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Fear modulates parental orienting during childhood and adolescence

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Abstract

Adults quickly orient toward sources of danger and deploy fight-or-flight tactics to manage threatening situations. In contrast, infants who cannot implement the safety strategies available to adults and depend heavily on caregivers for survival are more likely to turn toward familiar adults, such as their parents, to help them navigate threatening circumstances. However, work has yet to investigate how readily children and adolescents orient toward their parents in threatening or fearful contexts. The current work addressed this question using a visual search paradigm that included arrays of parents' and strangers' faces as target and distractor stimuli, preceded by a fear or neutral emotional priming procedure. Linear mixed-effects models showed that children and adolescents ($N = 88$, age range = 4–17 years; 42M/46F) were faster to search for the face of their parent than of a stranger. However, fear priming attenuated this effect of the parent on search times, such that children and adolescents were significantly slower to orient toward their parent in an array of strangers' faces if they were first primed with fear as opposed to a neutral video. This work indicates that fear priming may phasically interfere with parental orienting during childhood and adolescence, possibly because fear reallocates attention away from parents and toward (potentially threatening) unfamiliar people in the environment to facilitate the development of independent threat learning and coping systems.

Keywords

Social referencing; Caregiving; Fear learning; Development; Affective priming; Threat detection; Children; Adolescents

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Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jecp.2022.105461>.

Introduction

Learning to identify and respond to dangerous environments is critical for survival. Humans appear evolutionarily primed to orient toward threatening stimuli starting as young as infancy (Erlich, Lipp, & Slaughter, 2013; LoBue & DeLoache, 2010). For example, when confronted with a possible threat such as a potentially hazardous visual cliff (Sorace, Emde, Campos, & Klinnert, 1985) or an approaching stranger (Feinman & Lewis, 1983), infants orient toward their parents. Parental orienting, or directing attention toward caregivers, seems to be particularly prevalent early in life, likely because infants rely heavily on their caregivers to protect them from danger. Subsequently, parental orienting may serve as the first step in an adaptive cascade of behaviors that enables infants to quickly identify sources of security and evaluate the safety of their surroundings to exhibit situationally appropriate behaviors.

While infants look toward both familiar and unfamiliar adults to gather information about ambiguous stimuli (Striano, Vaish, & Benigno, 2006; Walden & Kim, 2005), they are more likely to be regulated by their parents in fearful contexts (Ehli, Wolf, Newen, Schneider, & Voigt, 2020; Tottenham, 2017). Cross-species research has demonstrated the critical buffering role that parents play in regulating their infants' fear responses both behaviorally and biologically (Gunnar, Hostinar, Sanchez, Tottenham, & Sullivan, 2015). For example, the physical presence of a caregiver encourages approach behavior to potentially threatening stimuli (Moriceau & Sullivan, 2006; Tottenham, Shapiro, Flannery, Caldera, & Sullivan, 2019), maternal availability reduces fear-potentiated startle responses (van Rooij et al., 2017), and viewing photographs of caregivers decreases neural reactivity within fear-relevant brain regions such as the amygdala (Gee et al., 2014). Taken together, this work suggests that parents can encourage greater learning and exploration of potentially frightening stimuli (Gopnik, 2019). Bowlby's (1982) attachment theory supports this interpretation, proposing that infants typically seek proximity to caregivers to feel safe enough for exploration. As a consequence, early availability of parents fosters eventual independent emotion management at older ages (Callaghan & Tottenham, 2016). These effects may also depend on early relationship quality (Callaghan et al., 2019), such that exposure to early caregiving adversity might interfere with these processes.

By childhood, dependence on caregivers begins to decrease while independent behavior increases. This rise in autonomy coincides with the emergence of independent threat response systems (Seiffge-Krenke, Aunola, & Nurmi, 2009), including the maturation of limbic brain structures involved in vigilance detection and fear processing (Callaghan et al., 2019). Indeed, adults prioritize the identification of dangerous information, exhibiting a robust attentional bias to threat by visually orienting toward and rapidly identifying threatening stimuli (Blanchette, 2006; Öhman, Flykt, & Esteves, 2001a; Öhman, Lundqvist, & Esteves, 2001b). These reflexive orienting processes may facilitate fear learning by repeatedly directing attention toward potential danger, thereby allowing individuals to better predict and independently respond to a potential threat (LoBue, 2013; LoBue, Rakison, & DeLoache, 2010; Parkinson, 2019). Despite continued use of interpersonal processes throughout the lifetime (Parkinson, Phiri, & Simons, 2012), as individuals demonstrate greater caregiver independence and motor/strength abilities (Adolph & Franchak, 2017),

intrapersonal emotional regulation overtakes interpersonal mechanisms (Holodynski, 2009). Consequently, when faced with danger, adults can self-regulate and use sophisticated motor skills to coordinate “fight-or-flight” responses to keep themselves safe without depending on others (Cannon, 1929).

We currently know very little about fear-provoked parental orienting during childhood and adolescence. During this time, youths are still dependent on and under the care of their parents, yet intrapersonal emotion regulation capabilities are readily available (Moreira & Silvers, 2018). The current study used a visual search paradigm coupled with an affective priming procedure (via movie clips) to assess how quickly youths orient toward their parents and unfamiliar adults while in fearful and neutral emotional states. We hypothesized that given independent emotion regulation capacity in this age range, fear priming may decrease parental orienting in children and adolescents (4–17 years of age). Characterizing how readily children and adolescents look toward parents when faced with fear may provide novel insights into the developmental trajectory of fear responsivity.

Method

Participants

Participants included 88 children and adolescents aged 4–17 years ($M_{\text{age}} = 10.19$ years, range = 4.42–17.29) (see online supplementary material). Participants were recruited through local classified advertisements, family networks, flyers, street fairs, and referrals. Parents accompanied participants to the laboratory for a larger in-person study visit involving a range of tasks, a subset of which were used for the following analyses. The protocol was approved by the institutional review board. Parents provided written consent for themselves and their children. Children and adolescents aged 7 years and over also provided written assent, whereas children under 7 years old provided verbal assent. Families were provided with a stipend.

Emotion priming

An emotion priming procedure was conducted before each block of a visual search task presented in E-Prime (Psychology Software Tools, Pittsburgh, PA, USA). The fear priming video was composed of four Disney movie clips containing scary scenes (i.e., shark attacks, haunted woods, witches) cut together into one continuous video. A compilation of four neutral Disney movie clips (i.e., birds chirping, fish swimming, characters walking) cut together into one continuous neutral video was used as a control. Each participant watched both the fear priming and neutral control videos (~2 min each), and the order of presentation was counterbalanced. Participants provided pre-priming and post-priming fear ratings for both videos by responding to the prompt “How scared are you?” using a 5-point Likert scale (1 = *not scared*, 5 = *very scared*). Two participants were missing fear rating data due to technical error, leaving us with fear rating data from 86 participants.

Visual search task

Following each video, participants completed one block of a computerized visual search task (two blocks total; Fig. 1A). Participants were told that on each trial they would see an

array of faces (24 photographs; 12 on each side of the screen) in which all faces had the same identity except for one face. They were instructed to press a button to indicate the side of the screen (left or right of center) that contained the face that differed in identity from the rest of the faces (target). Participants were informed that sometimes all the faces on the screen would be the same, in which case they were instructed not to press any buttons. In addition, participants were told that sometimes they might see their parent's face but to continue playing the game normally if this happened.

Parents' and strangers' neutral faces served as both target and distractor stimuli in the search array. Photos of parents were obtained on arrival to the laboratory. All photos were taken from a standardized position against a blank backdrop, and parents were asked to make a neutral face. Neutral faces from the NimStim stimuli set (Tottenham et al., 2009) were used as stranger face stimuli, and stranger targets were matched to the race and gender of the participating parents. Distractor stranger faces were also matched on gender but varied in racial identity (Black, White, or Asian). All images of faces were cropped to a circular shape. Search trials were presented for 5000 ms, and trial order was randomized between participants. Each block contained 30 trials (15 stranger targets, 10 parent targets, and 5 no-target foils) for a total of 60 trials per participant. Due to programming error, there were more stranger target trials than parent target trials per block. To address this statistically, we used mixed-effects models with a random slope for target. In addition, to address any performance differences (e.g., practice effects) that may have arisen from this imbalance, we reran the primary models with the last 5 stranger target trials per block removed to obtain a dataset that contained the same number of trials per condition (10 stranger targets and 10 parent targets per block), which resulted in the same pattern of results (see supplementary material).

Results

Emotion priming manipulation check

A two-way repeated-measures analysis of variance (ANOVA) examined the effect of each priming condition (fear and neutral) and timing (pre-prime and post-prime) on self-reported fear. There was a significant interaction between prime condition and timing on self-reported fear, $F(1, 85) = 6.47, p = .013, \eta^2 = .007$. Post hoc paired-samples t tests indicated that there was a significant effect of the fear video prime on self-reported fear, $t(85) = 2.29, p = .025$, Cohen's $d = .25$. As expected, the neutral video did not result in a change in fear rating, $t(85) = -0.29, p = .78$, Cohen's $d = .031$ (see Supplementary Fig. 1).

Visual search task

Linear mixed-effects models were run using the lme4 package in R (Bates, Mächler, Bolker, & Walker, 2015) to examine reaction time (RT) during the visual search task after removing outliers, determined as trials falling 2 standard deviations above or below the mean RT of each trial type for each participant. Only accurate trials, in which participants correctly identified the side of the screen containing the target, were included in analyses (88.43%). Difference scores were calculated by subtracting the mean RT following the neutral video from the mean RT following the fear prime for each target type (parent and stranger). An

initial model was run including only neutral trials to examine baseline orienting behavior, which revealed a significant effect of target ($b = 333.42$, $SE = 28.88$), $t(77.16) = 11.55$, $p < .001$, such that participants were slower to press to the stranger target than to the parent target following the neutral video (Fig. 1B) (see supplementary material). The primary model tested for fixed effects of prime (neutral vs. fear), target (parent vs. stranger), and their interaction, as well as participant sex and mean-centered age, and included a random intercept for each participant as well as a random slope for target. This model revealed a significant main effect of prime ($b = 70.89$, $SE = 31.08$), $t(3332.66) = 2.28$, $p = .023$, a significant main effect of target ($b = 325.90$, $SE = 33.55$), $t(183.96) = 9.71$, $p < .001$, and a significant interaction between prime and target ($b = -112.62$, $SE = 40.98$), $t(3333.76) = -2.75$, $p = .006$ (Fig. 1C and 1D).

Post hoc linear mixed-effects models investigated the source of this interaction and showed that participants were significantly slower to press to the parent target following the fear prime than following the neutral video ($M_{\text{difference}} = 84.25$, $SD_{\text{difference}} = 527.11$, $b = 68.65$, $SE = 25.96$), $t(1400.37) = 2.64$, $p = .008$. There was no statistically significant effect of priming on stranger target RT ($M_{\text{difference}} = -56.63$, $SD_{\text{difference}} = 524.36$, $b = -40.78$, $SE = 29.61$), $t(1912.09) = -1.38$, $p = .17$. We also investigated whether these effects were influenced by age (childhood vs. adolescence), by rerunning the primary model including a three-way interaction term with prime, target, and age split at 12 years and under ($n = 61$) versus above 12 years ($n = 27$). The initial interaction between prime and target remained significant in this model ($b = -141.63$, $SE = 50.16$), $t(3332.19) = -2.82$, $p = .005$; however, we did not detect statistically significant interactions with age. Finally, a mixed-effects model including an interaction term for post fear prime fear rating revealed a three-way interaction between prime, target, and fear rating ($b = -89.78$, $SE = 33.27$), $t(3238.26) = -2.70$, $p = .007$, such that the interaction between prime and target was driven by individuals who self-reported higher fear following the fear priming procedure (Fig. 2). There was no statistically significant three-way interaction with pre fear prime fear rating ($b = -65.34$, $SE = 39.26$), $t(3225.93) = -1.66$, $p = .10$.

Discussion

Using a visual search paradigm, we found that children and adolescents were faster to orient toward their parents than toward unfamiliar adults. However, this parental boost in RT was attenuated when participants were primed with fear, such that children and adolescents were significantly slower to orient toward their parents following fear priming compared with the neutral video, especially if participants indicated high levels of self-reported fear following the fear priming procedure. Our findings suggest that during childhood and adolescence, when cued with fear, individuals may abandon parental orienting strategies classically observed during infancy to prioritize gathering information about potential threats in the environment. Orienting away from parents and toward unfamiliar others in fearful contexts therefore may reflect the emergence of independent threat coping systems that we see present during adulthood.

Young children tend to look toward adults, particularly caregivers, when encountering ambiguous or potentially dangerous situations and determining how best to respond

(Boseovski & Thurman, 2014; Silvers et al., 2021; Zabatany & Lamb, 1985). This phenomenon, classically referred to as social referencing, is common at early ages (Feinman, 1982; Walden & Ogan, 1988). Conversely, adults use more readily available, autonomous fear response systems when faced with threatening circumstances. This distinction indicates that sometime between infancy and adulthood, individuals must develop the capability to independently respond to threat. While our primary aim was to investigate parental orienting in children and adolescents and not to examine age effects, our interaction analyses did not reveal any age-related interactions; however, given the relatively small sample size and wide age range, we were likely underpowered to adequately identify age effects. Further work is needed to replicate these results in a larger sample.

These findings suggest that fear attenuates parental orienting during childhood and adolescence. This behavior may represent the deprioritization of parental orienting as a primary method of fear responsivity relative to younger ages, although further research is necessary to support this hypothesis. For example, toddlerhood, a developmental period encompassing the 1- to 4-year age range, is defined by experiences of initial independence from caregivers (Colson & Dworkin, 1997). Relying on parents to assess environmental threats might not be an adaptive strategy when parents are not consistently physically present. Subsequently, the use of parental orienting may negatively correlate with the developmental timing of behavioral autonomy, diminishing when children demonstrate the first signs of independence during early toddlerhood. In line with this hypothesis, the emergence of fear processing capabilities in children has been suggested to coincide with the timing of increased independence from caregivers (Campos, Hiatt, Ramsay, Henderson, & Svejda, 1978). Future studies should characterize the trajectory of parental orienting from infancy through childhood to identify the possible inflection point at which fear response strategies shift from dependent to more independent.

Developing an autonomous threat response system requires correctly identifying potential sources of danger. This process is facilitated by the ability to effectively scan the environment to gather information about possible threats. Although our task used neutral faces as target and distractor stimuli, the neutral strangers' faces in the parent target condition may have been perceived negatively by our participants, as has been demonstrated in past studies with children (Marusak, Zundel, Brown, Rabinak, & Thomason, 2017; Tottenham, Phuong, Flannery, Gabard-Durnam, & Goff, 2013). Therefore, our result that fear priming impeded participants' ability to quickly orient toward their parent's face might suggest that children and adolescents looked longer at the distractor strangers' faces when scared. Future work may test this possibility by incorporating explicitly threatening or fear-inducing stimuli into the visual search paradigm.

There are important limitations to acknowledge within the current work. First, we introduced a novel computerized task to characterize orienting behavior. This paradigm allowed us to assess visual search behavior for parents and strangers while participants were in a fearful or neutral emotional state in a standardized way across a wide age range. Although the stimuli in the visual search paradigm were parents and unfamiliar strangers, we cannot conclude with certainty that the observed RT effects were due to a specific effect of parents as opposed to participants' familiarity with the target faces. Future studies may control for

this factor by including a familiar adult target condition in the visual search paradigm. In addition, although we cautiously interpret the current results as reflecting a developmental shift in fear response strategies (between infancy and adulthood), our sample did not include infants or very young children, and subsequently we were unable to investigate age-related change across the early lifespan. Age was relatively normally distributed within our sample, with few participants falling within the early childhood age bracket. Thus, studies incorporating a wider age range of participants, particularly at younger ages, would be better equipped to investigate potential age interactions and determine whether a developmental inflection point exists. Finally, whereas in the current study we used photographs of caregivers and strangers, many paradigms investigating parental orienting during infancy have manipulated physical caregiver presence or facial expression. Although work in adults has indicated that pictorial representations of loved ones elicit similar social regulatory responses as physical presence (Master et al., 2009), future research may examine whether the modality of caregiver presence affects orienting processes during development.

Despite these limitations, the current study demonstrates that when cued with fear, children and adolescents do not appear to rely on parental orienting strategies. Although parents continue to play an important role across the lifespan, children and adolescents may use more autonomous information gathering strategies when scared to independently evaluate the safety of their surroundings. These findings have important implications for informing our current understanding of the normative trajectory of fear responsivity throughout development.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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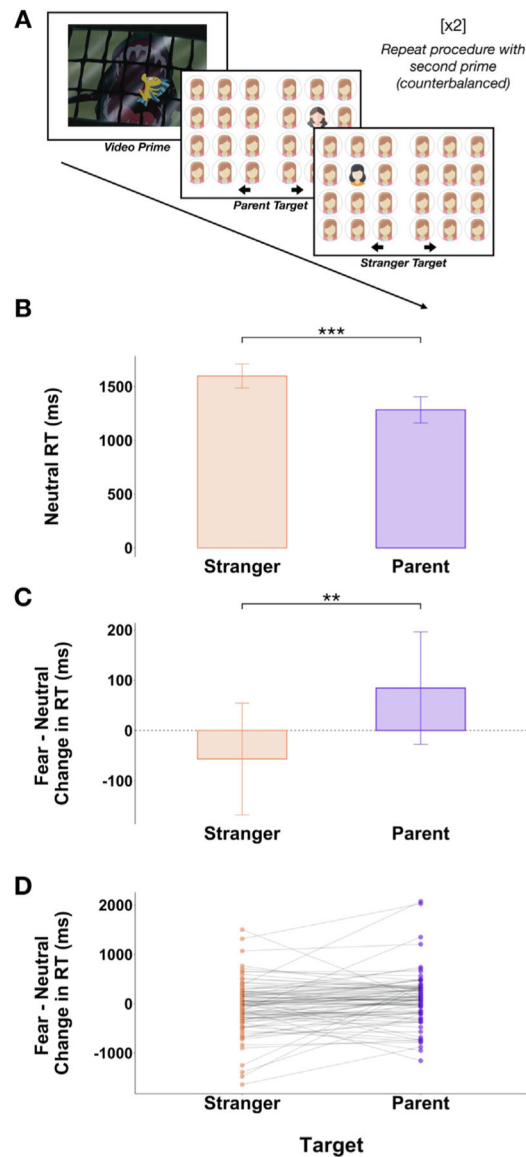


Fig. 1.

(A) Overview of task design. Participants were primed with a 2-min fearful or neutral video followed by a visual search paradigm. Participants were instructed to press a button to indicate the side of the screen that contained the differing face. Participants' parent's face and strangers' faces served as target and distractor stimuli. This procedure was repeated twice and was counterbalanced so that participants were exposed to both priming conditions (fear and neutral). (Images were obtained from [Flaticon.com](https://www.flaticon.com/).) (B) Bar plots for mean reaction time (RT) to press to parent and stranger target trials following the neutral video. Error bars represent 95% confidence intervals. The y axis represents RT, and the x axis represents target (stranger and parent). See supplementary material. (C) Bar plots for mean change in RT to press to parent and stranger target trials as a function of prime valence. Error bars represent 95% confidence intervals. The y axis represents change in RT (mean RT following fear video prime – mean RT following neutral video). The x axis represents

target (stranger and parent). (D) Raw individual points of the mean change in RT to press to parent and stranger target trials as a function of prime valence. Gray lines connect individual participants. The y axis represents change in RT (mean RT following fear video prime – mean RT following neutral video). The x axis represents target (stranger and parent). ** $p < .01$; *** $p < .001$.

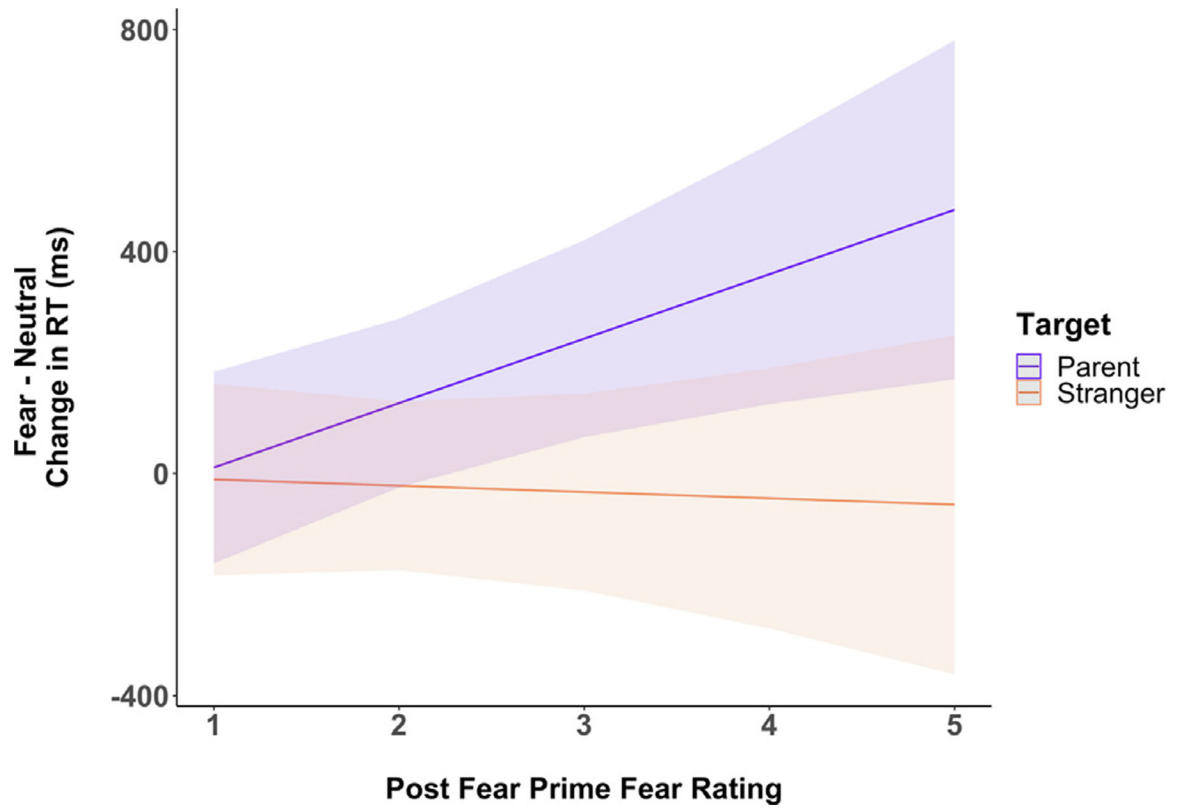


Fig. 2. Interaction between prime, target, and post fear prime self-reported fear rating. The y axis represents change in RT (mean RT following fear video prime – mean RT following neutral video). The x axis represents participants' self-reported fear following the fear priming procedure (1 = *not scared*, 5 = *very scared*). The colors represent target (purple [upper] = parent, orange [lower] = stranger). Ribbons represent 95% confidence intervals.