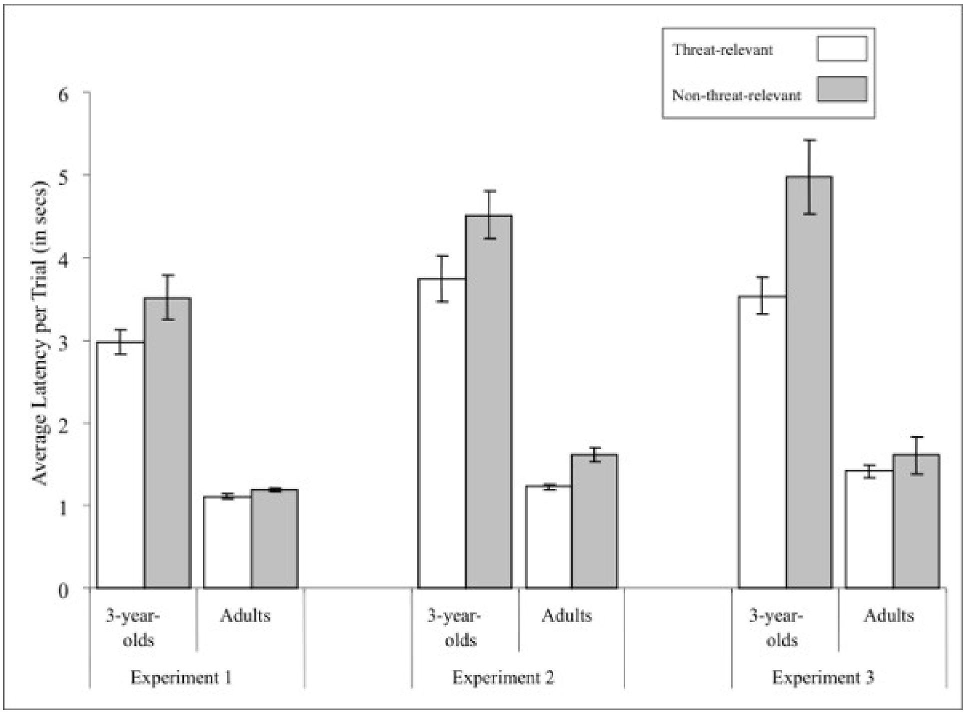

Figure 1 represents the data collected for 3-year-olds and adults in Experiments 1–3, and has been modified from LoBue & DeLoache (2008)[3]. In all three experiments, 3-year-olds detected threatening stimuli (snakes) significantly faster than various non-threatening stimuli (flowers, frogs, and caterpillars respectively). Adults showed the same pattern, but the results were only significant for Experiments 1 and 2 (flowers, frogs). This figure has been modified from LoBue & DeLoache (2008)[3]. Please click here to view a larger version of this figure.

Together, these results show that the touch-screen paradigm demonstrates an advantage for threatening over non-threatening stimuli—the same advantage reported in previous research. Further, the touch-screen paradigm produces the same patterns of responding across multiple age groups including adults and preschool-aged children[3-5].

Comparison Across Paradigms

How do the results produced by the touch-screen procedure compare to results produced by the classic adult button-press detection paradigm? One study recently sought to replicate the button-press[1] and touchscreen[3] methodologies within subjects to compare patterns of responding across these two paradigms[15]. In the study, a group of adults performed both the button-press detection and touch-screen detection tasks exactly, and the results were compared. As expected, in both paradigms, participants detected threatening targets (snakes, spiders) more quickly and accurately (*i.e.*, they made fewer errors) than non-threatening targets (flowers, mushrooms), consistent with previous work using both paradigms. These results show that the touch-screen paradigm indeed produces the same pattern of results as the classic button-press procedure[3-4,15], suggesting that minor differences between the paradigms (stimuli, number of trials, *etc.*) do not change the overall pattern of results with respect to the detection of threatening versus non-threatening stimuli.

Despite these similarities, there was also one important difference in the results worth noting. In the button-press procedure, increasing the matrix size from 4 to 9 photographs slowed detection of non-threatening targets, whereas detection of threatening targets was equally fast regardless of set size. No such interaction was found for the touch-screen paradigm, and detection of threatening and non-threatening targets was slower when increasing the matrix size from 4 to 9 photographs. Further, there was little relationship between responding in one task and responding in the other according to a correlational analysis. Thus, researchers should keep in mind that although the overall pattern of results—faster detection of threatening versus non-threatening stimuli—was the same between paradigms, it is still unclear whether the procedures are measuring the same underlying process[15] (**Figure 2**).

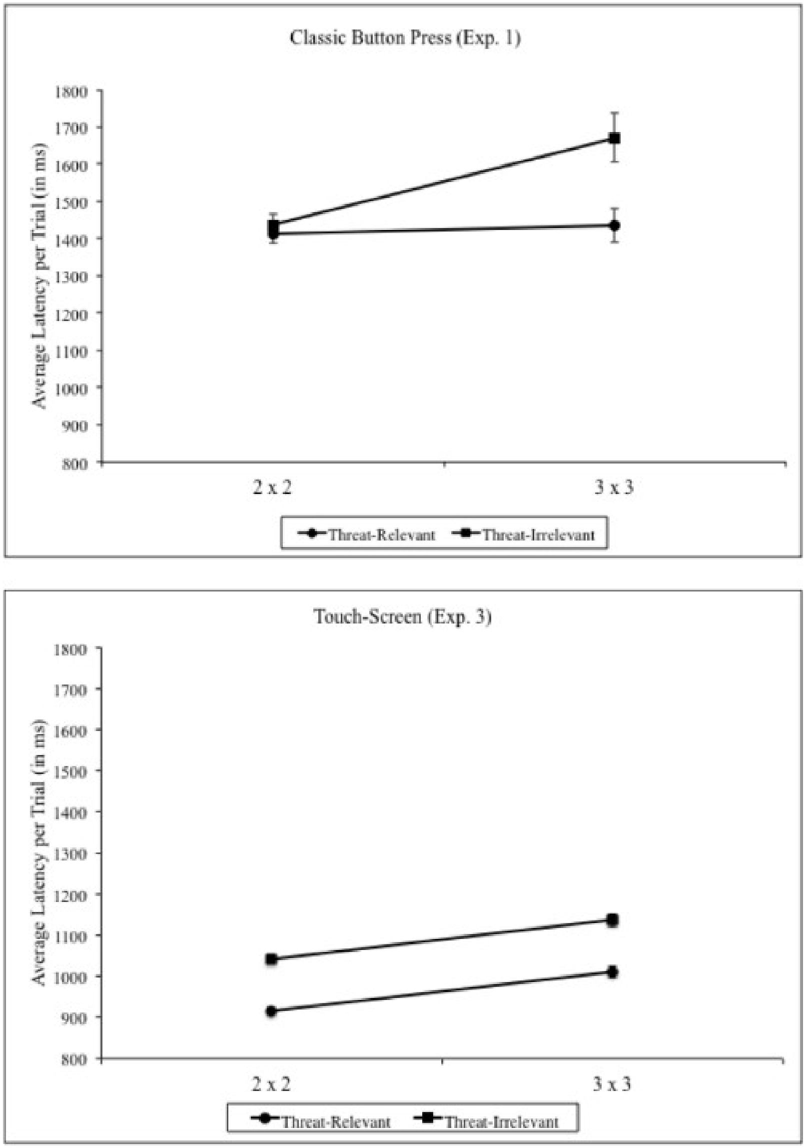

Figure 2 represents the data collected from adults (and has been modified from the figure) in LoBue & Matthews (2014)[15]. It presents average latencies to detect target stimuli in the button-press procedure (Experiment 1), and the touch-screen procedure (Experiment 3). Both procedures produced an advantage for threatening stimuli—snakes and spiders were detected more quickly than flowers and mushrooms. However, there was only a target by set size interaction for the button-press procedure, indicating that detection of threatening stimuli was not affected by number of distracters in each matrix, whereas detection of non-threatening stimuli was faster in 2 × 2 than in 3 × 3 matrices. Such an interaction was not found for the touch-screen procedure, and both types of stimuli were equally affected by increasing the matrix size from 4 to 9 photographs. This figure has been modified from LoBue & Matthews (2014)[15]. Please click here to view a larger version of this figure.

Discussion

Here a detailed protocol for the child-friendly touch-screen detection paradigm is presented, and previous results using the procedure with children and adults are discussed. There are some additional factors that researchers should consider when using the paradigm. First, researchers should think carefully about the experimental set-up, as labeling the targets, the participant's emotional state, and the participant's emotional traits (*e.g.,* phobias, anxiety) have all been shown to affect the results[1,11,15-16]. Further, researchers should take caution in choosing appropriate target stimuli. In much of the research on threat detection with adults, detection of snakes and spiders was compared to detection of flowers and mushrooms[1]. However, since flowers and mushrooms are not animals, the advantage for snakes and spiders reported in these studies might reflect an advantage for animals in general and not threatening animals per se. A handful of studies have shown that animals (regardless of threat-relevance) are detected more quickly than plants[17-19]; comparing snakes and spiders to other animals would rectify this potential issue[3-4]. Similar attention should be paid to choosing appropriate distracter stimuli for visual detection studies as threatening distracters have been shown to slow down participants when they are detecting non-threatening targets[20-26]. Using uniform distracters might help ensure that any differences found in detection can be attributed to the targets[7]. Finally, when choosing both target and distracter stimuli, attention should be paid to perceptual heterogeneity across the stimuli. In other words, photographs should be matched for color, brightness, luminance, *etc.*, as visual search paradigms are particularly sensitive to low-level perceptual differences of the stimuli.

A potential criticism of the touch-screen paradigm is that it requires participants to make physical contact with the target stimuli by touching them on the screen. One could argue that requiring participants to make physical contact with photographs of threatening stimuli might slow responding instead of facilitating it. However, extensive work using the touch-screen paradigm has shown consistently that threatening stimuli are detected (and touched on the screen) more quickly than a variety of non-threatening stimuli, even if the participants are phobic or afraid of the threatening targets[1]. Further, several studies have suggested that the pressing motion required for the touch-screen detection paradigm is indeed in line with *avoidance* responding. More specifically, Cacioppo and colleagues have suggested that the act of pulling towards oneself is generally associated with approaching positive stimuli, while the act of pushing produces feedback in the body that is akin to avoiding negative stimuli. For example, participants who were asked to rate neutral stimuli during an arm flexion task preferred the stimuli more than participants who rated them during an arm extension task[27]. Thus, although the touch-screen procedure requires participants to make physical contact with threatening stimuli, there is no evidence to suggest that making physical contact with these threats slows responding.

One final note is that the touch-screen procedure can now be used in combination with eye tracking technology, which can allow for the potential to uncover the mechanisms that drive rapid threat detection. Some researchers, for example, have suggested that the advantage for threat in visual search paradigms is driven by rapid first fixations to threatening stimuli[28]. Others have reported that these results are driven by the fact that participants make fewer fixations before detecting threatening than non-threatening stimuli[29]. In contrast, other researchers have shown that the advantage for threat in anxious or phobic participants is driven by difficulty disengaging from the object of the participants' fear[30-31]. Finally, there are others who have suggested that the advantage for threat in detection paradigms is due to faster *behavioral responding* (pressing a button or touching a screen) after threatening targets are first fixated. In other words, threatening stimuli might evoke faster action, and not necessarily faster detection[32-33]. Using the touch-screen paradigm in combination with eye-tracking technology can help to clarify this important (and still controversial) issue.

In conclusion, the child-friendly touch-screen paradigm produces results similar to those produced with traditional adult-focused visual detection paradigms. Future research using this paradigm might not only help elucidate the kinds of stimuli that are detected particularly quickly, but it may also help uncover how humans acquire these biases for threat in visual attention.

Disclosures

The authors have nothing to disclose.

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