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Do faces facilitate or distract children from attending to threats?

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Do Faces Facilitate or Distract Children from Attending to Threats?

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Abstract

Threatening stimuli may produce an attentional bias in humans, capturing and holding attention to a greater extent than other types of stimuli. Humans rely on others to alert their attention to threats in their environment, and social stimuli, such as faces, have privileged processing compared to nonsocial stimuli. We wanted to explore whether task-irrelevant fearful or neutral faces facilitate, distract, or have no effect on the detection of threatening or neutral images (spiders and frogs, respectively). Three- to-five-year-old children (*N*=37) completed a visual search task in which they searched for threatening or neutral animals. Consistent with previous literature, we found that participants were slower to detect targets when a face was present, particularly if it was fearful. Interestingly, we found that participants were slower to detect threatening targets than neutral targets. These findings suggest that faces may provide crucial information about the environment that cannot be ignored and therefore, pay particular attention to. This study provides information about how children process fearful and neutral faces in their environments and how these faces may influence their responses to stimuli in their environments.

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Do Faces Facilitate or Distract Children from Attending to Threats?

Many aspects of our environments—including threatening stimuli and human faces—receive prioritized processing (Brosch, 2014). Both of these categories provide socially relevant information that gives context to a situation in which a person is experiencing. With such information, humans are able to decide what their next step is going to be. Because humans live in such a complex world, with sensory systems being constantly overloaded, it is important that the brain is able to prioritize specific stimuli that will help aid in survival and reproduction.

Threatening animals capture and hold attention

Threatening stimuli provide more crucial information about the environment than neutral stimuli (Baumesister, Bratslavsky, Finkenauer & Vohs, 2001). Humans attend longer to threatening stimuli because the outcomes of a situation that include such stimuli may be more harmful than situations with neutral stimuli (Cacioppo & Berntson, 1999; Cacioppo, Gardner, & Bernston, 1997). For example, in studies with adults, threatening (e.g., snakes and spiders) and neutral (e.g., mushrooms and flowers) stimuli were used to determine if an attentional bias to threat exists. The results found that adults detect threatening stimuli more quickly than fear irrelevant stimuli (Blanchette, 2006; LoBue & DeLoache, 2008; Ohman et al., 2001). Similar studies were replicated among children, aged 3 to 5, and found consistent results. Children are faster to identify threatening stimuli than they are to identify neutral stimuli (LoBue & DeLoache, 2008; LoBue & DeLoache 2010). We can conclude from the literature on the topic of attentional bias for threat that humans detect threatening stimuli more quickly than neutral stimuli.

Fearful faces capture and hold attention

Fearful faces may alert us to the fact that there is something to be fearful of in the environment, which would direct attention away from the face (Williams, Moss, Bradshaw, & Mattingley, 2005) but they are ambiguous in that they do not tell us what specifically is potentially threatening (Adams, Gordon, Baird, Ambady, & Kleck, 2003; Whalen, Shin, McInerney, Wright, & Ruach, 2001). Participants orient quickly to fearful faces (Bannerman, Milders, & Sahraie, 2010; Carlson & Mujica-Parodi, 2015) and differential orienting toward fearful faces is seen in electrophysiological studies (Pourtois, Grandjean, Sander, & Vuilleurmier, 2004). On the one hand, previous literature suggests that fearful faces may hold participants' attention, making it difficult to disengage attention from the face, and therefore, increasing reaction time to locate targets (Fox, Lester, Russo, Bowles, Pichler, & Dutton, 2000). On the other hand, fearful faces could alert participants to detecting other threatening stimuli in their environments, resulting in a quicker reaction time to locate targets (Helfinstein, White, Bar-Haim, & Fox, 2008).

Evolution and learning may contribute to threat detection

There are at least two theories as to why threatening stimuli capture attention, and these theories are not mutually exclusive. According to one theory, there is evidence for an evolved system of fear detection in humans that allows for self-defense and survival abilities to be heightened (Ohman & Mineka, 2001). The sooner that a human understands what stimuli are threatening, the more rapidly the individual can learn to avoid such stimuli, thereby increasing the chances for survival (Sato & Kawahara, 2015). Having the ability to quickly detect a threatening stimulus also allows for a quicker escape from a dangerous situation (Hansen & Hansen 1988; Ohman, Flykt, & Esteves, 2001). While the evolutionary theory is prominent in many literature discussions about fear and a proposed fear model, some studies suggest that this may theory may not present the whole story. In studies done with adults, which present both evolutionary relevant threats (e.g, snakes and spiders) and modern threats (e.g., syringes and guns), the results show an overall efficiency for detection of threat but not a consistent effect of evolutionary threats being detected faster than modern threats (Blanchette, 2006; Ohman & Mineka, 2001). Some researchers suggest that the apparent fear module that exists in humans may be flexible to allow evolutionary threatening stimuli to activate fear while also allowing certain stimuli to act as evolutionary relevant stimuli, if they have been consistently experienced (Ohman & Mineka, 2001; Seligman, 1970).

According to another theory, an attentional bias to fear is due to learning and conditioning. Certain cues in the environment may cause humans to change their posture and their course of action because they have learned that the consequence of such cues is threating (Kimble, 1961; Ohman & Mineka, 2001). In one study done in a laboratory setting, monkeys learned to acquire a fear of a snake just by viewing a member of their group acting in a fearful manner to a snake (Cook & Mineka, 1987). In another study, a team of researchers conditioned 8- and 9-year-old children to develop a visual bias for animals after trials pairing animals with fearful faces (Reynolds, Field, & Askew, 2014). Similarly, studies in human infants find that at very young ages, before babies have had direct experiences with threatening animals, they display no signs of fear to these species (LoBue & DeLoache, 2008, 2009; LoBue & Rakison, 2013; LoBue, Buss, Taber-Thomas, & Perez-Edgar, 2017).

Attention to feared stimuli in infants and young children

Of course, it is also possible that there is some combination of evolutionary-preparedness, which primes children to learn more rapidly in cases that are evolutionarily relevant threats, compared to non-threats (Klauer, 1997). One way to test this proposal is through studies with infants and young children. By 7 months of age, infants attend to and perceive differences in Woodward, 2008), and by 6 years of age they begin to understand the *meaning* behind facial expressions, such as fear (Lawrence, Campbell, & Skuse, 2016). Infants have developed a negativity bias by 7 months of age, perhaps to help avoid potentially harmful situations (Vaish, Grossmann, & Woodward, 2008). Also by 7 months of age, infants disengage their attention more slowly from fearful faces compared to happy and neutral faces (Peltola, Leppanen, Maki, & Hietanen, 2009; Peltola, Leppanen, Palokangas, & Hietanen, 2008; Peltola, Leppanen, Vogel-Farley, Hietanen, & Nelson, 2009). Once children reach preschool age (3- to 5-year-olds), children use information from their environment (actions, mood, etc. of others) to better understand emotions and why they occur (Ashiabi, 2000; Dunn & Huges, 1998), as the understanding of emotions becomes useful in every day life (Izard, 1971). LoBue and colleagues conducted multiple studies and found that, like adults, children are also quicker to respond to threatening stimuli than to neutral stimuli (LoBue, 2010; LoBue & DeLoache, 2008; LoBue & DeLoache, 2010). For example, children detect threatening snakes more quickly than neutral frogs and they detect fearful faces more quickly than they detected happy and sad faces (LoBue, 2009; LoBue, & DeLoache, 2008). Infants (4 to 24 months old) also display an attentional bias to snakes and angry faces (LoBue et al., 2017). These studies provide evidence for a mechanism by which humans are able to rapidly detect stimuli that may cause harm (Horstmann, 2007; LoBue et al., 2017; Ohman & Mineka, 2001).

Affective priming: Could fearful faces prime attention to threats in the environment?

How might emotional facial expressions guide one's attention to threatening items in the environment? One popular mechanism used when conducting research on emotional faces is affective priming. Affective priming is defined as the facilitation of a response to targets that have congruent, rather than incongruent valences (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). Previous affective prime studies have shown that emotions play an influential role in subsequent behavior (Fazio, 2001; Aguado, Garcia-Gutierrez, Castaneda & Saugar, 2007; Okubo & Ogawa, 2013; Conte et al, 2018). When presented with a prime—a stimulus that is meant to activate a concept in memory—participants automatically process the stimulus (Parkin, 2008). The results of priming differ in the literature in that there are conclusions which state that if the prime stimulus and target stimulus match in valence, the subsequent processing of the target will be sped up (Klauer, 1997; Conte, Brenna, Ricciardelli, & Turati, 2018) but there are also conclusions which state that negative prime emotions may result in no priming effects or reversed priming, even if trials are congruent (Donges, Kersting, and Suslow, 2012; LeMoult, Yoon and Joormann, 2012). These findings are true for child and adult participants (Conte et al., 2018; Kamio, Wolf, & Fein, 2006; Klein, Kleinherenbrink, Simons, de Gier, Klein, Allart… & Rinck, 2012).

Purpose and Hypothesis

Our study looked at the effect of fearful and neutral faces on the orienting of attention to threatening and neutral targets in 3- to 5-year-old children. This age range was selected due to our belief that 3-year-old children would be able to follow instructions as well as our desire to add to previous literature that has used this age group and found promising results in the area of threat detection (LoBue & DeLoache, 2008). Based on the evidence in the literature, we generally expected the presence of a face to delay the detection of a target because we know that faces capture and hold our attention.

We presented participants with two types of faces. In one condition, the faces were presented simultaneously with the array of objects and target—called the stay on condition. In this case, we expected that fearful faces may have an effect on locating targets compared to neutral faces. The literature suggests a few different possible effects of fearful faces. First, fearful faces may hold participants' attention for a longer time, which would increase reaction time to find the target (Fox, Lester, Russo, Bowles, Pichler, & Dutton, 2000) or they could alert participants to detect other threatening stimuli, resulting in a quicker reaction time (Helfinstein, White, Bar-Haim, & Fox, 2008).

In the other type of face presentation, faces were presented for 100 ms before there was a presentation of an array of objects that included the target stimulus. This condition is referred to as the "prime" condition. We expect that when the prime face and target are congruent (e.g., a fearful face with a threatening target or a neutral face with a neutral target) that participants would be faster to detect the target than if the prime face and target are incongruent (e.g., fearful face with a neutral target or a neutral face with a threatening target).

Method

Participants

The Institutional Review Board at James Madison University approved this study. Parents provided informed consent for their child to participate. Thirty-seven children (18 females) were recruited from the JMU and Harrisonburg communities. The children's ages ranged from 3 to 5 years (*M* = 4 years, *SD* = 10 months). We chose this age group because we know that by this age, children demonstrate attention to threatening stimuli. The task required children to locate particular target pictures, and children of this age can perform this task. Children were 83%

Caucasian/White, 2.8% Black/African American, 2.7% Asian, 5.5% Hispanic, and 5.5% multi-racial. All children tested, excluding one child who did not provide usable data, were included in the analysis.

Materials

Face stimuli were taken from the RADITE database (Conley, Dellarco, Rubien-Thomas, Cohen, Cervera, Tottenham, & Casey, 2018; Tottenham, Tanaka, Leon, McCarry, Nurse, Hare, Marcus… & Nelson, 2009). This database includes Asian, White, and Black faces, as well as male and female faces. We used faces that have fearful and neutral expressions for the face primes. The targets (items to be searched for) included spider and frog photos, which were found using Google Images. All targets were cropped to the same size (2.5 cm × 2.5 cm) while all faces were cropped to the same size (5 x 5 cm).

We created 12-item image arrays, each containing photos of 11 objects and 1 animal target (either a frog or spider). We used heterogeneous images rather than matching items on all low-level features (Hershler & Hochstein, 2005). Once the arrays were created, we used a Saliency Toolbox (Walther & Koch, 2006) to ensure that our effects were not due to low-level salience (i.e., that the faces and targets were not the most salient images within the array; Gluckman & Johnson, 2013). Our saliency analysis revealed that there was no difference in the saliency of the spider ($M = 7.25$, $SD = 2.78$) and the frog ($M = 5.86$, $SD = 3.54$), $t(55) = 1.64$, $p = .107$.

We used a Tobii TX300 Eye Tracker to collect eye movement data.

Procedure

Parents completed questionnaires reporting demographic information about their family, including age of participant, age of parents, occupation of parents, age of any siblings, and race.

Each child sat at a desk in front of a Tobii eye-tracker. We first calibrated each child by instructing the child to look at a cartoon appearing in 9 locations on the screen. Children were then instructed to find a specific target (either spider or frog) and to say aloud when they located the target ("found it!"). Children completed up to 60 trials total, presented in two 30-trial blocks (one with spider targets and one with frog targets), counterbalanced across participants. Within each set of 30 trials, 10 arrays had a neutral face, 10 arrays had a fearful face, and 10 arrays had no face. Each array was presented for a total 8 seconds. Attention getters (i.e., small centrally-presented cartoons with music/sounds) were presented between trials for about 4 seconds. In one third of the trials a face was presented simultaneously within the array (stay on distractor faces; Figure 1). Also prior to one third of the trials, a face was presented for 100 ms (i.e., face primes) in the center of the screen. These face primes disappeared and then the image array (containing no faces) appeared (Figure 2). In the last third of the trials, no face was presented before the presentation of the array (Figure 3). Families were compensated $10 for participating and children received a certificate of appreciation. In total the study took approximately 30 minutes.

Data analysis

Data were extracted using Tobii Studio (Danderyn, Sweden), with the default fixation filter. Areas of interest (AOIs) were drawn around each target, each face, and the entire screen. We analyzed children's eye movements to locate the spider and frog targets, specifically looking at the latency to look to the target from the time the array was first presented on the screen.

Trials were excluded if the child's attention was not on the screen at the beginning of the trial (e.g., they had a reaction time (RT) to the center of the screen that was greater than 0) because RTs to the target would not be accurate; 45% of trials were excluded for this reason.

Trials in the prime face condition were excluded if children did not attend to the face the full time it was presented (68% of trials).

Results

Do faces influence threat detection?

We used a 2 (Target type: spider, frog) × 3 (Face type: stay on faces, prime faces, no face) repeated measures ANOVA to determine the effect of the way the face was presented on target detection (Figure 4). We found a significant main effect of Face type, $F(2, 44) = 4.50$, $p = .017$, $\eta_p^2 = .170$. Follow-up paired-samples t-tests showed that children were faster to respond to targets when there was a prime face present (*M* = 2047 ms, *SD* = 822 ms) than when the face stayed on (*M* = 2862 ms, *SD* = 738 ms), $t(33) = 4.42$, $p < .001$, $d = .76$. They were faster to respond to targets when there was no face (*M* = 2301 ms, *SD* = 757 ms) than when there was a stay on face (*M* = 2814 ms, *SD* = 789ms), $t(35) = 3.57$, $p = .001$, $d = .60$. There was no statistically significant difference in children's responses to target when there was a prime face (*M* = 2047 ms, *SD* = 822ms) compared to a no face (*M* = 2352 ms, *SD* = 747ms), $t(33) = 1.54$, $p = .132$. We also found a significant main effect of target, $F(1, 22) = 11.50$, $p = .003$, $\eta_p^2 = .343$, in which children located frog targets (*M* = 2114 ms, *SD* = 513 ms) faster than the spider targets (*M* = 2877 ms, *SD* = 807 ms).

These main effects were qualified by a significant interaction between face type and target $F(2, 44) = 13.02$, $p < .001$, $\eta_p^2 = .372$. We ran the follow-up analysis to the interaction in two ways, both with paired-samples t tests. First, we examined the effect of face type for each target, then we examined the effect of target for each face type. When looking at the frog targets, we found a main effect of face type, $F(2, 58) = 6.22$, $p = .004$, $\eta_p^2 = .177$. Children were significantly faster to locate the frog when presented with a prime face (*M* = 1742 ms, *SD* = 776 ms) than a stay on face (*M* = 2289 ms, *SD* = 668 ms), *t*(29) = 2.59, *p* = .015, *d* = .47. They also had faster reaction times to the frog target when presented with a prime face (*M* = 1706 ms, *SD* = 789 ms) compared to when no face was present *(M* = 2141 ms, *SD* = 501 ms), *t*(30) = 3.08, *p* = .004, *d* = .55. There was no difference in reaction time to the frog when comparing stay on faces (*M* = 2239 ms, *SD* = 686 ms) and the no face condition (*M* = 2137 ms, *SD* = 514 ms), *t*(33) = 1.34, *p* = .191.

When looking at the spider targets, we found a main effect of face type, *F*(2, 50) = 8.01, *p* = .001, η_p^2 = .243. Children were faster to locate the spider target with prime faces (*M* = 2560 ms, *SD* = 1362 ms) than stay on faces (*M* = 3328 ms, *SD* = 1213 ms), *t*(25) = 2.39, *p* = .025, *d* = .47. They also had faster reaction times when no face was present (*M* = 2922 ms, *SD* = 854 ms) than when presented with a stay on face (*M* = 3420 ms, *SD* = 1194 ms), *t*(31) = 4.08, *p* < .001, *d* = .73. There was not a significant difference in reaction time to the spider target when looking at either a prime face (*M* = 2560 ms, *SD* = 1362 ms) or no face at all (*M* = 2836ms, *SD* = 822 ms), *t*(25) = 1.32, *p* = .198.

We next examined the effect of target type within each face type. When children were presented with prime faces, they were quicker to find the frogs (*M* = 16556 ms, *SD* = 724 ms) than the spiders (*M* = 2673 ms, *SD* = 1358 ms), *t*(22) = 3.425, *p* = .002, *d* = .71. When presented with a stay on face, children were also faster to locate the frog (*M*=2223ms, *SD*=641ms) than the spider (*M* = 3375 ms, *SD* = 1225 ms), *t*(28) = 5.708, *p* < .001, *d* = 1.06. If no face was present, there was not a significant difference in reaction time to either the frog or spider, *t*(28) = .774, *p* = .445.

Do facial expressions influence threat detection? Interaction of face type, emotion, and target type

We conducted a 2 (Face type: prime, stay on) × 2 (Emotion: fear, neutral) × 2 (Target type: spider, frog) repeated measures ANOVA to determine how the face type and emotion affect target detection (Figure 5). There was a significant main effect of emotion, $F(1,10) = 6.52$, $p = .029$, $\eta_p^2 = .395$, in which children's were faster to locate targets when there was a neutral face (*M* = 2336 ms, *SD* = 794 ms) compared to a fearful face (*M* = 2706 ms, *SD* = 953ms). We were able to further examine this in the stay on condition, and found that participants looked longer at the fearful face (*M* = 1174 ms, *SD* = 508 ms) than the neutral face (*M* = 921 ms, *SD* = 429 ms), $t(35) = 4.787$, $p < .001$, $d = .81$. There was also a significant main effect of target type, $F(1,10) = 9.70$, $p = .011$, $\eta_p^2 = .492$, in which children were faster to locate frogs (*M* = 1969 ms, *SD* = 576 ms) than spiders (*M* = 3118 ms, *SD* = 960 ms). There was also a significant main effect of face type, $F(1,10) = 8.07$, $p = .018$, $\eta_p^2 = .447$, in which children were faster to locate targets when presented with a prime face (*M* = 2047 ms, *SD* = 822 ms) than a stay on face (*M* = 2862 ms, *SD* = 738 ms). There was not a significant interaction among emotion, target type, and face type, although it did approach statistical significance, $F(1,10) = 3.77$, $p = .081$, $\eta_p^2 = .274$. There were no other significant effects, $p > .10$.

Discussion

Faces capture human attention (Hershler et al., 2010; Hershler & Hochstein, 2005; Langton, Law, Burton, & Schweinberger, 2008; Simpson, Husband, Yee, Fullerton, & Jakobsen, 2014). This implies that in a visual search task, such as the one used in this study, performance may be hindered when a task-irrelevant (distractor) face is present. Humans generally have a faster response time to threatening stimuli compared to neutral stimuli (Fox et al., 2000; LoBue & DeLoache, 2008; Ohman, Flykt, & Esteves, 2001). Our study aimed to replicate these findings while also determining if there was an effect of emotional faces on finding targets.

Does the presence of a face slow down RT?

We found that children had faster RTs to find the targets when there was no face presented and when prime faces were presented than when the face stayed on during the task. This finding is not surprising, given that we know that faces capture and hold attention, even when task-irrelevant (Devue, Belopolsky, & Theeuwes, 2012; Hodsoll, Viding, & Lavie, 2011). These results support the idea that having a face on the screen during the task slowed the detection of the targets. Additionally, the presence of a face results in differential reaction times to frogs and spiders. One explanation for this finding is that human faces capture attention due to their social and biological significance. In this situation, there may be an adaptive quality to attending to the faces because they are providing the participant with important context cues to what is occurring in the environment (Lavie, Ro, & Russell, 2002). The presence of a face, even when task-irrelevant, and regardless of the emotional information it provides, may have offered critical information for participants when they were looking for evolutionarily threatening stimuli (i.e., spiders); however, this was not the case in our study. The presence of a face slowed the detection of threatening stimuli, possibly because participants may have been attending to the face to get more specific information about their environment.

Does the emotion of the face affect the detection of targets?

We expected that the emotion of the face would have an effect on the RT to find the target based on the face type (e.g., prime or stay on). Although we were not sure of the direction of the effect, we hypothesized different results for the face types. For faces that stay on, we had two competing hypotheses about the effect of the fearful compared to neutral faces, not necessarily dependent on target type. On the one hand, fearful faces may hold attention longer and lead to slower reaction times to locate the target compared to the neutral faces (Fox et al., 2001). On the other hand, fearful faces may have primed participants and sped up reaction time to find the target (Helfinstein et al., 2008).

For prime faces, our hypotheses were based on previous results with affective priming paradigms, which takes into account the valence of the prime as well as the specific target. Affective priming states that reaction time should be facilitated if the prime and target are congruent (e.g., fearful face and threatening target) while reaction time should be hindered when the prime and target are incongruent (e.g., fearful face and neutral target). Although this is often the case for positive stimuli (Conte et al., 2018; Klauer, 1997), prior studies are inconsistent in regard to negative primes (Donges et al., 2012; LeMoult et al., 2012). Our results show that participants were slower to find targets when fearful faces were presented compared to when neutral faces were presented, regardless of the face type (i.e., prime, stay on).

For stay on faces, consistent with previous research, fearful faces appear to hold attention and subsequently slow reaction time to locate the target (Langton et al., 2008). This is supported by our analyses that indicate that participants spent more time looking at the fearful face than the neutral faces in the stay on condition. It is possible that a task-irrelevant fearful face distracts from the task at hand regardless of whether a participant is searching for a threatening or neutral stimulus. To our knowledge, previous studies have not explored the effect of a stay on fearful faces on the detection of threatening and neutral targets. Rather, these studies have focused on how threatening and neutral faces impact the detection of a target; in other words, they have not manipulated the valence of the target itself.

For prime faces, our results seem to suggest that fearful faces slow down RT to find a target, regardless of the specific target. These findings do not support affective priming because we did not find different RTs to locate spiders and frogs depending on the emotional expression of the prime face. Previous studies show that children take longer to process information than adults do (De Sonneville, Verschoor, Njiokiktjien, Op het Veld, Toorenaar, & Vranken, 2002). A study by Conte and colleagues (2018) found that for 5- and 7-year-olds demonstrate affective priming when the prime and target were faces. Older children and longer presentation of the prime (e.g., 200 ms) may be necessary for children to demonstrate affective priming as we see in adults.

Detection of threatening and neutral stimuli

Based on previous studies, we expected that threatening stimuli would be detected more quickly than neutral stimuli (LoBue, 2010; LoBue & DeLoache, 2008, 2010). Perhaps our most surprising finding was that spiders were detected more slowly than frogs when a face was present—prime or stay on, but not in the no face condition—regardless of the emotion of the face. Although we cannot say anything about the impact of the specific features of our targets, we are confident that our results are not due to differences in luminance and contrast of our arrays that contained frogs and spiders. Prior to beginning the study, we used a saliency analysis and found that the frog and spider targets were not the most salient objects in the array, and that their relative salience was not statistically different from each other. These analyses suggest that the differences in saliency are not a contributing factor, but it is possible that other stimuli-related factors could contribute to our finding. Some studies suggest that the shape of stimuli might play a role in the speed of detection of targets (Coelho, Suttiwan, Faiz, Ferreira-Santos, & Zsido, 2019; Vlamings, Goffaux, & Kemner, 2009). Perhaps the basic geometric shape of either the frog or spider lead to the difference in reaction times that we found (Larson, Aronoff, Sarinopoulos & Zhu, 2008; Larson, Aronoff, & Steuer, 2011; Van Strein, Christiaans, Franken, & Huijding, 2016). For example, Van Strein et al. (2016) found that participants were particularly sensitive to the curvilinear features of snakes. Although LoBue (2014) argues that spiders have curvilinear legs, they are not as prevalent as the curvilinear body of snakes Van Strein et al. (2016). We are not aware of previous studies that have examined the holistic shape of frogs and spiders that may influence the detection of these targets. However, given that we did not find this effect when no faces were present, we are not convinced that the shape of the spiders and frogs contribute to our understanding of their detection. This may be an important area to explore further.

Interestingly, we did not find any difference in RT to the frog or spider when there was no face presented. In previous studies, which have found faster reaction times to spiders than frogs, a singular spider was placed among a group of frogs, and vice versa (Lipp & Water, 2007; LoBue & DeLoache, 2008; LoBue & Rakinso, 2013; Tipples, Young, Quinlan, Broks, & Ellis, 2005), whereas, our study placed a spider or frog among heterogenous objects. A few studies have compared RTs to threatening animal and neutral animal stimuli in visual search tasks and found that when placed among flowers and mushrooms (neutral stimuli), there seems to be no difference in reaction times to threatening animals and neutral animals (Lipp, Deraskhan, Waters, & Logies, 2004; Tipples et al., 2005). According to the evolutionary view, this might be due to a general preparedness that exists for the detection of animals (Coelho et al., 2019; Lipp &

Waters, 2007; Shen & Reingold, 2001). These studies may help explain why participants detected frogs and spiders equally quickly.

Limitations and Future Research

One of the biggest limitations of our study, is that we were unable to analyze a large percentage of our trials. We excluded almost half of the trials because the participants was not attending the screen at the start of the trial. It was important to do this, so that we had accurate measures of RT to find the targets. Had we included these trials, we may have artificially decreased the RT to find targets. Additionally, we excluded more than half of the prime face trials because the participants were not attending to the prime face for the full 100 ms. Attending the prime face for the whole time is critical to be able to draw conclusions about its effectiveness. Given that children may need more time to be able to process prime faces, it may also be valuable to present prime faces for longer times to see an effect.

To have a better understanding of the effects of faces on the detection of threatening and neutral stimuli, future studies should explore older participants' responses. Previous literature shows that children recognize fear as early as 7 months of age, but the accuracy of recognition, particularly for negative emotions (i.e., fear), continues to increase with age and is not evident until about 7 years of age (Gao & Maurer, 2009, 2010; Guarnera, Hichy, Cascio, & Carrubba, 2015; Lawrenece, Campbell, & Skuse, 2016). Testing participants who have a more complete understanding of the meaning of fearful faces may help us get a clearer picture of the relationship between facial expressions and the detection of threatening and neutral targets. Additionally, older participants may provide more usable data for analysis

Conclusions

Our results provide valuable information for continuing the exploration of the effect of neutral and fearful faces on the detection of threatening and neutral targets. We found that the presence of a face slows down the detection of targets. More specifically, when a face is present, it slows down the detection of spiders, but not frogs. Interestingly, the absence of a face does not. Additionally, when a face is present, fearful faces slow down the detection of targets. Researchers should continue to explore the reasoning behind why faces have an effect on the detection of targets in order to develop a more cohesive explanation. Further exploration may lead to important discoveries regarding how humans process emotions and what effect that processing may have on our actions that follow.

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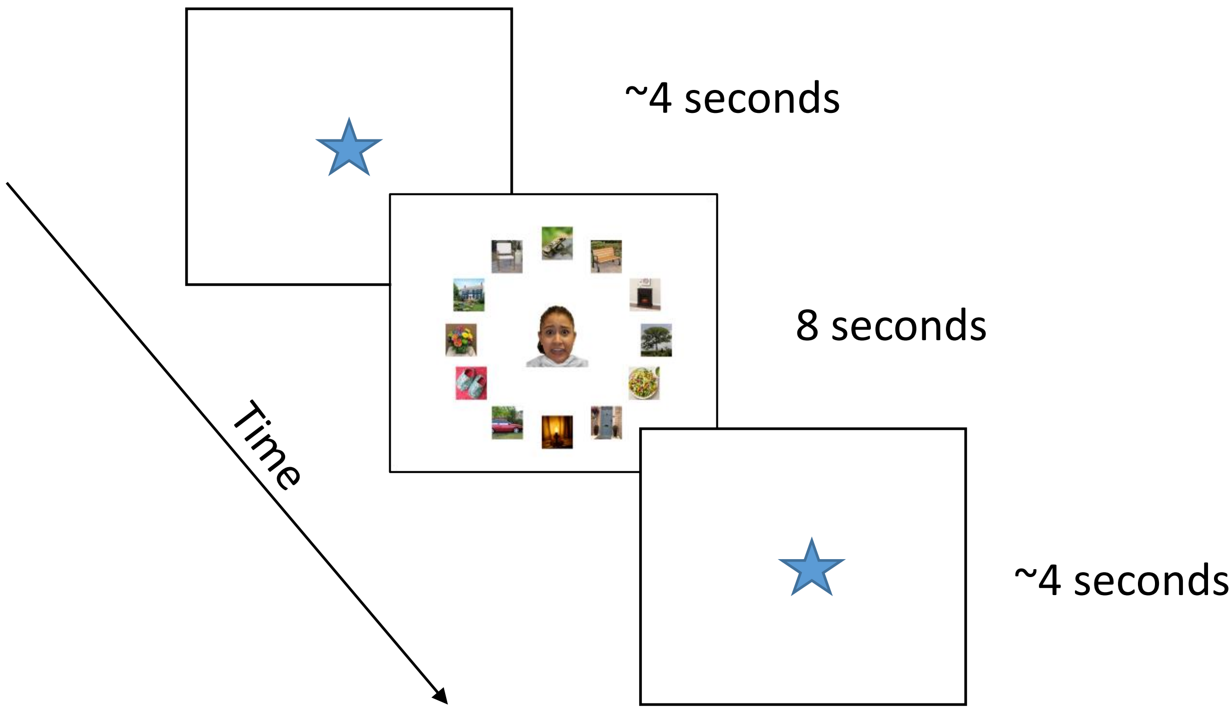
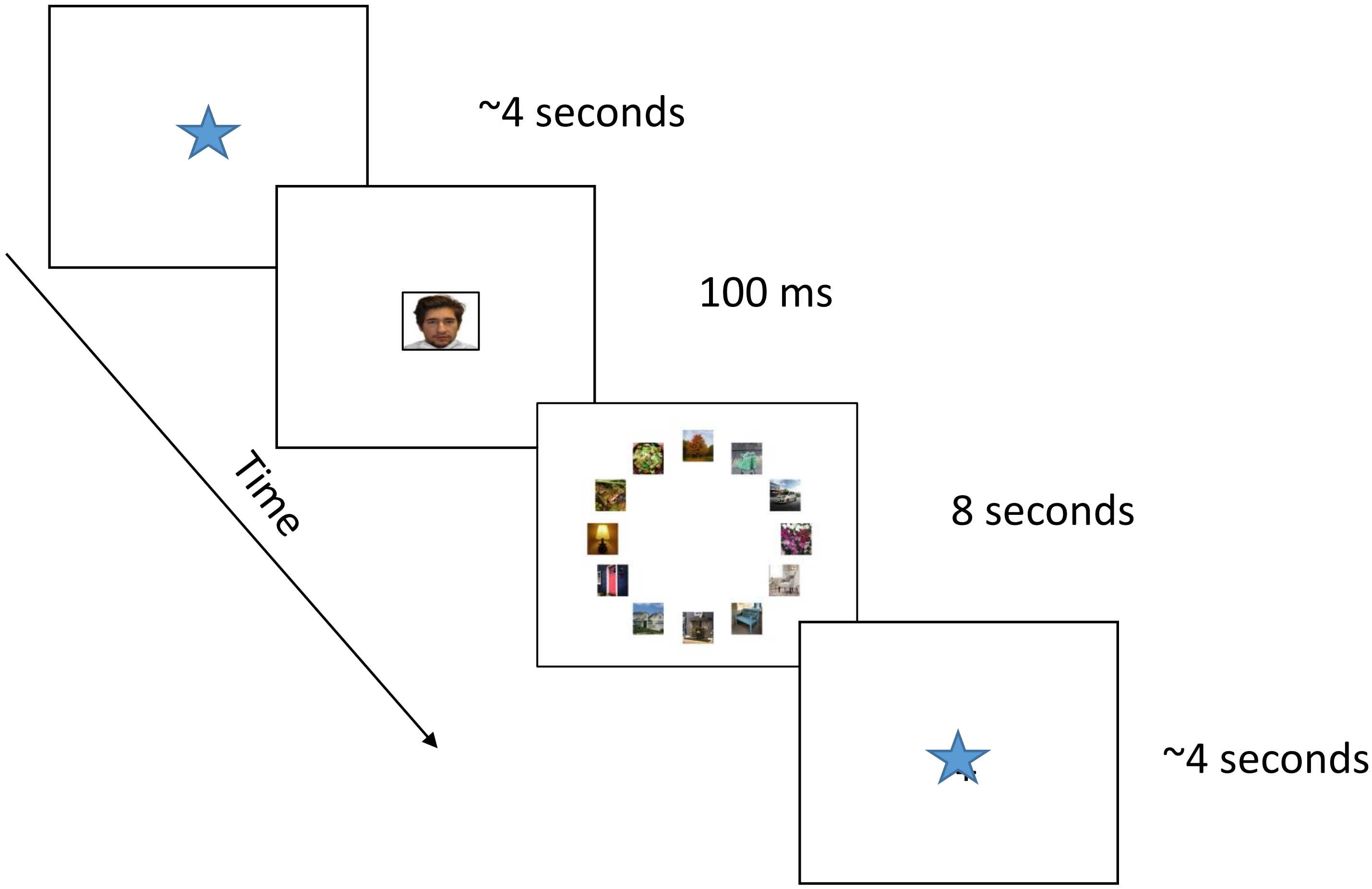
***Figure 1*. Stay on face sequence**



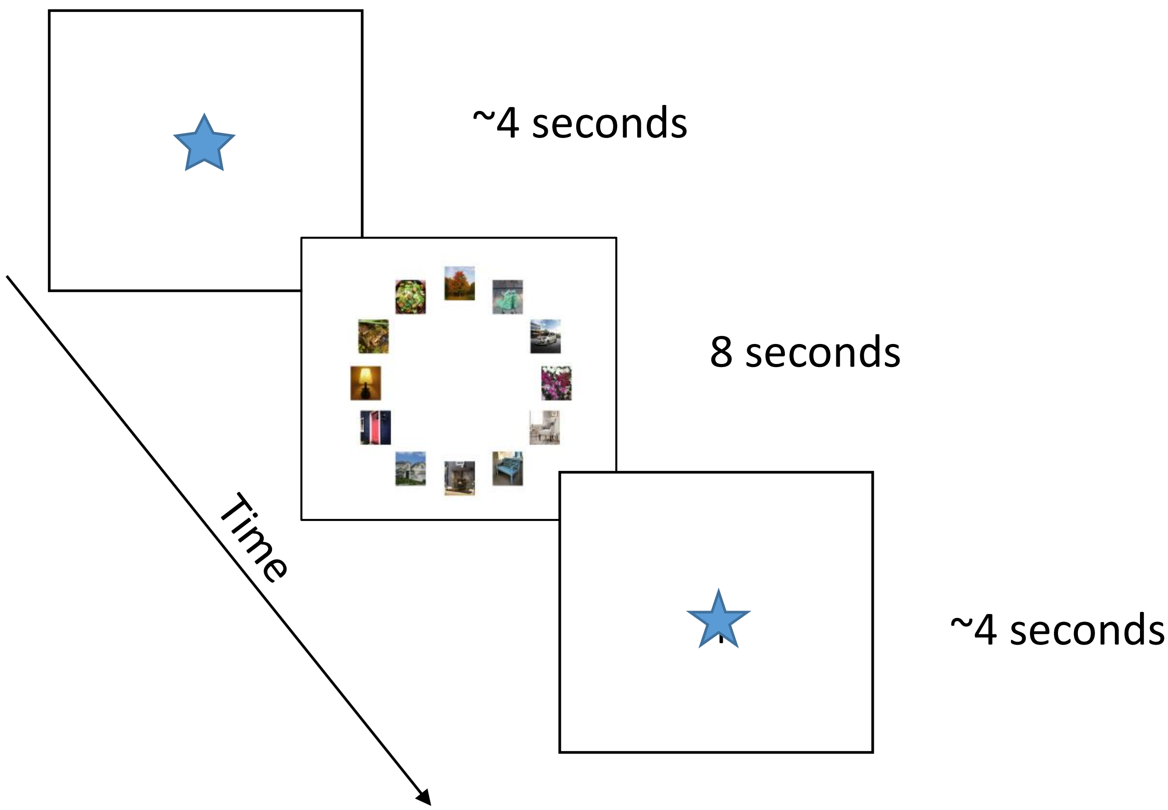
Notes. Participants saw an attention-getter for about 4 seconds, followed by the presentation of a stay on face condition for 8 seconds.

***Figure 2*. Prime face sequence**



Notes. Participants saw an attention-getter for about 4 seconds, followed by the presentation of prime face for 100 ms. Next, the array was presented for 8 seconds.

***Figure 3*. No face sequence**



Notes. Participants saw an attention-getter for about 4 seconds, followed by the presentation of an array for 8 seconds.

***Figure 4*. Exploration of the type of face on target detection**

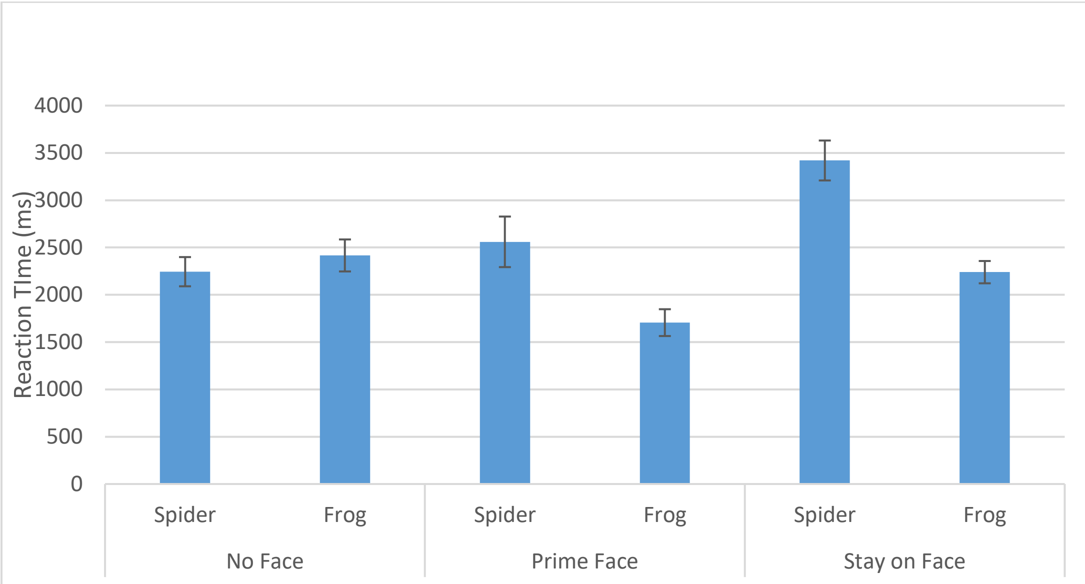


***Figure 5*. Exploration of the type of face and emotion on target detection**