ATTENTION ORIENTING TO MOTIVATIONALLY SALIENT FACES ACROSS DEVELOPMENT

AN ABSTRACT

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Abstract

Developing attention skills allow children to parse the world by orienting to a subset of especially salient or meaningful inputs. Understanding how infants and children direct their attention towards parts of their environments is critical to furthering our knowledge of how learning unfolds. However, the current theoretical models guiding this developmental research are limited in scope, compared to models of adult selective attention (Colombo, 2001; Luck et al., 2021). Adult models of attention orienting incorporate several factors including the extent to which a stimulus is perceptually salient, related to task goals, and/or rewarding or motivationally salient, as well as the individual’s attentional state and previous selection history (Luck et al., 2021; Kim et al., 2021). Developmental models have instead more narrowly emphasized perceptual salience and goal-relevance as the primary mechanisms driving attention orienting without considering the role of other factors such as motivational salience. Across four studies, we evaluated whether 6- to 10-year-old children demonstrated automatic attention orienting biases to faces that varied in familiarity and motivationally salience. We first established that orienting biases to faces could be detected using online methods (Study 1) and then tested whether these biases varied depending on the motivational relevance (Study 2) or familiarity (Study 3) of faces. We demonstrated that children showed stronger attention orienting biases to motivationally salient caregiver faces compared to stranger faces, but orienting biases to faces did not vary across familiar own
race versus less familiar other-race faces. In subsequent exploratory analyses of individual differences (Study 4), we found that the quality of parent-child relationships and interactions were significant predictors of children’s orienting biases to caregiver faces but exposure to diversity did not relate to their orienting to own- vs. other-race faces. Overall, these studies provide novel evidence that motivational salience may drive children’s attention orienting biases to faces to a greater extent than familiarity. These findings have critical implications for our understanding of attention development, as they suggest that the motivated selective attention mechanisms previously identified in adulthood may also be functional in childhood.
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A DISSERTATION

SUBMITTED ON THE TWENTIETH DAY OF APRIL 2022 TO THE DEPARTMENT OF PSYCHOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE SCHOOL OF SCIENCE AND ENGINEERING OF TULANE UNIVERSITY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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CHAPTER 1: INTRODUCTION

Infants and children are immersed in a complex world with limitless opportunities for learning. Developing attention skills support effective learning within this complex world by facilitating efficient encoding and selection of meaningful information (Leppanen, 2016). One important skill is *attention holding*, also referred to as sustained attention. Attention holding involves maintaining focus on a stimulus over a period of time which is important for detailed information processing. Another important skill is *attention orienting*, also referred to as selective attention. Attention orienting involves the initial capture of attention, as well as the subsequent shifts in focus, particularly when multiple stimuli compete for attention. Attention orienting thus allows infants and children to explore their environments by rapidly shifting their focus towards parts of their environments that may provide valuable information about the objects, events, and people embedded within these unique environments (Cohen, 1972). Therefore, understanding the development of selective attention is critical to furthering our knowledge of how infants and children learn. However, the current theoretical models guiding this developmental research are limited in scope, compared to models of adult selective attention (Colombo, 2001; Luck et al., 2021). Adult research has identified a range of factors that drive attention orienting, including the extent to which a stimulus is perceptually salient, related to task goals, and/or rewarding or motivationally salient, as well as the individual’s attentional state and previous selection history (Luck et al., 2021; Kim et al., 2021). In contrast, developmental models have emphasized perceptual...
salience and goal-relevance as the primary mechanisms driving attention orienting without considering the role of other factors such as motivational salience. The overall goal of the current studies was to investigate the extent to which motivational salience influences attention orienting during childhood, as it does in adulthood. In Study 1, we replicated a previous attention capture task (Riby et al., 2012) using online/remote data collection methods. We then used similar online attention capture tasks to examine the role of motivational salience and familiarity in 6- to 10-year-old children’s attention orienting biases to faces. Specifically, Study 2 assessed the role of motivational salience in selective attention development by examining children’s attention orienting biases to their caregivers’ faces, while Study 3 examined children’s attention orienting biases to familiar own-race versus less familiar other-race faces. We hypothesized that caregiver motivational salience would drive children’s attention orienting biases to a greater extent than frequency of exposure. Finally, in Study 4, we explored whether individual differences in the amount and quality of experiences with caregivers and own-race individuals predicted the extent to which children showed these motivation-driven and/or familiarity-driven attention biases.

**Attention Development**

Although attention orienting and attention holding work together to mediate exploration and encoding of the environment (Fisher, 2019), early research on attention development initially largely focused on how different types of stimuli hold, or sustain, infant attention. These attention holding biases are typically measured in duration of looking and reflect the amount of time that is necessary for detailed information processing and memory encoding (Aslin, 2007). Because these studies typically measure
the duration that an individual spends looking in one general direction (e.g., central or left versus right), stimuli are often presented in isolation or paired with one other stimulus. More recent work has also considered how stimuli initially capture attention (i.e., attention orienting) when they are presented among multiple competing stimuli, which more closely reflects the complex worlds infants and children experience (e.g., Kwon et al., 2015; Hunter & Markant, 2021; Riby et al., 2012).

Attention orienting involves shifting attention to an item or location to focus on one specific aspect of the environment (Oakes & Amso, 2018; Petersen & Posner, 2012). This information selection can occur by exogenous mechanisms based on perceptual salience of stimuli (e.g., brightness) or by engaging endogenous, or voluntary, control mechanisms to select task-relevant stimuli while suppressing irrelevant information (e.g., Katsuki & Constantinidis, 2014). Researchers measure attention orienting biases by examining preferential selection of relevant parts of the environment as well as efficient suppression of attention to irrelevant parts of the environment. For example, the visual search task examines participants’ ability to select target stimuli while concurrently suppressing distractors. In a classic visual search task, individuals are instructed to identify a target stimulus that appears in an array among multiple irrelevant distractors. Typically, as the number of distractors (i.e., set size) increases, individuals respond more slowly to the target as increased endogenous control is needed to suppress additional irrelevant information. Response times also slow down on trials in which the target is absent from the array (target absent trials), compared to when present (target present trials). This performance cost on target absent trials is thought to reflect a shift in search strategy. On target present trials, participants can quickly identify the target and move on
to the next trial. However, on target absent trials, participants must instead carefully inspect each stimulus in the array to confirm the absence of the target (Wolfe, 2015). Thus, reduced reaction time costs during target absent trials and as the number of distractors increases indicates more efficient selective attention during a visual search task. A similar task, the attention capture task, is often used to measure attention orienting biases (e.g., Erb et al., 2022; Theeuwes & Burger, 1998). During this task, participants search for a target within arrays containing multiple irrelevant distractors, similar to a visual search task. Consistent with classic visual search effects described above (e.g., Wolfe, 2015), individuals typically respond slower during target absent trials and as the number of distractors (i.e., set size) increases. However, during attention capture tasks, a subset of trials includes one distractor that is more perceptually salient than the others. Individuals also typically show poorer accuracy or slower response times during these trials, and these performance costs indicate the extent to which attention was captured by the perceptually salient distractor in the array (e.g., Belopolsky et al., 2007).

Both exogenous and endogenous orienting mechanisms are functional beginning early in development. Exogenous mechanisms explain why, for example, infants’ attention is often captured by highly salient moving toys dangled in their periphery whereas endogenous mechanisms reflect the processes infants use when they voluntarily search for a particular toy in a cluttered playroom. Developmental models primarily emphasize the importance of these two mechanisms, arguing that young infants initially rely heavily on exogenous orienting but shift toward increasingly efficient endogenous control over attention orienting later in infancy and childhood (see Oakes & Amso, 2018 for review). For example, children show faster response times and reduced set size costs
with age during visual search tasks, reflecting improvements in their ability to ignore competing distractors to efficiently select a target (Lobaugh et al., 1998; Trick & Enns, 1998). However, compared to adults, children remain more susceptible to attention capture by salient distractors compared to adults (Gaspelin et al., 2014), indicating that they have increased difficulty inhibiting automatic orienting biases to salient stimuli.

Overall, increased endogenous attention control over development allows individuals to efficiently direct their attention towards parts of the environment that reflect their prior knowledge and are relevant for ongoing task demands.

Although adult work traditionally described a similar dichotomy between exogenous and endogenous control (Posner & Peterson, 1990; Corbetta & Shulman, 2002), more recent adult models have expanded to include multiple additional factors that influence selective attention, including implicit learning and motivational salience (Awh et al., 2012; Kim et al., 2021; Luck et al., 2021). Motivational salience refers to the relative value of a stimulus that is learned through association with reward or threat (e.g., a color that is reliably paired with a monetary reward or an aversive shock; Kim et al., 2021). Critically, studies investigating motivational salience use stimuli that are neither perceptually salient nor goal-relevant (Anderson et al., 2011; Anderson, 2019; Theeuwes & Belopolsky, 2012) demonstrating that motivational salience can elicit biased attention orienting independently from exogenous and endogenous mechanisms. However, it is unknown whether motivational salience similarly influences selective attention during infancy and childhood. Therefore, the overall aim of the current studies is to determine the extent to which motivational salience drives biased attention orienting during
development. We addressed this question by investigating children’s attention orienting biases to motivationally salient (i.e., rewarding) and frequently experienced faces.

**Biased Attention to Faces**

Faces are a prevalent and valuable source of information in infants’ and children’s environments. Within the first few hours of life, infants prefer looking at faces compared to non-face stimuli, and by 1 month of age, they spend nearly a quarter of their waking hours exposed to faces (Sugden et al., 2013; Valenza et al., 1996). As infants and children accumulate experience with faces, they gain familiarity with specific types of faces that dominate their unique environments. Markant and Scott (2017) proposed that infants’ and children’s perceptual learning of these specific face categories may drive attention biases. There is mounting work demonstrating that infants’ and children’s *attention holding* biases to faces are shaped by their prior learning about face features and face categories, including those that are most familiar and socially relevant in their daily lives. Decades of research have examined how the gender, race, and species of faces influence how long infants sustain their attention to them (DiGiorgio et al., 2012; Kelly et al., 2005; Quinn et al., 2002). Results from these investigations indicate that infants show stronger attention holding biases towards faces that share characteristics with the faces that they regularly experience in their caregiving environment. For example, infants show stronger attention holding biases for female compared to male faces, but this trend is reversed when a male is the primary caregiver (Quinn et al., 2002). Similarly, young infants show stronger attention holding biases for own-race faces (e.g., Kelly et al., 2007), but this is reversed if an other-race individual assumes a caregiving role (e.g., through adoption; Sangrigoli et al., 2005). Similarly, infants in Singapore with a part-time other-race caregiver (e.g.,
nanny) show larger differences in looking time to own- and other-race faces, compared to infants with only own-race caregivers (Singh et al., 2022). This work highlights the role of experience in shaping the development of early attention holding biases, particularly for faces that resemble the caregiver. However, much of this research has investigated attention biases to face categories at the group level. Much less research has examined how variations in experiences influence individual differences in attention biases to faces. Emerging research in infancy suggests that frequency of exposure to other-race faces in daily life also contributes to the development of these attention holding biases. Infants raised in a racially homogenous city (e.g., Grinnell, IA) showed stronger race-based attention biases compared to those raised in a racially diverse community (e.g., Davis, CA; Ellis et al., 2017). These findings indicate that infants’ unique environments and experiences, including frequency of exposure to other-race faces, may influence the development of biased attention holding to faces.

Experiences with caregivers may also shape attention biases to caregiver faces themselves, since caregivers are among the most prevalent faces in infant's and children’s environments (Dotti Sani & Treas, 2016; Sugden & Moulson, 2019). Research investigating the development of attention biases to caregivers has focused primarily on how these cues hold, or sustain, attention. A long line of research suggests that infants prefer their primary caregiver’s face, odor, and voice compared to a stranger’s face, odor, or voice (DeCasper & Fifer, 1980; Pascalis et al., 1995; Russell, 1976). This early preference for caregiver cues may facilitate rapid learning of caregivers and support the development of the child-caregiver attachment relationship (Bowlby, 1969). These attachment relationships are based on a socio-emotional connection between the child
and caregiver that allows children the safety to explore and learn from novelty in their environments. The quality of attachment relationships is classically evaluated in infancy using the strange situation procedure (SSP) developed by Ainsworth and colleagues (1978). During this procedure, researchers stage eight caregiver-child separation and reunion episodes. Subsequent analysis of the child and caregiver’s responses during these episodes provides insight into the quality of the relationship between the dyad. An adaptive caregiver-child attachment is referred to as a secure attachment. This attachment style is characterized by a pattern of behaviors that promote infant security (Sroufe & Waters, 1977). For example, securely attached children may become distressed when separated from their caregiver during the SSP but are happy and seek proximity to their caregiver upon reunion. Caregivers of securely attached children are sensitive to and respond quickly and positively to their child’s needs during the SSP. Research investigating how the quality of attachment relationships influences daily behaviors suggests that more secure infants may use their caregiver as a secure base, such that they feel safe to prioritize exploring novelties in their environment compared to familiar stimuli (Waters & Cummings, 2003). However, insecure attachment types (sub-classified as avoidant, ambivalent, or disorganized) each describe maladaptive relationships between the child and parent. For instance, children may be un-distressed during separations or may not seek a caregiver’s proximity when upset during the SSP. Caregivers of these children may behave inconsistently, dismissively, or neglectfully (Ainsworth & Bell, 1970).

Although the SSP is a well-validated measure of relationship quality in early life (9-30 months), researchers have sought alternative measures that can assess child-
caregiver relationships later in childhood without requiring time-intensive testing and behavioral coding. For example, the Security Scales questionnaire (SS; Kerns et al., 1996) is a child-reported measure of perceived attachment security by assessing children’s perceptions of caregiver responsiveness, availability, reliability, as well as their willingness to communicate thoughts and feelings with their caregiver. Although this questionnaire has been validated for use with 8–12-year-old children, researchers have used this measure to examine attachment security among individuals as young as 7-years of age (e.g., Kim & Page, 2012) and as old as 18 years (e.g., Williams et al., 2017). Other questionnaires, such as the Alabama Parenting Questionnaire (APQ, validated for use with 6- to 18-year-old samples; Elgar et al., 2006), focus on discrete parenting behaviors (e.g., positive reinforcement) that may contribute to the quality of child-caregiver relationships. Although lacking in ecological context compared to the SSP, these questionnaires have been useful in discovering how attachment relationships and positive parenting influence outcomes such as stress reactivity (SS: Bendezú et al., 2019) and externalizing behaviors (SS: Kochanska et al., 2015, APQ: Frick et al., 1999).

Previous research suggests that individual differences in attachment relationships and attachment-related behaviors may shape the development of attention biases to caregiver vs. stranger faces. Young infants initially show attention holding biases to caregiver faces (e.g., Pascalis, 1995), but then increasingly prefer looking at stranger faces over the first year of life (Bartrip et al., 2001). Furthermore, behavioral antecedents of attachment in infancy (e.g., proximity-seeking behaviors), as well as attachment security in early childhood, predict this shift towards increased attention to stranger faces (Kungl et al., 2017; Swingler et al., 2007). Researchers have interpreted these findings as
evidence that increased attention to stranger faces reflects security in attachment relationships (Carver, 2003; Kungl et al., 2017). Together, this research suggests that the quality of caregiver-child relationships can influence the extent to which infants’ and children’s attention is biased to caregivers vs. stranger faces.

Attention Orienting to Faces

Although the vast majority of research investigating attention to faces has focused on attention holding biases, more recent research has also examined attention orienting to faces when they appear with multiple competing stimuli. As infants gain endogenous control over selective attention, they begin to reliably orient to faces in visual search tasks (Kwon et al., 2015) and in naturalistic displays (Frank et al., 2014). These findings suggest that by 6 months, infants show preferential selection of faces among distractors. Researchers have also used attention capture tasks to demonstrate similar orienting biases to faces among children and adults. Eight- to fourteen-year-old children and adults detected targets more slowly when a face appeared as a distractor in a search array (Langton et al., 2008; Riby et al., 2012), suggesting that faces are more salient than non-social distractors and elicit automatic orienting even when they are task-irrelevant. Thus, infants, children, and adults show robust orienting biases to faces in general, reflected by both preferential selection of faces and increased difficulty suppressing or ignoring faces that appear as distractors. However, limited work has investigated whether varying features of faces (e.g., identity, racial category) influence their ability to capture attention.

This past research has established that infants and children are biased to orient to faces in general. As described above, young infants also show attention holding biases to familiar face categories. However, limited work has compared attention orienting to
specific face categories. This is an important gap in the literature, since these attention biases may reflect the extent of learning about different face categories (Markant & Scott, 2018). Several studies have found that 6- and 11-month-old infants showed robust species-based orienting biases, as infants were more likely to and quicker to detect human faces compared to monkey faces (Hunter & Markant, 2021; Jakobsen et al., 2016). However, infants did not show similar preferential orienting to own- vs. other-race faces (Hunter & Markant, 2021; Prunty et al., 2020). These results suggest that, unlike attention holding biases, mere frequency of exposure to familiar human face categories may not contribute to developing attention orienting biases. However, these limited studies on attention orienting to specific types of faces have only considered experience at the group level (i.e., own-race vs. other-race), rather than quantifying individual differences in experience with faces. Therefore, it is possible that infants and children with more homogenous experiences with race categories may show attention orienting biases to own-race faces, but increasingly heterogenous experiences attenuate these biases and become undetectable at the group level.

While past research suggests that familiarity with face categories may not drive biased orienting during development, past research has indicated that social reward drives robust orienting biases in adulthood (Anderson, 2016). Caregiver faces may be an optimal stimulus for investigating the extent to which social reward and motivational salience similarly contribute to biased orienting during development. Developmental research has confirmed that cues associated with attachment partners elicit increased neural reward network activity in both the parent and child (Minagawa-Kawai et al., 2009). Caregiver faces and voices elicit increased activity in reward and social-emotional
brain networks in infancy and childhood (Abrams et al., 2016; Dehaene-Lambertz et al., 2010; Liu et al., 2019; Minagawa-Kawai et al., 2009). For instance, infants and mothers showed greater fNIRS activation in orbitofrontal cortex, a cortical reward region, when viewing videos of their own mother and own infant, respectively (Minagawa-Kawai et al., 2009). Moreover, an fMRI study of children found increased activation of the orbitofrontal cortex and nucleus accumbens, two structures involved in the reward network, when listening to their caregiver’s voice (Abrams et al., 2016). Finally, infants showed differences in spontaneous eye blink rate, an indirect measure of dopaminergic signaling in the ventral striatal reward network, when viewing videos of their caregiver versus a stranger (Tummeltshammer et al., 2019). These studies provide converging evidence that caregiver cues are processed as reward and are thus motivationally salient stimuli.

Past research has also demonstrated that adults showed biased orienting to cues associated with attachment partners (Dewitte et al., 2007). Consistent with this, infants and young children follow an attachment partner’s eye gaze shift more effectively than a stranger’s (Hoehl et al., 2012) and this increased eye gaze sensitivity may promote more efficient learning (Barry-Anwar et al., 2017; Markus et al., 2000). This work provides initial evidence suggesting that caregiver motivational salience may shape infants’ attention orienting to stimuli associated with an attachment figure. However, there is no work investigating how infants or children initially orient towards their caregiver. This is a major gap in our understanding of attention development since adult research has demonstrated that social reward drives orienting biases in adulthood (Anderson, 2016).
Summary

Attention holding and attention orienting are early developing cognitive skills that support efficient encoding and selection of meaningful information (Leppanen, 2016). Attention holding biases reflect biases in the duration of time needed for information processing whereas attention orienting biases reflect how stimuli may differentially capture attention among competing distractors. While developmental models of attention orienting development narrowly consider endogenous vs. exogenous mechanisms (Oakes & Amso, 2018), there is increasing work in adulthood indicating that other factors, such as motivational salience, may drive orienting biases (Kim et al., 2021). However, the extent to which motivational salience similarly drives attention orienting biases during development is unknown. Our primary aim was to address this critical gap in the literature because it limits our understanding of how children learn from meaningful parts of their environments.

We addressed this question by examining attention orienting to motivationally salient faces. Past research has identified robust attention holding biases to faces in general beginning early in infancy (Sugden et al., 2013; Valenza et al., 1996). As infants accumulate experience these biases narrow to reflect categories of faces that are most familiar (e.g., own-race faces; Kelly et al., 2005), as well as the individual faces that are most familiar (e.g., caregiver faces; Pascalis et al., 1995). Furthermore, attachment correlates (e.g., proximity-seeking behaviors, attachment security) relate to the extent to which infants and young children demonstrate attention holding biases towards caregiver versus stranger faces (Kungl et al., 2017; Swingler et al., 2007).
Although past research has also identified robust attention orienting biases to faces during infancy and childhood (e.g., Kwon et al., 2015; Riby et al., 2012), less work has examined how different types of faces differentially bias orienting. This limited work suggests biases toward human faces relative to animal faces (Hunter & Markant, 2021; Jakobsen et al., 2016), but not towards familiar categories of human faces, such as own-race faces (Hunter & Markant, 2021; Prunty et al., 2020). Socially rewarding faces bias orienting during adulthood (Anderson, 2016), suggesting that investigating attention to caregiver faces may provide insight into how motivational salience may bias orienting during development. Attachment theory and cognitive neuroscience findings suggest that caregivers are processed as rewarding stimuli (e.g., Minagawa-Kawai et al., 2008). We thus leveraged these findings to understand how motivational salience influences selective attention development. We predicted that children would show stronger attention orienting biases to caregiver faces, relative to faces in general.

However, in addition to their heightened reward value, caregiver faces are also familiar. Therefore, if we observed attention orienting biases to caregiver faces, it was important to also investigate whether familiarity of faces may similarly drive orienting biases. While caregiver faces are both motivationally salient and frequently experienced, own-race faces are more frequently experienced, but not motivationally salient. Thus, our second aim was to evaluate orienting to own- versus other-race faces. We expected that children would not show biased attention orienting biases to familiar own-race faces, based on past work indicating that race-based familiarity does not influence attention orienting biases to faces in infancy (Hunter & Markant, 2021; Prunty et al., 2020). Overall, if children showed biased orienting to caregiver, but not own-race faces, we may
conclude that the motivational salience of caregiver faces drives attention orienting biases beyond mere familiarity. These results would support the claim that motivational salience drives attention orienting during development, as it does in adulthood.

Finally, past research has shown that attention holding biases may reflect individual differences in experience (e.g., Ellis et al., 2017). However, it is unclear if children’s biased attention orienting biases to faces may also depend on their individual experiences. Therefore, our third and final aim was to conduct exploratory analyses relating the quantity and/or quality of children’s social interactions and experiences to their attention orienting biases to faces. In particular, children who have experienced a secure attachment relationship may show stronger orienting biases towards novel stranger faces since the child-caregiver attachment relationship influences children’s proximity-seeking and novelty exploring behaviors (Waters & Cummings, 2003). We similarly explored whether individual differences in children’s exposure to diversity predicted their attention orienting biases to familiar own-race faces.

**Current Studies**

We used a series of online, age-appropriate attention capture tasks to investigate attention orienting to caregiver versus stranger faces and own-versus other-race faces among 6- to 10-year-old children. We focused on this age range since previous research indicated that children in this age group show increased neural reward activity when listening to their caregiver’s voice (Abrams et al., 2016). We administered all study procedures remotely since we completed all data collection during the COVID-19 pandemic (between January 2021 and January 2022). To confirm the validity of these remote methods, Study 1 comprised an initial pilot study aimed at replicating previously
identified attention orienting biases to faces in general in the context of these remote testing procedures. Next, in Study 2, we examined the extent to which children automatically orient to caregiver faces when they appeared as a task-irrelevant distractor during an attention capture task. In Study 3, we used a similar attention capture task to examine the extent to which children automatically orient to highly familiar own-race faces compared to less-experienced other-race faces. During attention capture tasks we equated physical salience of faces across participants to ensure that any observed orienting biases could not be explained solely by exogenous factors. The faces were also always irrelevant to task demands, ensuring that orienting could not be explained solely by endogenous factors. We predicted that motivational salience of faces would bias children’s attention orienting to a greater extent than familiarity. Thus, we expected that the presence of the caregiver face would capture attention to a greater extent than stranger faces in Study 2, but children would show similar performance in the presence of own- and other-race faces in Study 3.

Last, in Study 4, we explored relations between children’s attention orienting biases and individual differences in the quality and quantity of their experiences with caregivers and own-race individuals. We used the Security Scales and Alabama Parenting Questionnaire to assess individual differences in parenting quality and children’s perceived attachment security and developed a Racial Diversity Exposure questionnaire to assess individual differences in children’s exposure to individuals from diverse races. We then conducted exploratory analyses examining links between 1) the quality of caregiver-child interactions (i.e., parenting quality, perceived attachment security) and children’s orienting biases to caregiver faces, and 2) variability in exposure to racial
diversity and children’s orienting biases to own-race faces. We predicted that the quality of child-caregiver interactions and relationships would relate to children’s orienting biases to caregivers. However, we did not have strong predictions about the direction of this effect. One possibility was that children who experience more positive relationships with their caregiver (e.g., more positive interactions, more secure relationships) would show stronger attention orienting biases to their caregiver’s face. Another possibility was that children who perceived more attachment security may instead show stronger biases towards stranger faces, consistent with increased novelty-seeking. Although we expected that children would not show biased orienting to own-race faces at the group level, we remained open to the possibility that children with relatively homogenous experience with own-race faces may show stronger race-based attention orienting biases.
CHAPTER 2: STUDY 1

Previous research has established that both children and adults show automatic attention orienting to faces when they appear as a task-irrelevant distractor during an attention capture task (Langton et al., 2008; Riby et al., 2012). For example, Riby and colleagues used a child-friendly attention capture task to examine 8- to 14-year-old children’s automatic attention orienting to a task-irrelevant face. Children viewed search arrays in which a target shape appeared among 2, 5, or 8 distractors. During half of the trials, one of the distractors was a face. Participants used a keyboard to indicate whether the target was absent or present within each search array. Children were significantly slower to respond when a face appeared as a distractor, but only during trials in which the target was also present in the array. Thus, Riby and colleagues concluded that unfamiliar faces automatically captured children’s attention and interfered with efficient target detection.

Because we collected all data remotely during the ongoing COVID-19 pandemic, we first conducted an initial pilot study based on Riby et al. (2012) to confirm the validity of our online data collection procedures. The attention capture tasks described in Studies 2 and 3 closely mirror the task used here but further manipulate the types of faces presented.
Method

Participants

The pilot sample included thirty-seven 7- to 10-year-old children (20 F; 17 M; 
$M_{age} = 9$ years, 7.14 days, $SD = 1$ year, 4.6 months). An a priori power analysis with 
alpha = 0.05 and power = 0.8 indicated that 26 participants were needed to identify the 
previously observed effect size reported by Riby and colleagues ($\eta_p^2 = .18$). We tested 
additional participants to account for the possibility of smaller effects and/or increased 
attrition during online testing. All participants were healthy children without a history of 
visual, auditory, or neurological impairments. We recruited families from across the 
United States and Canada through online child research consortiums (e.g., 
ChildrenHelpingScience.com), social media, and existing lab databases. According to 
parental report, 75.7% of children were White/Caucasian, 5.4% were Hispanic, 2.7 % 
were Black/African American and Non-Hispanic, 2.7% were Asian, and 13.5% were 
more than one race. One additional participant was tested but excluded from analyses 
because they did not complete the entire task. Participants were compensated with a $15 
gift card. All parents and participants completed informed consent and assent according 
to protocols approved by the local Institutional Review Board.

Stimuli

Participants completed an attention capture task (Figure 1) in which they searched 
for a target within search arrays that consisted of 3, 6, or 9 images (each image 150 x 150 
 pixels) appearing in a 3 x 3 grid (each square 200 x 200 pixels). We used three unique 
 butterfly images as potential targets. Non-face distractors included images of flowers,
fruits, houses, plants, shells, and shoes. We selected two face distractors from the Chicago Faces Database (Ma et al., 2015), ensuring that they were unfamiliar to the child. These faces were both White, female, and with a neutral emotional expression. We cropped each face to an oval shape to remove external face features. The target and face locations were counterbalanced so that each face and butterfly image appeared in all locations an equal number of times. After determining target and face locations, non-face distractor images were randomly placed in the remaining locations and appeared an equal number of times throughout the task.

![Figure 1. Example stimuli (target present, set size 6) for Study 1. Participants searched for a target butterfly. Half of the trials contained a task-irrelevant face as a distractor (Face Present trials, right) and half did not (Face Absent trials, left). See Appendix A, Figure A1 for examples of all other trial types (target present vs. absent, set size 3, 6, 9).](image)

**Procedure**

All participants in Study 1 completed the attention capture task remotely from home via video conference. Parents and their child met with a researcher via Zoom, during which children completed the computer task hosted on Pavlovia.org. The task was presented using PsychoPy3 (Peirce et al., 2019) in a full-screen web browser. Participants did not see the experimenter during the task but were able to communicate with them verbally if needed. Before beginning the task, the researcher verbally explained task
instructions and allowed the child to complete 6 practice trials (all face-absent trials) that provided audiovisual feedback. When the researcher confirmed that the child understood the directions, the child was instructed to begin the primary task.

At the beginning of each trial, the grid appeared empty for 500ms. Next, the search array appeared and remained visible until participants responded up to a maximum duration of 3500ms, and then a blank screen appeared for 1000ms. Participants used the Z or M keys (counterbalanced across participants) to indicate whether the target butterfly was present or absent in each search array. Participants completed a total of 108 trials, including the same number of target present vs. target absent trials (54 per target condition) and the same number of trials within each set size (36 per set size). All task images were counterbalanced and pre-selected so that each participant viewed the same 108 search arrays, presented in random order. We encouraged parents to sit with their child during the task without interfering. The task did not contain feedback between trials, but an encouraging message was presented halfway through the task in case the child needed to take a short break.

This pilot task was nearly identical to the task used by Riby et al. (2012), except that it included twice the number of trials since we intended to manipulate distractor face type in subsequent studies (i.e., caregiver and stranger faces, Study 2; own- and other-race faces, Study 3). However, the current pilot task only included strangers as distractor faces (i.e., 54 face present trials, 54 face absent trials).
Data processing

We focused on participants’ response time as the primary dependent variable in this pilot study, consistent with Riby et al. (2012). We computed response time (RT) based on the average time that the participant took to indicate whether the target was present vs. absent. We calculated response time only for trials with correct responses and excluded any trials in which RTs were faster than 200ms or slower than two SDs above the individual’s overall mean response time.

Results

We examined participants’ RTs to indicate whether the butterfly target was present or absent using a repeated measures ANCOVA with within-subject factors of target condition (present, absent), distractor trial type (face absent, face present), and set size (3, 6, 9), between-subjects factor of gender (Male, Female), and age centered as a covariate. Although Riby et al. (2012) did not examine set size in their model, we included this variable in our analyses to confirm that we observed classic visual search effects (i.e., slower response time as set size increased).

Consistent with Riby et al. (2012), results indicated that participants responded more slowly during face present vs. face absent trials, $F(1,34) = 12.62, p < .001, \eta_p^2 = .27$; $M_{Present} = 1745.72$ ms, $SD = 180.89$; $M_{Absent} = 1701.09$ ms, $SD = 188.38$; Figure 2. Participants also responded more slowly during target absent vs. target present trials, $F(1,35) = 130.85, p < .001, \eta_p^2 = .79$; $M_{Absent} = 1820.82$ ms, $SD = 202.79$; $M_{Present} = 1625.97$ ms, $SD = 171.84$. We additionally found that participants responded slower as the number of distractor images in the set size increased, $F(2,68) = 139.24, p < .001, \eta_p^2 =$
Finally, there was a main effect of age, $F(1,34) = 15.30$, $p < .001$, $\eta^2_p = .31$, reflecting overall slower responses among younger participants ($r = -.59$). However, there was no main effect of gender on overall response times ($p = .59$).

We also found a significant target presence x gender interaction, $F(1,34) = 5.22$, $p = .03$, $\eta^2_p = .13$. Follow-up ANCOVAs indicated that both male and female participants were slower on target absent vs. target present trials ($p$'s < .001). To compare the extent of these performance costs, we computed RT difference scores by subtracting response times during target present trials from response times during target absent trials. An independent samples t-test revealed increased RT difference scores for females compared to males ($t(35) = 2.39$, $p = .03$, $d = .77$), indicating increased slowing of reaction time during target absent trials.

Finally, results indicated a significant target presence x set size interaction, $F(2,68) = 11.97$, $p < .001$, $\eta^2_p = .26$, which was further moderated by a gender x target presence x set size interaction. Follow-up ANCOVAs revealed a significant target presence x set size interaction for females only, $F(2,36) = 18.21$, $p < .001$, $\eta^2_p = .50$. Follow-up analyses indicated a significant effect of target presence on response times within each set size among female participants ($p$’s < .001). We again computed RT difference scores (target absent RT – target present RT) to compare the extent of these performance costs within each set size. The rate of slowing on target absent vs. present trials increased as set size increased ($M_3 = 130.87$, $SD_3 = 99.87$; $M_6 = 230.57$, $SD_6 = 164.96$; $M_9 = 345.78$, $SD_9 = 167.31$; all $p$’s < .008). The target presence x set size interaction was not significant among male participants ($p = .29$). Critically, these effects
of gender, target presence, and set size did not interact with distractor face trial type ($p$'s > .07).

Study 1 Discussion

The goal of Study 1 was to confirm the validity of online testing procedures by replicating attention capture by faces that was previously documented in Riby et al. (2012). As in Riby et al. (2012), participants were slower to respond to targets when a face appeared as a distractor in the search array. These results suggest that children are biased to automatically orient to unfamiliar faces, even when they are irrelevant to an ongoing task. In addition to this attention capture by faces, we also replicated classic search task effects, including increased response time costs during trials in which the target was absent and as the number of distractors increased (Wolfe, 2015). Although these classic effects of target presence and set size were moderated by gender, participant gender was unrelated to the extent to which faces disrupted search performance.

Figure 2. Response times on trials in which the face was absent versus present. Error bars represent SEM.
Although the overall findings of Study 1 converge with Riby et al. (2012), there were several key differences in the tasks and analytic approaches across these two studies. First, and most notably, unlike Riby et al. (2012), participants in Study 1 completed the attention capture task remotely from home. Our successful replication suggests that face effects observed by Riby et al. (2012) generalize to other testing environments in which concurrent exposure to faces and other distractions could not be tightly controlled. In addition, participants in our study completed twice the number of trials compared to Riby et al. (2012). Because we found similar results, we can conclude that the observed effects of face presence do not attenuate over additional trials. Thus, attention orienting biases towards faces may not subside as habituation to the task occurs. Finally, whereas Riby et al. (2012) presented 5 stranger faces that ranged in race and gender, we only included two face identities that were both White females. We made this design decision so that we could confirm the effects observed in Riby et al. (2012) still replicate when only using only two face identities, which would be critical for the design of Study 2 (presenting a caregiver vs. a stranger’s face).

In summary, Study 1 successfully replicated previous attention capture by faces in childhood, suggesting that the online data collection methods used in the current studies are valid. In the two following studies, we modified this online attention capture task to vary the motivational salience and familiarity (Study 2) or just familiarity (Study 3) of the two face distractors.
CHAPTER 3: STUDY 2

Previous research indicates that rewarding (i.e., motivationally salient) stimuli bias attention orienting in adulthood, and these effects are independent of both endogenous and exogenous mechanisms (Anderson et al., 2011; Kim et al., 2021). Furthermore, developmental neuroscience studies have found that caregiver faces and voices selectively activate neural reward processing regions in infancy and childhood (Abrams et al., 2016; Dehaene-Lambertz et al., 2010; Liu et al., 2019; Minagawa-Kawai et al., 2009). However, it is not yet known whether rewarding stimuli, such as caregiver faces, bias attention orienting during development.

Researchers have used attention capture tasks to measure the extent to which individuals automatically orient to faces. Previous investigations in both child and adult samples have shown that the presence of a task-irrelevant face distractor interferes with efficient target detection (Langton et al., 2008; Riby et al. 2012), confirming that unfamiliar faces capture attention. Our findings in Study 1 replicated this effect with 6- to 10-year-old children and confirmed that this attention capture by faces can be measured effectively using online data collection measures.

The goal of Study 2 was to determine whether children showed attention orienting biases to caregiver faces to a greater extent than faces in general. To address this question, we examined 6- to 10-year-old children’s attention orienting to caregiver versus stranger faces. We focused on children in this age range since they show increased activity in neural reward networks in response to caregiver cues (e.g., Abrams et al.,
Children completed an attention capture task in which they indicated whether a target was present among multiple distractors. During some trials, either a stranger or the caregiver’s face appeared as one of the distractors. We predicted that the presence of the caregiver face would capture attention and interfere with target detection to a greater extent than a stranger face.

Method

Participants

The final sample included forty-four 6- to 10-year-old children (25 F; 19 M; $M_{age} = 8$ years, 5.1 months, $SD = 1$ year, 4.7 months). An a priori power analysis with alpha = 0.05 and power = 0.8 indicated that 24 participants were needed to identify previously observed effect sizes (e.g., Riby et al., 2012). Participants were healthy children without a history of visual, auditory, or neurological impairments. We recruited families from the United States and Canada through online child research consortiums (e.g., ChildrenHelpingScience.com), social media, and existing lab databases. Parents reported that 75.0% of participants were White/Caucasian, 9.1% were Black/African American, 4.5% were Hispanic, 2.3% were Native American, 2.3% were Asian, and 6.8% were more than one race. Five additional participants were tested but excluded due to technical error ($N = 1$), declining to complete the full task ($N = 1$), or because their overall task accuracy was $> 3 SD$ below the group mean ($N = 3$). Parents and participants completed informed consent/assent according to approved protocols and were compensated with a $15 gift card.
Stimuli

Search arrays in Study 2 were nearly identical to those described in Study 1 (Figure 3). Participants searched for a target within search arrays that consisted of 3, 6, or 9 images (each image 150 x 150 pixels) appearing in a 3 x 3 grid (each square 200 x 200 pixels). We again used three unique butterfly images as potential targets and non-face distractors included images of flowers, fruits, houses, plants, shells, and shoes. However, instead of two unfamiliar faces, trials contained some trials in which their caregiver’s face was present and others in which a stranger’s face was present. Prior to their remote session, parents submitted 2-3 photos of their child’s primary caregiver facing forward with a neutral facial expression and without accessories (e.g., glasses, jewelry, etc.). We selected the photo in which the face was most visible and cropped it to remove external face features. To control for perceptual differences across face stimuli, we used each photo twice: once as the caregiver stimulus for their child and again as the stranger stimulus for another participant. Caregiver and stranger faces were matched across participants for race and gender when possible. The target and face locations were counterbalanced so that each face and butterfly image appeared in all locations an equal number of times. After determining target and face locations, non-face distractor images

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1 The strangers presented to the Asian and Native American participants were White. Overall results did not change when we excluded these participants (N = 2) from analysis.
were randomly placed in the remaining locations and appeared an equal number of times throughout the task.

**Procedure**

Given our successful replication in Study 1, families participated remotely for Study 2. Prior to the remote session, we asked parents to complete a questionnaire about their parenting practices. This questionnaire is described in the methods of Study 4. The testing procedures were otherwise identical. During the attention capture task participants again used the Z or M keys (counterbalanced across participants) to indicate whether the target butterfly was present or absent in the search array, and a face distractor appeared during a subset of trials. As in Study 1, the task included 6 practice trials and 108 trials in the primary task (54 target present, 54 target absent; 36 trials of each set size (3, 6, and 9)). The primary difference between Study 1 and Study 2 was the identities of the faces that appeared during the task. For both target present and target absent trials, one-third (18 trials) contained no face distractor (face absent), one-third contained a caregiver face distractor (caregiver present), and one-third contained a stranger face distractor (stranger

![Example stimuli (target present, set size 6) for Study 2. Trials contained either no face (Face Absent trials, left), their caregiver’s face (Caregiver Present trials, center), or a stranger’s face present (Stranger present trials, right) as a task irrelevant distractor. See Appendix A, Figure A1 for examples of all other trial types (target present vs. absent, set size 3, 6, 9).](image-url)
present). All task images were counterbalanced and pre-selected so that each participant viewed the same 108 search arrays, presented in random order.

After the task, we asked participants if they noticed any faces and if so, whether they recognized them. All participants noticed a face. Thirty-seven participants (84.1%) reported seeing both their caregiver and a stranger, 4 participants (9.1%) did not recognize any of the faces, and 3 participants (6.8%) reported seeing their caregiver and incorrectly reported seeing the experimenter. The overall results did not differ when we restricted analyses to the 37 participants who accurately reported seeing both their caregiver and a stranger.

Finally, we asked the parent to exit the room so that the researcher could administer two questionnaires about perceived attachment security and parenting behaviors. These questionnaires are described in the methods of Study 4.

**Data processing**

We expanded our analytical approach for Studies 2 and 3 to assess three performance measures during the attention capture task, instead of the one (i.e., response time) reported by Riby and colleagues (2012). First, we computed *omission errors* based on the proportion of trials in which participants failed to make any response. Next, we computed *accuracy* based on the proportion of trials in which participants correctly indicated that the target was present vs. absent. Last, we computed *response time (RT)* based on the average time that the participant took to indicate whether the target was present vs. absent. We again calculated RT only for trials with correct responses and
excluded any trials in which responses were faster than 200ms or slower than two $SD$s above the individual mean. Increased errors, poorer accuracy, and slower RTs reflect increased distraction that interferes with target detection.

**Results**

We examined error rate, accuracy, and RTs using repeated measures ANCOVAs with within-subject factors of target presence (present, absent), distractor face type (face absent, caregiver present, stranger present), and set size (3, 6, 9) and age centered as a covariate. We used Greenhouse-Geisser corrections as necessary to correct for violations of sphericity. We did not include participant gender in the model because data from our pilot study suggested that distraction by faces was not moderated by gender (see Study 1 Results). ANCOVA results are listed in Table 1 and summarized in the sections below.
Table 1

ANCOVA results for omission errors, accuracy and response times for Study 2.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Errors</th>
<th>Accuracy</th>
<th>Response Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>F</td>
<td>p</td>
</tr>
<tr>
<td>Target</td>
<td>1.42</td>
<td>28.74</td>
<td>&lt;.001***</td>
</tr>
<tr>
<td>Face Type</td>
<td>1.62,18.13</td>
<td>3.87</td>
<td>.03*</td>
</tr>
<tr>
<td>Set Size</td>
<td>2.84</td>
<td>11.27</td>
<td>&lt;.001***</td>
</tr>
<tr>
<td>Age</td>
<td>1.42</td>
<td>8.50</td>
<td>.006**</td>
</tr>
<tr>
<td>Target x Face Type</td>
<td>2.84</td>
<td>.32</td>
<td>.72</td>
</tr>
<tr>
<td>Target x Set Size</td>
<td>2.84</td>
<td>8.21</td>
<td>.001**</td>
</tr>
<tr>
<td>Target x Age</td>
<td>1.42</td>
<td>6.40</td>
<td>.015*</td>
</tr>
<tr>
<td>Face Type x Set Size</td>
<td>3.13,13.40</td>
<td>1.93</td>
<td>.15</td>
</tr>
<tr>
<td>Face Type x Age</td>
<td>2.84</td>
<td>.04</td>
<td>.96</td>
</tr>
<tr>
<td>Set Size x Age</td>
<td>2.84</td>
<td>1.29</td>
<td>.28</td>
</tr>
<tr>
<td>Target x Face Type x Set Size</td>
<td>3.15,13.47</td>
<td>.94</td>
<td>.43</td>
</tr>
<tr>
<td>Target x Face Type x Age</td>
<td>2.84</td>
<td>.42</td>
<td>.66</td>
</tr>
<tr>
<td>Target x Set Size x Age</td>
<td>2.84</td>
<td>1.93</td>
<td>.15</td>
</tr>
<tr>
<td>Face Type x Set Size x Age</td>
<td>4.168</td>
<td>.49</td>
<td>.75</td>
</tr>
<tr>
<td>Target x Face Type x Set Size x Age</td>
<td>3.15,13.47</td>
<td>.55</td>
<td>.67</td>
</tr>
</tbody>
</table>

Note: * indicates p < .05, ** indicates p < .01, *** indicates p < .001
Omission Errors

Participants showed overall low error rates ($M = 0.04, SD = 0.04$), indicating that they responded during most trials. However, these errors were influenced by age, task demands, and the presence of the caregiver face distractor. We found a main effect of age, $F(1, 42) = 8.50, p = .006, \eta^2_p = .17$, reflecting increased errors among younger children ($r = -.41, p = .006$). Participants also made more errors as the number of distractors increased ($F(2, 84) = 11.27, p < .001, \eta^2_p = .121; M_{SetSize3} = .025, SD = .04; M_{SetSize6} = .028, SD = .04; M_{SetSize9} = .057, SD = .06$; all post-hoc t-test $p$’s < .03) and when the target was present ($F(1, 42) = 28.74, p < .001, \eta^2_p = .41; M_{Present} = .06, SD = .05, M_{Absent} = .02, SD = .03$). Critically, we also found an effect of distractor face type ($F(1.62, 68.13) = 3.87, p = .03, \eta^2_p = .08$; Figure 4), with increased errors during caregiver present trials ($M = .05, SD = .06$) compared to both face absent ($M = .03, SD = .03; t(43) = 2.21, p = .03, d = .33$) and stranger present trials ($M = .03, SD = .04; t(43) = 2.16, p = .04, d = .27$). Participants showed similar error rates across the face absent and

![Figure 4](image_url)
stranger present trials ($p = .62$). These results suggest that the presence of a caregiver face distractor resulted in increased omission errors to a greater extent than faces in general.

**Accuracy**

Participants showed overall high accuracy in determining whether the target was present ($M = 0.91, SD = 0.06$), which did not vary by age ($p = .99$). However, participants were less accurate during target present vs. target absent trials ($F(1, 42) = 30.86, p < .001, \eta^2_p = .42$; $M_{\text{Present}} = .92, SD = .07$; $M_{\text{Absent}} = .97, SD = .03; p < .001$). Accuracy also varied based on set size, $F(2, 84) = 9.96, p < .001, \eta^2_p = .19$, as participants demonstrated increased accuracy during set size 3 ($M = .96, SD = .04$) compared to both set size 6 ($M = .93, SD = .05; t(43) = 4.08, p < .001, d = .54$) and set size 9 ($M = .93, SD = .05; t(43) = 3.73, p < .001, d = .60$). Accuracy during set sizes 6 and 9 did not differ ($p = .67$).

These main effects were moderated by a significant face type x target presence x set size interaction ($F(3.31, 138.95) = 2.80, p < .038, \eta^2_p = .06$). Follow-up analyses indicated that the target presence x set size interaction was not reliable during caregiver present trials ($p = .32$; Figure 5), reflecting poorer accuracy in detecting the target’s presence when the caregiver face appeared, regardless of set size. In contrast, distractor accuracy on target present vs. target absent trials depended on set size when there was no face distractor or a stranger face ($F_{\text{FaceAbsent}}(2.84) = 7.45, p = .001, \eta^2_p = .15$; $F_{\text{Stranger}}(1.71,71.68) = 4.34, p = .02, \eta^2_p = .10$; Figure 3). When there was no face distractor, participants were less accurate on target present trials only during set sizes 6
and 9 (Set Size 6: $M_{\text{Present}} = .91, SD = .12; M_{\text{Absent}} = .96, SD = .09; t(43) = 2.31, p = .03, d = .48$; Set Size 9: $M_{\text{Present}} = .88, SD = .12; M_{\text{Absent}} = .98, SD = .06; t(43) = 4.86, p < .001, d = 1.03$), but not during set size 3 ($p = .90$). When there was a stranger face distractor, participants were less accurate on target present trials only during set size 9 ($M_{\text{Present}} = .89, SD = .15; M_{\text{Absent}} = .98, SD = .04; t(43) = 3.65, p < .001, d = .78$) but not during set sizes 3 or 6 ($p$’s > .36). Overall, these results indicate that only the caregiver face distractor resulted in consistently poorer accuracy during target present trials, regardless of set size.

![Figure 5](image-url)  

**Figure 5.** Proportion of correct responses during target absent and target present trials across set sizes, plotted separately for caregiver present trials, face absent trials, and stranger present trials. The presence of the caregiver face distractor resulted in consistently poorer performance during target present trials, regardless of set size. In contrast, poorer accuracy during target present trials was evident only in larger set sizes when there was no face distractor or a stranger face distractor. Error bars represent SEM. * $p < .05$.

**Response Times (RTs)**

We conducted a final ANCOVA examining RTs to correctly indicate whether the target was present or absent. Overall, participants showed faster responses with age ($F(1,$
42) = 18.34, \( p < .001, \eta^2_p = .30, r(43) = -.53 \). RTs also varied by distractor face type \( (F(2, 84) = 5.24, p = .007, \eta^2_p = .11 \). Compared to face absent trials \( (M = 1777.89\,\text{ms}, \, SD = 227.71) \), participants were overall slower to respond during both caregiver present \( (M = 1818.76\,\text{ms}, \, SD = 239.87; \, t(43) = 2.87, p = .006, \, d = .17) \) and stranger present trials \( (M = 1803.02\,\text{ms}, \, SD = 230.87; \, t(43) = 1.96, p = .057, \, d = .11) \). There was no difference in overall RTs during caregiver present and stranger present trials \( (p = .16) \). Participants also responded more slowly during target absent trials \( (F(1,42) = 96.71, \, p < .001, \, \eta^2_p = .70; \, M_{\text{Absent}} = 1903.00\,\text{ms}, \, SD = 227.35, \, M_{\text{Present}} = 1696.79\,\text{ms}, \, SD = 244.91) \) and as the number of distractors in the set size increased \( (F(2, 84) = 115.33, \, p < .001, \, \eta^2_p = .73; \, \text{all post hoc t-test } p \text{'s } < .001).\)

These effects were moderated by a significant face type x target presence x set size interaction \( (F(4, 168) = 2.74, p = .03, \, \eta^2_p = .04; \, \text{Figure 6}) \). This interaction was driven by a face type x set size interaction during target present trials, \( F(4,172) = 5.90, \, p < .001, \, \eta^2_p = .12 \). When the target was present, response times varied based on distractor face type within the larger set sizes \( (F_{\text{SetSize6}}(2,84) = 7.41, \, p = .001, \, \eta^2_p = .15; \, F_{\text{SetSize9}}(2,84) = 4.56, \, p = .01, \, \eta^2_p = .10), \) but not in set size 3 \( (p = .17) \). During set size 6, participants responded more slowly when the caregiver face appeared \( (M = 1734.53\,\text{ms}, \, SD = 263.22) \) compared to trials in which the stranger face appeared \( (M = 1626.56\,\text{ms}, \, SD = 244.30; \, t(43) = 3.58, \, p < .001, \, d = .43) \). Participants also responded more slowly when no face distractor appeared \( (M = 1728.67\,\text{ms}, \, SD = 272.57) \) compared to trials in which the stranger face appeared \( (t(43) = 3.13, \, p = .003, \, d = .39), \) but there was no difference across face absent and caregiver present trials \( (p = .85) \). During set size 9 there were no differences in RTs across caregiver present trials and either face absent or
stranger present trials ($p’s > .08$). However, participants responded more slowly when a stranger face appeared ($M_{\text{Stranger}} = 1834.45 \text{ ms}, SD = 271.26$) compared to face absent trials ($M = 1733.58 \text{ ms}, SD = 273.95; t(43) = 2.80, p = .008, d = .37$).

Study 2 Discussion

These results demonstrate that the appearance of caregiver faces as a distractor disrupted 6- to 10-year-old children’s target detection during an attention capture task. Participants showed consistently poorer performance (i.e., increased omission errors, poorer accuracy, slower response times) during trials in which their caregiver appeared compared to those in which a stranger or no face appeared as a distractor. Although omission errors (i.e., failure to respond) were rare, the increased error rate during caregiver present trials suggests an overt distraction that disrupted children’s ability to
effectively complete task demands. Analyses of accuracy and reaction time indicated that the presence of the caregiver face also impacted children’s performance when they were able to execute a response. Compared to stranger faces, the presence of the caregiver face distractor resulted in poorer accuracy and slower response times, suggesting that the caregiver face was a salient distractor that captured children’s attention and interfered with effective target detection. These effects were more pronounced during target-present trials and as the number of distractor images increased. These results offer novel evidence that caregiver faces capture children’s attention to a greater extent than faces in general and suggest that these orienting biases may be sensitive to task context.

Participants were more likely to make omission errors during trials in which the caregiver face appeared as a distractor, regardless of target presence or set size. These effects were consistent across age and did not depend on the child explicitly recognizing their caregiver during the task. These results are consistent with recent findings demonstrating that the presence of highly salient distractors makes adults more likely to stop searching early (Lawrence & Pratt, 2021; Moher, 2020). Our error data suggest that caregiver faces, more so than stranger faces, acted as a highly salient distractor in the task and may have led participants to abort their search. Although previous attention capture studies have not typically reported omission errors, we interpret this increased error rate as a strong overt behavioral distraction in the context of the caregiver face. Future research is needed to determine whether other salient stimuli (e.g., color singletons, abrupt onsets) similarly disrupt task performance, or if these effects are specific to the familiar and/or motivating properties of the caregiver face.
Participants’ accuracy and reaction time to determine whether the target was present also revealed effects that are consistent with extensive past research using visual search and attention capture tasks. Although there were no age-related changes based on distractor face type, younger children’s overall slower responses suggest improvements in attention control with age (e.g., Keebler et al., 2020). We also saw poorer accuracy and slower response times as set size increased, reflecting increased difficulty of suppressing additional information (e.g., Duncan & Humphreys, 1989; Gerhardstein & Rovee-Collier, 2002; Treisman & Gelade, 1980). Participants also responded more slowly when the target was absent, consistent with the use of different search strategies for target present versus absent trials (Godwin et al., 2014; Treisman, 1988). Findings from the current study and our pilot study converge with this past work, suggesting that our online testing protocol was effective for assessing attention orienting in childhood.

The present study also demonstrated that the size of the search array and the presence vs. absence of the target influenced the extent to which caregiver faces disrupted target detection. These findings mirror past research indicating that faces interfered with search performance only during target present trials (Langton et al., 2008; Riby et al., 2012). Effects of distractor face type may have been attenuated during target absent trials because participants needed to attend to every item, including the caregiver and stranger faces, before confirming that the target was absent. The presence of caregiver faces resulted in poorer accuracy during target present trials regardless of set size. Effects of caregiver face distractors on reaction time were also specific to target present trials, but only within set size 6. In contrast, caregiver faces did not affect response times within set size 3, and response time differences across caregiver and stranger present trials were
attenuated in set size 9. Research on infants has shown that the number of items in an array can influence orienting to faces. Kwon et al. (2016) found that 4-month-old infants detected faces when there were few distractors, even though infants typically do not reliably orient to faces in search arrays until 6 months (e.g., Gliga et al., 2009). In the current study, the limited number of items in set size 3 may have similarly supported rapid orienting to faces, regardless of their identity. However, as set size increases individuals may rely on more global search strategies rather than scanning items individually (Liesefeld et al., 2021), and this wider attentional window can be more susceptible to distraction from salient distractors (Belopolsky et al., 2007). We speculate that the differential salience of caregiver vs. stranger faces may have had a stronger impact on orienting within set size 6 due to these changing search strategies. Although previous research has demonstrated that faces capture attention (Langton et al., 2008; Riby et al., 2012), these studies did not examine how set size or search strategies modulated these effects. Future studies can further investigate how these factors influence orienting to caregiver faces by determining whether similar biases are observed in naturalistic contexts that contain many distractors.

One possibility is that children showed biased attention to caregiver faces relative to stranger faces is because they are socially rewarding (e.g., Abrams et al., 2015). This interpretation is consistent with adult research demonstrating that rewarding stimuli bias attention orienting (e.g., Anderson et al., 2011). Therefore, the results of the current study suggest that the motivational salience of caregiver faces may similarly bias attention orienting during childhood. However, caregivers are both socially reward and highly prevalent stimuli in children’s environments (e.g., Dotti Sani & Treas, 2016). Therefore,
another possibility is that the observed orienting bias reflects children’s frequency of experience with caregiver faces, rather than their motivational salience. We conducted Study 3 to examine this potential role of familiarity in mediating children’s attention orienting to faces.
CHAPTER 4: STUDY 3

Although we found evidence that children’s attention was captured by caregiver faces in Study 2, the mechanisms underlying this orienting bias to caregivers remain unclear. We hypothesize that these effects were driven by the reward value of the caregiver (e.g., Abrams et al., 2005), reflecting motivated selective attention mechanisms that have previously been identified in adulthood (Kim et al., 2021). However, because caregivers are also highly familiar, it remains possible that children’s orienting bias during the attention capture task reflects the familiarity, rather than motivational salience, of caregiver faces. To address this possibility, Study 3 determined whether children showed a similar attention orienting bias to highly familiar own-race faces.

Past research had indicated that infants show stronger attention holding biases for familiar race faces. For example, 3-month-old infants look longer towards own-race faces (e.g., Kelly et al., 2007), but this is reversed or attenuated if the infant is cared for by an other-race individual (e.g., through adoption; Sangrigoli et al., 2005; or nannying, Singh et al., 2022). This work demonstrates that frequency of exposure (i.e., familiarity) shapes the development of early attention holding biases such that stronger biases are observed for more frequently experienced own-race faces. Moreover, these attention holding biases for own-race faces are even more pronounced among populations that experience increased homogeneity of racial diversity exposure (e.g., Ellis et al., 2017).

However, previous work in our lab found that infants showed similar attention orienting to own- and other-race faces at the group level (Hunter & Markant, 2021). This
work suggests that familiarity alone may be insufficient to drive children’s automatic attention orienting to faces during an attention capture task, as we observed in Study 2. However, this previous research only tested infants and used an eye tracker to assess orienting to target faces during a visual search task. Therefore, it is not known if older children who have more cumulative experience with faces would also show similar orienting to own- and other-race faces when they appear as task-irrelevant distractors during an attention capture task. To address this question, we examined 6- to 10-year-old children’s attention orienting to own- versus other-race faces. We selected this age range to mirror the approach of Study 2. Children completed an attention capture task in which they indicated whether a target was present among multiple distractors. During some trials, either an own-race or other-race face appeared as one of the distractors. Based on the findings in infancy that race-based information does not influence attention orienting (Hunter & Markant, 2021), we predicted that we would not observe differences across face types.

Method

Participants

The final sample included 39 6- to 10-year-old children (22 F; 17 M; M_{age} = 8 years, 0 months, SD = 1 year, 3.60 months). An a priori power analysis with alpha = 0.05 and power = 0.8 indicated that 24 participants were needed to identify previously observed effect sizes (e.g., Riby et al., 2012). Recruitment and screening procedures were identical to Study 2. Parents reported that 92.31% of participants were White/Caucasian, and 7.69% were Black/African American. Fourteen additional participants were tested
but excluded from analyses since they did not identify as White or Black and thus did not have own- and other-race trial conditions. Two additional participants were tested but excluded due to technical error (N = 1) or because their overall task accuracy was > 3 SD below the group mean (N = 1). Parents and participants completed informed consent/assent according to approved protocols and were compensated with a $15 gift card.

**Stimuli**

Search arrays in Study 3 were nearly identical to those described in prior studies (Figure 7). Participants searched for a target within search arrays that consisted of 3, 6, or 9 images (each image 150 x 150 pixels) appearing in a 3 x 3 grid (each square 200 x 200 pixels). We again used three unique butterfly images as potential targets and non-face distractors included images of flowers, fruits, houses, plants, shells, and shoes. However, we presented White and Black faces rather than caregiver and stranger faces distractors. Similar to Study 1, face distractors were all female faces with neutral emotion selected from the Chicago Faces Database (Ma et al., 2015) and therefore unfamiliar to the child. The White face stimulus was one of the two face identities presented in Study 1. We selected the Black face stimulus to approximately match the width and height of the White face. We cropped both faces to remove external face features. As in prior studies, the target and face locations were counterbalanced so that each face and butterfly image appeared in all locations an equal number of times. After determining target and face

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2 Participants were never recruited based on race or ethnicity.
locations, non-face distractor images were randomly placed in the remaining locations and appeared an equal number of times throughout the task.

![Figure 7](image_url)

Figure 7. Example stimuli (target present, set size 6) for Study 3. Trials contained either no face (Face Absent trials, left), a White face (White Face Present trials, center), or a Black face present (Black Face present trials, right) as a task irrelevant distractor. See Appendix A, Figure A1 for examples of all other trial types (target present vs. absent, set size 3, 6, 9).

**Procedure**

Families again participated remotely for Study 3 and the testing procedures were identical to Study 2. As in prior experiments, participants used the Z or M keys (counterbalanced across participants) to indicate whether the target butterfly was present or absent in the search array. The task timing and number of trials were identical to Study 2 (6 practice trials; 54 target present, 54 target absent trials; 36 trials of each set size (3, 6, 9)). The primary difference between Study 2 and Study 3 was the identities of the faces that appeared during the task. For both target present and target absent trials, one-third (18 trials) contained no face distractor (face absent), one-third (18 trials) contained a White face distractor (White face present), and one-third (18 trials) contained a Black face distractor (Black face present). All task images were counterbalanced and pre-
selected so that each participant viewed the same 108 search arrays, presented in random order.

After the task, we asked participants if they noticed any faces and if so, whether they recognized them. All participants noticed a face. However, none of the participants reported that they recognized a face.

Data processing

We first re-coded data for trials containing the White and Black faces to “own-race” and “other-race” trials based on the parent’s report of their child’s race (e.g., we coded trials with White faces as own-race for Caucasian/White participants but other-race for African American/Black participants, and vice versa). Thus, all participants had 18 trials in which an own-race face was present, 18 trials in which an other-race face was present, and 18 trials in which no face was present.

We then assessed the same three measures of attention capture task performance described in Study 2. Omission errors were the proportion of trials in which participants failed to make any response. Accuracy was the proportion of trials in which participants correctly indicated that the target was present vs. absent. Last, response time (RT) was the average time that the participant took to indicate whether the target was present vs. absent. We again calculated RT only for trials with correct responses and excluded any trials in which responses were faster than 200ms or slower than two SDs above the individual mean. Increased errors, poorer accuracy, and slower RTs reflect increased distraction that interferes with target detection.
Results

We examined error rate, accuracy, and RTs using repeated measures ANCOVAs with within-subject factors of target presence (present, absent), distractor face type (face absent, own-race present, other-race present), and set size (3, 6, 9) and age centered as a covariate. ANCOVA results are listed in Table 2 and summarized in the sections below.

We conducted separate analyses for the full sample of participants and after removing non-Caucasian/White participants (N=3). Although accuracy and response time results did not vary, omission error results varied slightly across these analyses. When including all participants in the analyses (described below), we found that errors on target absent vs. present trials varied across age. However, when restricting analyses to only Caucasian/White participants, this interaction was no longer significant, and we instead found a significant face type x set size interaction. These differences are described in full detail in Appendix B. However, we report results for the full sample below as these differences did not affect the overall patterns of results and conclusions.
Table 2

**ANCOVA results for omission errors, accuracy and response times for Study 3.**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Errors df</th>
<th>F</th>
<th>p</th>
<th>$n^2$</th>
<th>Accuracy df</th>
<th>F</th>
<th>p</th>
<th>$n^2$</th>
<th>Response Time df</th>
<th>F</th>
<th>p</th>
<th>$n^2$</th>
</tr>
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<td>Target</td>
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<td>6.94</td>
<td>.01*</td>
<td>.16</td>
<td>1,37</td>
<td>24.71</td>
<td>&lt;.001 ***</td>
<td>.40</td>
<td>1,37</td>
<td>143.14</td>
<td>&lt;.001 ***</td>
<td>.80</td>
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<td>.44</td>
<td>.02</td>
<td>2.74</td>
<td>.96</td>
<td>.39</td>
<td>.03</td>
<td>2.74</td>
<td>.10</td>
<td>.38</td>
<td>.03</td>
</tr>
<tr>
<td>Set Size</td>
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<td>9.66</td>
<td>&lt;.001 ***</td>
<td>.21</td>
<td>2.74</td>
<td>.45</td>
<td>.64</td>
<td>.01</td>
<td>2.74</td>
<td>108.08</td>
<td>&lt;.001 ***</td>
<td>.74</td>
</tr>
<tr>
<td>Age</td>
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<td>.18</td>
<td>.05</td>
<td>1.37</td>
<td>.45</td>
<td>.51</td>
<td>.01</td>
<td>1.37</td>
<td>20.04</td>
<td>&lt;.001 ***</td>
<td>.35</td>
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<td>Target x Face Type</td>
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<td>2.63</td>
<td>.08</td>
<td>.07</td>
<td>2.74</td>
<td>1.58</td>
<td>.21</td>
<td>.04</td>
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<td>.94</td>
<td>.00</td>
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<tr>
<td>Target x Set Size</td>
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<td>.07</td>
<td>.07</td>
<td>2.74</td>
<td>4.01</td>
<td>.02**</td>
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<td>1.56,57.67</td>
<td>21.01</td>
<td>&lt;.001 ***</td>
<td>.36</td>
</tr>
<tr>
<td>Target x Age</td>
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<td>4.53</td>
<td>.04*</td>
<td>.11</td>
<td>1.37</td>
<td>.58</td>
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<td>.51</td>
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<td>.46</td>
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<td>.09</td>
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<td>.72</td>
<td>.01</td>
<td>4.148</td>
<td>.68</td>
<td>.60</td>
<td>.02</td>
<td>3.20,118.52</td>
<td>2.88</td>
<td>.04*</td>
<td>.07</td>
</tr>
<tr>
<td>Target x Face Type x Age</td>
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<td>.18</td>
<td>.83</td>
<td>.01</td>
<td>2.74</td>
<td>.04</td>
<td>.96</td>
<td>.00</td>
<td>2.74</td>
<td>.20</td>
<td>.82</td>
<td>.01</td>
</tr>
<tr>
<td>Target x Set Size x Age</td>
<td>2.74</td>
<td>.54</td>
<td>.59</td>
<td>.01</td>
<td>2.74</td>
<td>.27</td>
<td>.76</td>
<td>.01</td>
<td>2.74</td>
<td>2.71</td>
<td>.07</td>
<td>.07</td>
</tr>
<tr>
<td>Face Type x Set Size x Age</td>
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<td>.56</td>
<td>.69</td>
<td>.02</td>
<td>4.148</td>
<td>.67</td>
<td>.61</td>
<td>.02</td>
<td>4.148</td>
<td>.57</td>
<td>.69</td>
<td>.02</td>
</tr>
<tr>
<td>Target x Face Type x Set Size</td>
<td>4, 148</td>
<td>.88</td>
<td>.48</td>
<td>.02</td>
<td>4.148</td>
<td>.47</td>
<td>.76</td>
<td>.01</td>
<td>4.148</td>
<td>.08</td>
<td>.99</td>
<td>.00</td>
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</tbody>
</table>

*Note. * indicates $p < .05$, ** indicates $p < .01$, *** indicates $p < .001$*
Omission Errors

Participants showed overall low error rates ($M = 0.03, SD = 0.04$), indicating that they responded during most trials. However, these errors were influenced by age and task demands. Participants made more omission errors when the target was present ($F(1, 37) = 6.94, p = .01, \eta_p^2 = .16$; $M_{\text{Present}} = .04, SD = .05, M_{\text{Absent}} = .02, SD = .04$). This effect was moderated by an age x target presence interaction ($F(1, 37) = 4.53, p = .04, \eta_p^2 = .11$). To investigate this interaction effect, we computed the difference in error rates on target present vs. absent trials. We found that this difference in error rate on target present vs. absent trials increased with age ($r = .33$), indicating that older children showed increased search performance costs when the target was present. We additionally found a main effect of set size ($F(2, 74) = 9.66, p < .001, \eta_p^2 = .21$). Follow-up paired comparisons indicated that participants made more errors during set size 9 ($M = .04, SD = .06$) compared to both set size 3 ($M = .02, SD = .04; t(38) = 4.01, p < .001, d = .39$) and set size 6 ($M = .02, SD = .04; t(38) = 3.58, p < .001, d = .39$). However, participants omitted responses on a similar number of trials during set sizes 3 and 6 ($p = .98$). All other main effects and interactions related to age and task demands were not significant ($p$’s > .06). Critically, error rates were not influenced by face distractor face type ($p$’s > .08).

Accuracy

Participants showed overall high accuracy in determining whether the target was present ($M = 0.92, SD = 0.05$), which did not vary by age ($p = .51$). However, participants were more accurate during target present vs. target absent trials ($F(1, 37) = 4.53, p = .04, \eta_p^2 = .11$).
24.71, \( p < .001, \eta^{2} = .40; M_{\text{Present}} = .97, SD = .03; M_{\text{Absent}} = .93, SD = .06 \). This effect of target presence was further moderated by set size \( (F(2, 74) = 4.01, p = .02, \eta^{2} = .10) \). To investigate this interaction, we computed the difference in accuracy on target present vs. absent trials (i.e., target absent accuracy cost) for each set size. Follow-up paired samples t-tests revealed increased target absent accuracy cost during set size 9 \( (M = .07, SD = .06) \) compared to set size 3 \( (M = .02, SD = .07; t(38) = 3.02, p = .005, d = .09) \). However, this accuracy cost on target absent trials did not differ during set size 6 trials \( (M = .04, SD = .09) \) compared to set size 3 or 9 trials \( (p's > .09) \). Thus, participants showed the greatest target absent accuracy costs during trials that required searching a large number of distractors, compared to trials in which there were only a few distractors in the array.

There were no other effects of task demands or age that influenced participants’ accuracy \( (p's > .21) \). There were no effects of distractor face type on accuracy \( (p's > .21) \).

**Response Times (RTs)**

We conducted a final ANCOVA examining RTs to correctly indicate whether the target was present or absent. Overall, participants showed faster responses with increasing age \( (F(1,37) = 20.04, p < .001, \eta^{2} = .35; r(38) = -.58) \). Participants responded more slowly during target absent trials compared to target present trials \( (F(1, 37) = 143.14, p < .001, \eta^{2} = .80; M_{\text{Absent}} = 1812.22 \text{ ms}, SD = 177.35, M_{\text{Present}} = 1630.90 \text{ ms}, SD = 144.77) \) and as the number of distractors in the arrays increased \( (F(2,74) = 108.08, p < .001, \eta^{2} = .74; \text{all post hot t-test } p's < .001) \). Furthermore, target presence and set size interacted to influence response times \( (F(1.56, 57.67) = 21.01, p < .001, \eta^{2} = .36) \). To further investigate this interaction, we computed RT cost scores by subtracting
participants’ RT during target present trials from their RT during target absent trials within each set size. Follow-up t-tests revealed increased slowing of response times during target absent trials as the number of distractors increased (p’s < .004). In addition to target presence, age also interacted with set size. To investigate this effect, we computed RT costs scores across each set size (i.e., RT during SS6 - RT during SS3; RT during SS9 - RT during SS6). Older children showed increased RT costs across set sizes 3 and 6 (r = .35, p = .03) but age was unrelated to RT costs across set sizes 6 and 9 (r = .05, p = .78).

Finally, these effects were moderated by a significant face type x target presence x set size interaction (F(3.20, 118.52) = 2.88, p = .04, ηp² = .07; Figure 8). This interaction was driven by a face type x set size interaction during target present trials, F(4,148) = 4.34, p = .002, ηp² = .11, but not target absent trials (p = .48). When the target was present, there was no effect of distractor face type within set size 3 (p = .55). In contrast, RTs varied significantly based on face type within set size 6 (F(2,74) = 6.63, p = .002, ηp² = .15) and marginally within set size 9 (F(2,74) = 3.00, p = .056, ηp² = .08). During set size 6, participants responded slower during face absent trials (M = 1686.64 ms, SD = 178.11) compared to both own-race (M = 1631.23 ms, SD = 218.34; t(38) = 2.10, p = .04, d = .28) and other-race present trials (M = 1583.76 ms, SD = 219.97; t(38) = 3.65, p < .00, d = .51). However, there was no difference in RTs to own- versus other-race present trials (p = .11). During set size 9 there were no differences in RTs across own-race present trials and either face absent or other-race present trials (p’s > .15). However, participants responded more slowly when an other-race face appeared (M =
1728.55 ms, $SD = 224.78$) compared to face absent trials ($M = 1653.89$ ms, $SD = 204.76$; $t(38) = 2.52, p = .02, d = .35$).

![Figure 8](image.png)

**Figure 8.** Response times during own-race present, face absent, and other-race present trials across set sizes, plotted separately for target absent and target present trials. When the target was present, response times varied by face type only during the larger set sizes. Error bars represent SEM. * $p < .05$.

**Study 3 Discussion**

In Study 2 we found evidence that children showed stronger attention orienting biases towards caregiver faces, relative to unfamiliar faces. However, it was not clear whether these observed effects were mediated by the motivational salience or the familiarity of the caregiver. We, therefore, conducted Study 3 to evaluate the extent to which own-race faces, which are highly familiar but less motivationally salient, bias attention orienting, relative to less familiar other-race faces. The results of the current study demonstrate that the appearance of own-race faces did not disrupt 6- to 10-year-old children’s target detection to a greater extent than other-race faces during an attention capture task. Participants showed similar performance (i.e., omission errors, accuracy,
and response times) during trials in which an own- versus an other-race face appeared. These results suggest that the increased familiarity of own-race faces did not drive biased attention orienting to these faces in childhood.

Children were faster and more accurate on trials in which the target was present, but they were also more likely to make omission errors on these trials. While previous studies have also typically reported faster and more accurate responding on target present trials (e.g., Treisman, 1988), no studies to our knowledge have also considered the number of trials in which participants fail to respond. Therefore, future work is needed to determine why improvements in accuracy and response times during target present trials may be accompanied by increased omission error rates.

As in Study 2, participants’ accuracy and reaction time to determine whether the target was present replicated past research findings based on visual search and attention capture tasks. For instance, we saw faster response times and improved accuracy on target present trials, which is consistent with previous work demonstrating participants shift their search strategies on target present versus absent trials (Godwin et al., 2014; Treisman, 1988). Whereas participants may quickly scan and correctly identify targets on target present trials using a more global search strategy, target absent searches require that participants carefully examine each item in the array, which may introduce costs in response times and accuracy. We also saw slower response times as set size increased, which may reflect increased difficulty of suppressing additional information (e.g., Duncan & Humphreys, 1989; Gerhardstein & Rovee-Collier 2002). Past research has also demonstrated that the development of endogenous attention control supports this ability to ignore competing distractors such that older children are faster to orient toward targets
compared to younger children who are more distracted by perceptual salience via exogenous mechanisms (Gaspelin et al., 2014; Lobaugh et al., 1998; Trick & Enns, 1998). Consistent with this, older children in the current study showed overall faster responses, suggesting that their improvements in endogenous attention control supported more efficient target detection (e.g., Keebler et al., 2020).

We did not find an overall effect of face presence, suggesting that faces in general did not robustly capture children’s attention during this task. This finding is contrary to previous studies investigating face attention capture, including our own pilot experiment (Study 1). Given this successful replication of Riby et al. (2012) in Study 1, we feel confident that the lack of a face capture in the current experiment is not due to the online nature of the task. Instead, the current results suggest that distraction by faces may be highly sensitive to task context. Specifically, we found effects of face presence on children’s response times only during target present trials, consistent with past research investigating children’s and adults’ attention biases to faces using attention capture tasks (Langton et al., 2008; Riby et al., 2012). These effects of distractor face type specifically on target present trials may reflect differences in search strategies during target absent versus present trials. Automatic attention orienting to the distractor faces may have been attenuated during target absent trials because participants needed to inspect each item before confirming that the target was absent. Although past investigations did not examine how set size interacted with attention capture by faces during target present trials, we found that these effects were specific to set size 6 and set size 9 trials. Children’s attention was not captured by the face distractors during set size 3, which may reflect their ability to effectively suppress attention to non-targets when there were only a
few items to ignore. In contrast, during set size 6 and 9, children may have had more difficulty suppressing this additional information and may have relied on a more global search strategies to detect the target (Liesefeld et al., 2021). This broader strategy can be more susceptible to interference from salient distractors (Belopolsky et al., 2007), such as faces. Future work using eye tracking methodologies may offer additional insight as to whether distraction by faces is related to differences in scanning patterns at increasing set sizes.

Automatic orienting to the face distractors may have also been attenuated in the current study due to their reduced novelty. In Study 1, half of the trials in the attention capture task contained a face distractor. In contrast, in the current study, two-thirds of the trials contained a face distractor (from varying race categories) and the remaining third did not. This increased prevalence of faces in the current task may have reduced their novelty, resulting in less effective attention capture by faces compared to Study 1. Additional research with an equal number of face present and absent trials is needed to investigate this possibility. Future work should also use a wider range of face exemplars to rule out the possibility that the specific stimuli we selected in this task contributed to these null results.

Overall, children were not more distracted by own- versus other-race faces, replicating previous work in infancy (Hunter & Markant, 2021). These findings, together with those of Study 2, allow us to draw conclusions regarding what types of faces are most effective at capturing children’s attention. In Study 2, children were biased by caregiver faces to a greater extent than unfamiliar stranger faces. We hypothesized that this biased orienting to caregivers may be due to the rewarding nature of caregivers (e.g.,
Abrams et al., 2015) or the familiarity of caregivers (e.g., Dotti Sani & Treas, 2016). However, the current study demonstrated that faces from a more familiar category (i.e., own-race) did not bias attention to a greater extent than those from a less familiar category (i.e, other-race). We, therefore, suggest that motivational salience may have a stronger influence than familiarity on children’s attention orienting to faces. However, Studies 2 and 3 examined the effects of reward and familiarity on children’s attention orienting at the group level. As a result, it is unclear how the extent of reward and familiarity associated with the faces may relate to individual differences in children’s attention orienting biases. For example, individual differences in the quality of child-caregiver interactions (e.g., more positive parenting, secure attachment) may relate to children’s attention orienting biases to caregiver vs. stranger faces. Similarly, while the current study did not observe biased orienting when considering the group as a whole, it remains possible that children with more homogenous own-race exposure may show stronger attention orienting biases to familiar own-race faces. In Study 4 we conducted exploratory analyses aimed at investigating these relations.
CHAPTER 5: STUDY 4

In Study 2, we found that participants showed stronger attention capture by caregiver faces, indicated by consistently poorer performance (i.e., increased omission errors, poorer accuracy, slower response times) during trials in which their caregiver appeared as a distractor, compared to those in which a stranger or no face appeared. Caregiver faces are both social rewarding (e.g., Abrams et al., 2016) and highly familiar (e.g., Dotti Sani & Treas, 2016), but the results of Study 3 indicated that these impairments did not extend to face types that were merely familiar (i.e., own-race). We, therefore, suggest that the rewarding nature of caregiver faces was a key mechanism driving the effects observed in Study 2. Although biased attention orienting to caregivers was robust at the group level in Study 2, additional work suggests that individual differences in children’s experiences with their caregivers may shape these attention biases. In particular, attachment theory argues that children’s biases to explore novelty in the environment vs. seek proximity to their caregiver depends on the quality of the caregiver-child attachment (Sroufe & Waters, 1997), and previous studies suggest that attention orienting biases to stranger faces may reflect children’s use of their caregiver as a secure base (Carver, 2003; Kungl et al., 2017). Therefore, the extent to which children were biased to orient towards their caregiver versus a novel stranger in Study 2 may relate to individual differences in caregiver-child relationships. Previous research has similarly shown that experience shapes attention holding biases to own- vs. other-race faces in infancy. Specifically, relatively homogenous own-race exposure has been related
to greater differences in looking times to own- vs. other-race faces, whereas these attention holding biases are attenuated among infants with increased exposure to other races (Ellis et al., 2017; Singh et al., 2022). Overall, these findings demonstrate that frequency of exposure to own-race faces may determine the extent to which individuals show attention holding biases to own-race faces. However, it is unknown if this extends to attention orienting biases.

Therefore, Study 4 conducted exploratory analyses to determine whether individual differences in caregiver-child relationship quality and frequency of own-race face exposure are related to the extent to which children demonstrate caregiver- and race-related attention orienting biases, respectively. To address this question, we used questionnaire data completed by the parents and children in Study 2 and Study 3, which provided metrics of positive parenting and the child’s perceived attachment security (Study 2), and frequency of exposure to own- and other-race individuals (Study 3). We predicted that children with more secure attachment relationships, and with parents who use more positive parenting behaviors that contribute to this attachment security, would demonstrate attention orienting biases towards novel strangers. Finally, although we did not observe biased orienting to familiar own-race faces at the group level in Study 3, we remained open to the possibility that individual differences in racial diversity exposure may predict race-based orienting biases.

**Method**

**Participants**

We analyzed questionnaire data for all participants who provided useable attention capture task data for Study 2 (N = 44; 25 F, $M_{age} = 8$ years, 5.1 months, $SD = 1$...
year, 4.7 months) and Study 3 (N = 39; 22 F, M_age = 8 years, 9.31 days, SD = 1 year, 3.60 months). These sample sizes were determined based on power analyses for the attention capture tasks in Studies 2 and 3. We conducted post hoc sensitivity analyses (see Results), which revealed that the current exploratory analyses of individual differences were underpowered. Therefore, the following results should be considered preliminary.

A subset of parents or children did not agree to complete all questionnaires. As a result, of the 44 participants who completed Study 2, questionnaire data were missing from five participants for the APQ-Parent and two participants for the Security Scales. If a male caregiver provided consent and participated with the child, we did not assume the child had a mother, so we did not administer the Security Scales questionnaire in these cases (N = 5) because this questionnaire specifically asked questions about the mother. Thus, for Study 2 the final sample with usable data on all questionnaires was N = 33. Of the 39 participants who completed Study 3, nine participants did not contribute any diversity questionnaire data and an additional five did not complete the full questionnaire, resulting in usable data for a final sample of N = 25.

Materials

Quality of Caregiver-Child Relationships

Alabama Parenting Questionnaire (APQ-9). Both parents and children completed this 9-item questionnaire (Appendix C and D; Elgar et al., 2006). Each question asked parents and children to use a Likert scale to respond to statements regarding a parenting behavior (e.g., “You let your child know when he/she is doing a good job with something”; 1 = “Never” to 5 = “Always”). Questions focused on three
topics: positive parenting (e.g., complimenting the child), inconsistent parenting (e.g., letting out of a punishment early), and poor supervision (e.g., not knowing the child’s friends).

**Security Scales Questionnaire.** Only children completed this 15-item questionnaire. The Security Scales questionnaire assesses children’s perceptions of their mother’s responsiveness, availability, reliability, as well as children’s willingness to communicate thoughts and feelings to their mother (Appendix E; Kerns et al., 1996). Although this questionnaire was validated for use in 8-12-year-old children, researchers have successfully used this measure with children from 7 to 18 years (e.g., Kim & Page, 2012; Williams et al., 2017). Each security scales question had two parts. First, the question described two types of kids (e.g., “Some kids go to their mother when they’re upset BUT other kids do not go to their mother when they’re upset”) and participants were asked to select which kid was more like themself. Then, participants were asked if their selection was “Really true for me” or “Sort of true for me”. The responses were scored 1-4 depending on whether the participants’ response described a more secure attachment behavior (e.g., going to their mom when upset), and how true the statement was for them. For instance, a response that indicates a participant is more similar to a kid who “goes to their mom when they’re upset” would receive a score of 4 (if the statement was “really true”) or 3 (if the statement was “sort of true”). Conversely, if the participant indicated they were more like a kid with less secure attachment behaviors (e.g., do not go to their mom when upset), they would receive a score of 1 (if the statement was “really true”) or 2 (if the statement was “sort of true”).
Racial Diversity Exposure

**Diversity Questionnaire.** This parent-report questionnaire assessed the diversity of race exposure in the child’s life (Appendix F). We developed this novel questionnaire by combining approaches from questionnaires used in multiple prior studies that assessed diversity exposure (Hwang et al., 2020; McKone et al., 2019; Montoya et al. 2017). Parents were asked to report 1) their local zip code 2) the name of their child’s school, 3) the race and ethnicities of the top five non-parent adults that their child spends time with, and 4) the estimated percentage of their child’s friends, neighbors, and classmates who are of the same vs. a different race. These questions allowed us to quantify the racial diversity in children’s relationships and broader environments.

**Procedure**

Questionnaires assessing child-caregiver relationship quality (APQ-9, Security Scales) were administered to parents and children during both Study 2 and Study 3. The Diversity Questionnaire was administered only to parents whose children participated in Study 3.

Questionnaires were administrated using identical procedures across Studies 2 and 3. Parents completed their questionnaires independently without assistance before the remote testing session. Children completed their questionnaires during the testing session and after completing the attention capture task. For each questionnaire, the researcher read each question to the participant and recorded their responses. Parents were asked to
leave the room while their child completed the questionnaires so that they could answer as honestly as possible.

Data Processing

Attention Biases

Using data from Studies 2 and 3, we computed difference scores to assess the caregiver and own-race attention orienting biases. For each dependent measure (omission errors, accuracy, response time), we calculated a distraction index by the difference in task performance during caregiver vs. stranger present trials (Study 2) and own- vs. other-race face present trials (Study 3). More positive values indicate increased omission errors, reduced accuracy, and slowing of reaction time reflecting increased difficulty suppressing the caregiver and own-race faces, relative to stranger and other-race faces, respectively. In other words, higher distraction indices suggest stronger attention orienting biases to the face distractor due to heightened motivational salience (caregivers) or familiarity (own- race).

Child-Caregiver Relationship Quality

APQ-9. We calculated three scores from the parent and child APQ-9 responses: positive parenting, inconsistent discipline, and poor supervision. We computed these scores by adding the Likert response (1-5) for the three questions per each subscale measure. We computed scores separately based on parent and child responses. We
focused on the positive parenting measure, which is defined as the parents’ tendencies to respond to desirable child behavior with positive reinforcement (e.g., “praising [the] child if he/she behaves well”). We focused on positive parenting because previous research has shown that more positive and warm parenting practices (e.g., using positive reinforcement) may influence children’s neural reward network reactivity (Morgan et al., 2014). Higher scores indicated more frequent use of positive reinforcement by parents.

**Security Scales.** We averaged participants’ responses across the 15 items to produce a single measure of their perceived attachment security (ranging from 1 = insecure to 4 = secure).

**Diversity of Exposure**

Diversity variables extracted from this questionnaire included 1) actual proportion of own-race neighbors, determined by census data reported on UnitedStatesZipCodes.org, 2) proportion of own-race students enrolled in each participant’s school, determined by data reported by USNews.com, 3) perceived proportion of own-race neighbors, estimated by the parent, 4) perceived proportion of own-race classmates, estimated by the parent, 5) perceived proportion of top five non-parent adults that the child interacts with that are own-race, reported by the parent and 6) perceived proportion of the child’s friends that are own-race, estimated by the parent. Unsurprisingly, these variables were highly correlated with each other (all r’s > .39 and all p’s < .05; Table 3). Rather than arbitrarily using one of these variables, we instead used all 6 variables to extract a single diversity exposure factor by entering them into a principal component analysis using a correlation
matrix method of extraction. The Kaiser-Meyer-Olkin measure and Bartlett’s test of sphericity indicated that the dataset was appropriate for principal components analysis (KMO=.81; $\chi^2$(10)=77.8, $p < .001$). Results of the principal components analysis yielded one component that accounted for 63.48% variance across the 6 variables. We will refer to this component as Own-Race Homogeneity, with higher scores reflecting increased homogeneity (i.e., primarily own-race exposure). Loadings for each of the variables on this component are presented in Table 4.

Table 3. Pearson correlation coefficients ($r$) between each diversity variable.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Own-Race Neighbors (actual)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Own-Race Neighbors (estimate)</td>
<td>.53**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Own-Race Students in School (actual)</td>
<td>.46*</td>
<td>.39*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Own-Race Classmates (estimate)</td>
<td>.56**</td>
<td>.49**</td>
<td>.76***</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Own-Race Top 5 Non-Parent Adults (actual)</td>
<td>.65***</td>
<td>.39*</td>
<td>.50**</td>
<td>.77***</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6. Own-Race Friends (estimate)</td>
<td>.58***</td>
<td>.57**</td>
<td>.46*</td>
<td>.79***</td>
<td>.65***</td>
<td>1</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; **$p < .01$; ***$p < .01$

Table 4. Diversity variable loadings on the Own-Race Homogeneity component.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Own-Race Neighbors (actual)</td>
<td>.79</td>
</tr>
<tr>
<td>2. Own-Race Neighbors (estimate)</td>
<td>.68</td>
</tr>
<tr>
<td>3. Own-Race Students in School (actual)</td>
<td>.76</td>
</tr>
<tr>
<td>4. Own-Race Classmates (estimate)</td>
<td>.90</td>
</tr>
<tr>
<td>5. Own-Race Top 5 Non-Parent Adults (actual)</td>
<td>.82</td>
</tr>
<tr>
<td>6. Own-Race Friends (estimate)</td>
<td>.83</td>
</tr>
</tbody>
</table>


Results

Bivariate Correlations

Table 5 displays bivariate correlations across participant age and questionnaire responses from Study 2 and Study 3. These initial analyses indicated that child-reported positive parenting scores were significantly correlated with children’s perceived attachment security ($r = .48, p = .002$). However, parent-reported positive parenting was not reliably correlated with children’s perceived attachment security ($r = .32, p = .07$) or child-reported positive parenting scores ($p = .98$). We, therefore, focused on parent-reported positive parenting and children’s perceived attachment security for subsequent analyses.

Initial correlations also indicated that participant age was positively correlated with children’s perceived attachment security ($r = .35, p = .03$), indicating that older children were more likely to report increased perceived attachment security. Prior studies using the Security Scales measure have tested children beginning at age 7. When we limited our analyses only to participants ages 7 and up (i.e., excluding 6-year-olds), we found only a marginally significant link between participant age and perceived attachment security scores ($r = .36, p = .053$). For subsequent analyses we report results for the full sample here, but also include results for the more limited sample that excludes 6-year-old participants in Appendix G.
Table 5. Bivariate correlations across participant age and questionnaire responses from Study 2 and Study 3.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Positive Parenting- Child Report</td>
<td>.32*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Positive Parenting- Parent Report</td>
<td>-.01</td>
<td>.004</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Perceived Attachment Security</td>
<td>.35*</td>
<td>.48**</td>
<td>.32</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5. Own-Race Homogeneity component</td>
<td>.24</td>
<td>---</td>
<td>--</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

* Note. *p < .05, **p < .01

Regression Analyses

We conducted separate linear regressions exploring how measures of caregiver-child relationship quality and racial diversity exposure related to the extent of reward-based (caregiver vs. stranger bias) and familiarity-based (own-race vs. other-race bias) attention orienting biases.

Quality of Caregiver-Child Relationships

Our first set of linear regressions explored the relationship between the quality of child-caregiver relationships (i.e., parent-reported positive parenting, children’s perceived attachment security) and children’s attention orienting to caregiver vs. stranger faces. The dependent variable in the model was the caregiver distractor index scores, which reflected the extent to which the presence of the caregiver face disrupted performance during the Study 2 attention capture task more than a stranger’s face. We conducted
separate regressions for caregiver distractor index scores based on overall omission errors, accuracy, and response time. Predictors included centered age, parent-reported positive parenting scores, and children’s perceived attachment security. We also included the age x positive parenting and age x perceived attachment security interaction terms to examine whether the relationship between caregiver-child relationship quality and attention biases to caregivers varied as children become more autonomous during middle childhood (Eccles, 1999). Although participant age was correlated with children’s perceived attachment security, as described above, tests to evaluate the assumption of collinearity indicated that multicollinearity was not a concern (Tolerance = .69; VIF = 1.45). We did not include gender in the model because Study 1 results indicated that attention orienting biases towards faces did not vary by gender. Furthermore, we did not expect that male and female participants would demonstrate meaningful differences in relationship quality with their caregiver.

Results indicated no significant effects for caregiver distraction indices based on omission errors or accuracy (p’s > .16). Regression coefficients for caregiver distraction indices based on RT are presented in Table 6. The overall model was not significant, F(5, 32) = 1.24, p = .31, R² = .19. However, perceived attachment security was a significant negative predictor of caregiver distraction indices (B = -68.66, SE = -68.66; t(32) = -2.09, p = .047; Figure 7A). This preliminary result suggests that children who reported more secure relationships with their caregivers showed increased RT performance costs when the novel stranger face appeared as a distractor during the attention capture task. We also found a preliminary trend indicating a potential positive relation between parent-reported and caregiver distraction indices (B = 19.08, SE = 10.97; t(32) = 1.74, p = .093; Figure
suggested that children who experienced more positive interactions with their
caregiver may instead show increased RT performance costs when their caregiver
appeared as a distractor during the attention capture task. Overall, these results suggest
that individual differences in the quality of child-caregiver relationships may relate to
children’s attention orienting to caregiver vs. stranger faces.

Table 6. Regression coefficients for caregiver distraction index (RT) and child-caregiver
relationship predictors

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B(SE)</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-.99 (151.34)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-57.70 (106.38)</td>
<td>-.01</td>
</tr>
<tr>
<td>Positive Parenting</td>
<td>19.08 (10.97)</td>
<td>1.74*</td>
</tr>
<tr>
<td>Attachment Security</td>
<td>-68.66 (32.92)</td>
<td>-.209*</td>
</tr>
<tr>
<td>Age x Positive Parenting</td>
<td>7.02 (7.65)</td>
<td>.92</td>
</tr>
<tr>
<td>Age x Attachment Security</td>
<td>-7.55 (24.4)</td>
<td>-.31</td>
</tr>
<tr>
<td>R²</td>
<td>.19</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

*Note. # indicates p < .10, * indicates p < .05*
Figure 9. Partial regression plots depicting the relationship between caregiver distraction index and (A) child-reported attachment security based on the Security Scales questionnaire and (B) parent-reported positive parenting based on the Alabama Parenting Questionnaire.
Racial Diversity Exposure

Our second set of linear regressions examined the relationship between racial diversity exposure and children’s attention orienting to own- vs. other-race faces. The dependent variable in the model was the own-race distractor index scores, which reflected the extent to which the presence of the own-race face disrupted performance during the Study 3 attention capture task more than an other-race face. We again conducted separate regressions for caregiver distractor index scores based on overall omission errors, accuracy, and response time. Predictor variables included centered age, the Own-Race Homogeneity variable, and the Own-Race Homogeneity x age interaction term. The overall regression models were not significant for any of the three distraction indices ($p’s > .49$) and there were no significant predictors ($p’s > .33$). These results suggest that individual differences in children’s diversity exposure did not reliably predict their orienting to own- vs. other-race faces.

Sensitivity Analyses

Sample sizes for the current analyses were determined based on a priori power analyses to detect attention orienting biases in Studies 2 and 3. Of the final samples, several participants did not provide complete questionnaire data, yielding even smaller sample sizes for the regression models examining caregiver distraction and own-race distraction indices. Post-hoc sensitivity analyses (alpha = .05, power = .8) indicated that our final sample size of $N = 33$ for caregiver distraction analyses would allow us to reasonably detect Cohen’s $d$ effect sizes of .78 or larger. Similarly, our sample size of $N$
= 25 for own-race distraction indices would allow us to reasonably detect Cohen’s \( d \) effect sizes of .88 or larger. However, our actual observed effect sizes for the overall regression models of \( d = .40 \) and \( .72 \), respectively, were below these thresholds. These results suggest that these exploratory analyses did not have sufficient power and the following results should be considered on a preliminary basis.

**Study 4 Discussion**

Study 4 explored how individual differences in caregiver-child relationship quality and diversity exposure related to attention orienting biases towards caregiver and own-race faces, respectively. Though preliminary in nature, our results suggested that caregiver-child relationship quality may predict children’s attention orienting biases to caregiver faces, specifically when indexed by the difference in response times on caregiver present vs. stranger present trials. We did not observe these effects when assessing omission error or accuracy data, which may be attributed to overall high accuracy rates and low omission error rates. Therefore, it is possible that these measures were not sensitive enough to capture individual differences in our analyses. We also did not find a link between diversity of racial exposure and race-based attention orienting biases, suggesting that frequency of exposure to familiar race categories may be insufficient to drive orienting biases.

The current results offer preliminary evidence that children’s experiences with their caregivers may influence attention orienting biases to caregiver vs. strangers. In particular, we found an inverse relationship between children’s perceived attachment security and their orienting biases to caregivers, such that, children who reported a more
secure relationship showed stronger attention capture (i.e., distraction) by stranger faces. This is consistent with previous research that has linked child-caregiver attachment to attention holding biases to caregiver faces such that biases toward strangers may reflect the child’s ability to effectively use their caregiver as a secure base (Kungl et al., 2017; Swingler 2007). Infants’ and children’s openness to explore novelty (e.g., strangers) may reflect the security of the child-caregiver relationship (Bowlby, 1969; Sroufe & Waters, 1977). Thus, securely attached children would use their caregiver as a secure base, allowing them to prioritize orienting to novel stimuli. We also observed a trend-level positive relation between parent-reported positive parenting scores and attention orienting to caregivers. This trend may suggest that individual behaviors that contribute to attachment security, such as parental positive reinforcement, may shape attention orienting biases to caregivers in a different way than the overall sense of attachment security, which develops from a multitude of behaviors (e.g., sensitivity, consistency, contingency, etc.) from both the parent and the child. However, these preliminary results should be interpreted cautiously given that the sample size did not offer sufficient power to detect robust effects. Therefore, additional research with larger samples will be needed to confirm the current results. In addition, future research is needed to further understand the role of discrete behaviors in orienting biases to caregivers versus strangers. For example, the parent-reported questionnaires may have introduced a social-desirability bias (Paulhus, 1984), such that responding may have reflected how parents would like to be perceived, rather than their actual parenting behaviors. Thus, using other observational or other non-self-report approaches may provide a better understanding of how caregiving behaviors influence attention. Nonetheless, these preliminary results provide
initial evidence that the child-caregiver attachment relationship can shape children’s attention orienting to caregiver vs. stranger faces.

Although children did not show race-based orienting biases at the group level in Study 3, past research has shown that race-based attention holding biases are related to individual differences in diversity exposure (e.g., Ellis et al., 2017). Infants raised in environments with more homogenous exposure to own-race individuals showed larger differences in looking time to own- and other-race faces (i.e., race-based attention holding biases) compared to infants raised in racially diverse communities (Ellis et al., 2017; Singh et al., 2022). Thus, infants’ unique environments and experiences, including frequency of exposure to other-race faces, has been linked to the development of attention holding biases to faces. We expanded upon this past work to investigate the extent to which individual differences in diversity exposure may similarly relate to children’s orienting to own- vs. other-race faces, despite observing null effects at the group level. Based on the attention holding findings described above, we reasoned that children with more homogenous exposure to own-race individuals (e.g., higher proportion of own-race friends, neighbors, classmates, etc.) may show stronger attention orienting biases to own-race faces. However, the current results indicated that individual differences in children’s exposure to diversity (indexed as a composite of actual and perceived proportions of own-race neighbors and classmates, as well as the proportion of friends and top five non-parent adults that are own-race) did not predict race-based orienting biases. Taken with Study 3, these null results suggest that frequency of exposure may not influence children’s attention orienting biases to own- vs. other-race faces at the group or individual level. These findings contrast with past research
demonstrating experience-based attention holding biases, that attention holding biases to faces may be more strongly influenced by frequency of exposure than attention orienting biases.

The current results are based on exploratory analyses that were conducted using data collected during Studies 2 and 3. Sample sizes were determined based on the primary aims for each of these studies. As a result, the current study is significantly limited by a lack of sufficient power. Future research with larger samples will be needed to replicate the current findings that caregiver-child relationships, but not familiarity, relate to children’s attention orienting biases. Additionally, research is needed to validate the use of the Security Scales measure throughout childhood. Although this questionnaire is validated among 8-12-year-old children (Kerns et al., 1996), other researchers have used this questionnaire for children as young as 7 years (Kim & Page, 2012) and as old as 18 years (Williams et al., 2017). We found that children’s responses on the security scales measure varied with age when including all of our participants, but this effect was only marginal when we excluded 6-year-old participants. This suggests that these younger children may have consistently answered questions differently and thus the measure may be inappropriate for children under 7. Nonetheless, children’s perceived attachment security related to attention orienting to caregiver vs. stranger faces even when we excluded 6-year-old participants from our analyses, suggesting that this effect may be robust. Finally, it is important to note that the Security Scales questionnaire provides only a single composite measure of perceived attachment security and does not distinguish specific attachment styles. Future research is needed to determine whether
discrete categories of attachment styles relate to children’s attention biases to caregivers versus strangers.

In sum, Study 4 provided preliminary evidence that individual differences in experience influence children’s attention orienting biases to caregiver but not own-race faces. These initial results suggest that children’s perceived attachment security and positive parenting, to a lesser extent, may relate to children’s orienting biases to caregiver vs. stranger faces. In contrast, diversity exposure did not relate to children’s orienting to own- vs. other-race faces. Together with Studies 2 and 3, these results suggest that frequency of exposure alone may not drive attention orienting biases. Instead, the motivational salience of caregiver interactions may have a stronger influence on children’s orienting to caregiver vs. stranger faces.
CHAPTER 6: GENERAL DISCUSSION

Across four studies, we investigated attention orienting to motivationally salient and frequently experienced faces. In Study 1, we first confirmed the validity of studying attention orienting to faces using online data collection methods. In the subsequent two studies, we evaluated 6- to 10-year-old children’s attention orienting biases to caregiver versus stranger faces (Study 2) and own-versus other-race faces (Study 3). Overall, we predicted that motivational salience, but not frequency of exposure, would bias children’s attention orienting to faces. Consistent with our predictions, we found that the presence of the caregiver face captured attention to a greater extent than stranger faces in Study 2, but children showed similar performance in the presence of own- and other-race faces in Study 3. In Study 4, we conducted exploratory analyses to investigate the possibility that individual differences in quality and quantity of experiences with these faces predict children’s attention orienting biases. These analyses examined links between 1) the quality of caregiver-child interactions (i.e., parenting quality, perceived attachment security) and children’s orienting biases to caregiver faces, and 2) variability in exposure to racial diversity and children’s orienting biases to own-race faces. We found preliminary evidence that the quality of child-caregiver interactions and relationships may relate to children’s orienting biases to caregivers, but racial diversity exposure did not relate to orienting biases to own-race faces. These exploratory analyses support the conclusion from Study 2 and 3 that the motivational salience of caregivers drives attention orienting biases, above and beyond any effects of mere familiarity. Together,
this series of studies suggest that children, like adults, are biased to orient towards motivationally salient stimuli.

Studies 1, 2, and 3 all utilized attention capture tasks, which indexed the extent to which an individual demonstrated automatic attention orienting biases to a task-irrelevant distractor. In these studies, participants searched for a target stimulus among search arrays containing 3, 6, or 9 items, one of which was sometimes a task-irrelevant face. Participants in all three studies demonstrated classic visual search effects typically associated with attention capture tasks (Keebler et al., 2020; Wolfe, 2015). Across all studies, participants showed faster reaction times with age. Participants also made more omission errors, were less accurate, and were slower to respond as the number of distractors (i.e., set size) increased. These performance costs reflect increased demands for endogenous control to suppress additional information. Participants in all three tasks were also slower to respond during target absent trials, and those in Studies 2 and 3 also made more omission errors during these target absent trials. These effects reflect shifts in search strategies, such that children may have needed to search each location individually to confirm the absence of a target. Overall, this consistent replication of classic visual search effects further supports the conclusion that our online/remote testing procedures were a valid method to assess attention orienting biases during childhood.

The primary difference across the attention capture tasks in Studies 1, 2, and 3 was the type of face that appeared as a task-irrelevant distractor. During Study 1, half of the attention capture task trials did not include a face, whereas the remaining trials included a stranger’s face as a task-irrelevant distractor. Children were slower to respond during trials in which the face was present versus when it was absent. Consistent with
past research (Langton et al., 2008; Riby et al., 2012), these results indicated that children showed automatic attention orienting biases towards faces in general. During Study 2, we further manipulated face type such that the attention capture task included an equal number of trials with no face, trials in which a stranger’s face was present, and trials in which their caregiver’s face appeared as a task-irrelevant distractor. Children again showed increased RT costs during trials in which a face appeared as a distractor, as well as increased omission errors and decreased accuracy. Furthermore, these effects depended on the identity of the face. Specifically, children made more errors, were less accurate, and were slower to respond when a caregiver appeared in the task, compared to when a stranger’s face appeared. These performance costs suggest that compared to faces in general, children showed more robust automatic attention orienting biases to their caregiver’s face. Finally, during Study 3, the attention capture task included an equal number of trials with no face, trials in which an other-race face was present, and trials in which an own-race face appeared as a task-irrelevant distractor. Unlike the previous study, children’s errors, accuracy, or RT did not vary based on the type of face presented (own- versus other-race). Instead, we only found slower RT on trials with an other-race face present compared to trials with no face, but only during set size 9. Across studies, these results demonstrate that children’s performance during the attention capture task was disrupted when faces were both rewarding and familiar (caregiver faces), but not when they were only familiar (own-race faces). Notably, the presence of caregiver faces (Study 2) impacted children’s attention capture task performance across all three measures (i.e., omission errors, accuracy, response time). In contrast, effects of own- vs. other-race faces (Study 3) were observed for response time measures, but not omission
errors or accuracy. Overall, these results suggest that motivationally salient caregiver faces elicit automatic attention orienting biases to a greater extent than highly familiar own-race faces.

The effects of face presence also depended on task context across both Studies 2 and 3. Consistent with previous investigations (Langton et al., 2008; Riby et al., 2012), we only found effects of face type when the target was present in the array and at larger set sizes (i.e., set size 6 and 9), but not when there were only a few competing distractors to suppress (i.e., set size 3). These effects are consistent with adult research demonstrating that individuals may rely on more global search strategies, rather than scanning items individually, during both target present trials and trials with increased set sizes, (Liesefeld et al., 2021). This global search strategy widens their attentional window which becomes more susceptible to distraction from salient distractors (Belopolsky et al., 2007), such as faces. At set size 9, we found significant differences in performance during face absent trials and those with less experienced faces (i.e., stranger faces in Study 2; other-race faces in Study 3). This may suggest that the global search strategy induced by larger set sizes may be especially vulnerable to distraction by novel stimuli. However, we also observed a key difference between Studies 2 and 3 during set size 6 trials. During Study 2, children were slower to detect the target during set size 6 trials when the caregiver face was present relative to set size 6 trials in which a stranger was present. This suggests that children were more distracted by motivationally salient faces compared to unfamiliar faces. However, during Study 3 children showed similar reaction times during set size 6 trials when familiar own-race and less familiar other-race faces appeared as distractors. This suggests that, in contrast, children were not more distracted
by familiar faces compared to unfamiliar faces. Overall, this discrepancy across Studies 2 and 3 suggests that attention orienting to faces may be biased based on the motivational salience of the faces to a greater extent than the mere familiarity of the faces, but these biases may depend on the search strategy that is elicited by the task context.

In Study 4 we conducted exploratory analyses to examine whether attention orienting biases towards faces observed in Studies 2 and 3 depended on the quality or frequency of exposure with these face types. The analyses suggested that children’s perceived attachment security and positive parenting, to a lesser degree, may relate to their orienting biases to caregiver vs. stranger faces. These preliminary results suggest that daily experiences and relationship quality may influence the child’s representation of their caregiver’s motivational salience. In contrast, we did not find evidence that experience with own- and other-race individuals related to children’s race-based orienting biases. Together with the null results at the group level in Study 3, these results suggest that frequency of exposure may be insufficient to drive attention orienting biases. While these results should be considered cautiously given that we had insufficient power to detect robust effects, these results add to the findings of Studies 2 and 3 to suggest that children’s attention orienting biases towards caregivers are more likely relate to the motivational salience of caregiver interactions and relationship quality, rather than familiarity.

We designed these experiments to determine the extent to which motivationally salient caregiver faces and familiar own-race faces bias children’s attention orienting during an attention capture task. We ensured that any observed orienting biases could not be explained solely by exogenous factors since we equated the physical salience of face
stimuli across participants. The faces were also irrelevant to task demands, suggesting that increased orienting would not be solely driven by endogenous (i.e., goal-based) mechanisms. Therefore, the biased orienting to caregivers observed in Study 2 cannot be fully attributed to either solely exogenous or endogenous mechanisms. Adult research has established that rewarding stimuli can bias selective attention, independent of their perceptual salience or task-relevance (e.g., Anderson et al., 2011), suggesting that the orienting bias to caregivers observed in the current study may be mediated by motivated attention mechanisms like those identified in adulthood. Furthermore, the results of Study 3 demonstrated that familiarity of faces did not elicit similar orienting biases. We thus suggest that motivational salience was a key factor driving children’s biased attention orienting to caregiver faces.

More broadly, these findings suggest that the current prevailing model of selective attention development that describes a dichotomy between stimulus driven (i.e., exogenous) versus goal-driven (i.e., endogenous) mechanisms (Colombo, 2001) may need to be expanded to also account for mechanisms based on motivational salience. Future investigations can examine these motivated attention mechanisms earlier in development to determine their developmental trajectory, including the timing when infants or children begin to rely on motivational salience to allocate attention. This research will reveal whether neonates can rely on motivated attention mechanisms in addition to exogenous mechanisms, or if sensitivity to motivational salience develops more slowly across development. This enhanced understanding of factors influencing selective attention development, beyond exogenous and endogenous mechanisms alone, will inform our understanding of atypical attention development within populations that
show differential sensitivity to social reward, such as infants and children with caregivers diagnosed with depression and children diagnosed with autism spectrum disorders (Abrams et al., 2019; Field et al., 2006).

**Limitations and Future Directions**

There are several limitations to the current work that should be considered when interpreting the results. First, all participants completed study procedures remotely while at home with their own-race caregiver, which may have influenced their orienting to caregiver or own-race faces. For example, it is possible that completing the attention capture task in a familiar environment rich with caregiver cues may have primed children to attend to the caregiver or own-race faces during the task. Alternatively, these face stimuli may have been less salient in these conditions due to the relative abundance of caregiver-related stimuli in the child’s immediate environment. Although we could not control for these factors, we argue that these conditions offer unique insight into how children’s attention orienting may operate during typical daily interactions in which their caregiver and related cues are often present. Future studies can determine the extent to which the current results generalize across multiple contexts, including educational or traditional laboratory settings.

Although completing the task at home may have been more naturalistic than a laboratory environment, there were other aspects of the task that lacked naturalistic context. For instance, we presented tightly controlled search arrays to children to counterbalance spatial locations and number of competing distractors. We also used static images of faces to ensure orienting to faces could not be explained by exogenous factors,
such as motion. However, these tightly controlled arrays and static face images contrast with the typical experiences that children have with a range of dynamic faces. Future research may aim to evaluate attention biases to faces embedded within more naturalistic scenes or presented in arrays that contain several faces that simultaneously compete for attention. This work will be important for furthering our understanding of how children orient to faces in daily life.

The current results suggest that motivational salience elicits biased orienting to a greater extent than familiarity. However, a limitation of this work is that the own-race face was a stranger and therefore reflected a familiar face category but an unfamiliar identity. In contrast, caregiver faces were from a familiar face category (i.e., own-race) and were also a familiar identity. Future work should evaluate attention orienting biases to familiar, yet less motivationally salient identities (e.g., a family friend, familiar celebrities). Future work may also further disentangle the role of reward versus familiarity by investigating whether other types of reward (e.g., non-social rewards) also influence children’s attention as it does in adulthood. Furthermore, research can isolate the role of reward vs. familiarity by investigating the extent to which individual differences in measures of neural reward activity may also predict children’s orienting biases to caregiver faces. For instance, the extent of fNIRS activation in cortical reward regions (e.g., medial prefrontal/orbitofrontal cortex) while viewing their caregiver may predict attention biases to caregiver versus stranger faces. This evidence would provide further support that the mechanisms driving orienting biases are specifically related to the rewarding nature of caregivers. It is also possible that instead of activation in localized reward regions, attention biases may instead reflect the functional connectivity between
reward processing regions and the frontoparietal attention network. If these areas of future work confirm that the caregiver effects observed in Study 2 are directly related to neural reward processing and/or the functional connectivity between reward and frontoparietal attention networks, our task may be adapted for clinical use. For instance, classic visual search tasks may provide valuable information for clinicians about a child’s selective attention abilities but may be less useful for assessing individual differences in attention to rewarding or motivationally salient stimuli. The attention capture task used in the current studies may be more effective for measuring attention to rewarding stimuli, which may be beneficial for linking individual differences in reward sensitivity to broader behavioral syndromes, such as autism spectrum disorder and attention deficit hyperactivity disorder.

Finally, our exploratory analyses of individual differences in Study 4 suggested that children’s experiences with their caregivers influenced their attention orienting biases to caregiver faces, whereas experience with racial diversity exposure did not influence attention orienting biases to own-race faces. Specifically, children’s increased perceived attachment security predicted stronger attention biases to stranger faces, while positive parenting was weakly related to increased orienting to caregiver faces. However, these analyses were exploratory and did not have sufficient power to support strong conclusions. Future work with larger samples can further investigate mechanisms linking parenting behaviors and child-caregiver attachment to these attention orienting biases. Furthermore, our understanding of how caregiver-child relationships relate to attention orienting biases to caregiver versus stranger faces is limited in the current study because the security scales questionnaire has not been validated for children under the age of 8,
and it has not been systematically compared to more ecologically valid measures of attachment (e.g., Strange Situation Procedure in infancy). Naturalistic observations of child-caregiver interactions may provide a more nuanced understanding of specific behaviors and relationship qualities that are most influential in shaping children’s orienting to their caregiver versus a novel stranger.

**Conclusions**

Developing attention skills allow children to parse the world by orienting to a subset of especially salient or meaningful inputs. Research has established that infants and children are biased to orient to faces in general (e.g., Kwon et al., 2016; Riby et al., 2012), reflecting their increased salience over non-social stimuli. In Study 1 we replicated this effect using an online attention capture task, confirming the validity of online data collection procedures. We then extended this past research by examining 6- to 10-year-old children’s attention orienting biases to motivationally salient caregiver faces (Study 2) and frequently-experienced own-race faces (Study 3). Study 2 demonstrated that children showed stronger attention orienting biases to caregiver faces compared to stranger faces, particularly when task demands may elicit a more global search strategy. In contrast, Study 3 demonstrated that children did not show differential attention orienting biases to own- vs. other-race faces. Finally, we conducted exploratory analyses (Study 4) to determine how individual differences in caregiver-child relationship quality and diversity exposure related to attention orienting biases towards caregiver and own-race faces, respectively. We found preliminary evidence that the quality of parent-child relationships predicted children’s attention orienting biases to caregiver vs. stranger.
faces, whereas children’s exposure to diversity was unrelated to their orienting to own-vs. other race faces. Overall, the results of this work suggest that motivational salience may drive children’s attention orienting biases to faces to a greater extent than familiarity. These findings have critical implications for our understanding of attention development, as they suggest motivated selective attention mechanisms previously identified in adulthood may also be functional in childhood.
Appendix A: Examples of all trial types for Study 1

Figure A1. Example of trial types ranging in set size and target presence for Study 1. Pictured are all 12 combinations of target presence (2 levels), face distractor type (2 levels) and set size (3 levels). Note that target and face location are counterbalanced across trials.
Appendix B: Supplemental Results for Study 3

Study 3 investigated White/Caucasian and Black/African American children’s attention orienting to White and Black faces. Our final sample included 36 White/Caucasian children and 3 Black/African American participants. Because the sample racial demographics were skewed and race was a primary interest in the study, we investigated whether results would differ when we removed the non-White/Caucasian participants from our analyses. Overall patterns of results did not differ for accuracy or response time measures. However, results differed slightly for omission errors. We report these results below and highlight differences across the primary (full sample) and secondary (White/Caucasian only sample) analyses in Table B1 and in Figure B1.

Omission Errors

Participants showed overall low error rates ($M = 0.02, SD = 0.03$), indicating that they responded during most trials. However, these errors were influenced by task demands. Participants made more omission errors when the target was present ($M_{\text{Present}} = 0.03, SD = 0.04, M_{\text{Absent}} = 0.02, SD = 0.04; F(1, 34) = 5.00, p = .03, \eta^2_p = .13$). There was also a main effect of set size ($F(1.68, 57.06) = 11.73, p < .001, \eta^2_p = .26$). Follow-up paired comparisons indicated that participants made more errors on set size 9 ($M = .04, SD = .05$) compared to set size 3 ($M = .01, SD = .03; t(35) = 3.97, p < .001, d = .73$) and set size 6 ($M = .02, SD = .04; t(35) = 3.58, p < .001, d = .44$). However, participants omitted responses on a similar number of trials during set size 3 and 6 ($p = .51$).
This main effect of set size was further moderated by face distractor type ($F(4, 136) = 2.43, p = .05, \eta_p^2 = .07$; on the right in Figure B1). On face absent trials, participants made more errors on set size 9 ($M = .033, SD = .059$) compared to set size 6 ($M = .013, SD = .036$; $t(35) = 2.27, p = .03, d = .41$), but no differences on set size 3 ($M = .019, SD = .04$) versus 6 or 9 ($p$’s > .08). On other-race present trials, participants made more errors on set size 9 ($M = .036, SD = .054$) compared to set size 3 ($M = .016, SD = .039$; $t(35) = 2.45, p = .02, d = .42$), but no differences on set size 6 ($M = .016, SD = .039$) versus 3 or 9 ($p$’s > .07). Finally, on own-race present trials, participants made more errors on set size 9 ($M = .056, SD = .081$) compared to set size 3 ($M = .007, SD = .023$; $t(35) = 3.60, p < .001, d = .82$) and set size 6 ($M = .022, SD = .049$; $t(35) = 3.04, p = .004, d = .51$) but no difference across 3 versus 6 ($p = .07$). All other main effects and interactions related to age and task demands were not significant, including the significant target x age interaction previously detected with the full sample ($p$’s > .10).
Table B1

**ANCOVA results for omission errors. On the left is results from all participants. On the right is results from only White/Caucasian participants.**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>All Participants</th>
<th>Only White/Caucasian Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>F</td>
</tr>
<tr>
<td>Target</td>
<td>1.37</td>
<td>6.94</td>
</tr>
<tr>
<td>Face Type</td>
<td>2.74</td>
<td>.82</td>
</tr>
<tr>
<td>Set Size</td>
<td>2.74</td>
<td>9.66</td>
</tr>
<tr>
<td>Age</td>
<td>1.37</td>
<td>1.88</td>
</tr>
<tr>
<td>Target x Face Type</td>
<td>2.74</td>
<td>2.63</td>
</tr>
<tr>
<td>Target x Set Size</td>
<td>1.70</td>
<td>62.70</td>
</tr>
<tr>
<td>Target x Age</td>
<td>1.37</td>
<td>4.53</td>
</tr>
<tr>
<td>Face Type x Set Size</td>
<td>3.06</td>
<td>113.27</td>
</tr>
<tr>
<td>Face Type x Age</td>
<td>2.74</td>
<td>.46</td>
</tr>
<tr>
<td>Set Size x Age</td>
<td>2.74</td>
<td>.74</td>
</tr>
<tr>
<td>Target x Face Type x Set Size</td>
<td>2.28</td>
<td>84.47</td>
</tr>
<tr>
<td>Target x Face Type x Age</td>
<td>2.74</td>
<td>.18</td>
</tr>
<tr>
<td>Target x Set Size x Age</td>
<td>2.74</td>
<td>.54</td>
</tr>
<tr>
<td>Face Type x Set Size x Age</td>
<td>4.148</td>
<td>.56</td>
</tr>
<tr>
<td>Target x Face Type x Set Size x Age</td>
<td>4.148</td>
<td>.88</td>
</tr>
</tbody>
</table>

*Note. *p < .05, ***p < .001*

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**Figure B1.** Differences in omission error results when including all participants (left) versus only White/Caucasian participants (right).
Appendix C

Alabama Parenting Questionnaire (APQ-9) - child report

**Directions:** The following are a number of statements about your family. Please rate each item as to how often it typically occurs in your home. The possible answers are Never (1), Almost never (2), Sometimes (3), Often (4), Always (5). PLEASE ANSWER ALL ITEMS.

<table>
<thead>
<tr>
<th>#</th>
<th>Item</th>
<th>1 Never</th>
<th>2 Almost Never</th>
<th>3 Sometimes</th>
<th>4 Often</th>
<th>5 Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Your parent(s) tell you that you are doing a good job</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Your parent(s) threaten to punish you and then do not do it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>You fail to leave a note or let your parent(s) know where you are going</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>You talk your parent(s) out of punishing you after you have done something wrong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>You stay out in the evening past the time you are supposed to be home</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Your parent(s) compliment you when you have done something well</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Your parent(s) praise you for behaving well</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Your parent(s) do not know the friends you are with</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Your parent(s) let you out of a punishment early (like lift restrictions earlier than they originally said)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix D  

Alabama Parenting Questionnaire (APQ-9) - parent report  

**Directions:** The following are a number of statements about your family. Please rate each item as to how often it typically occurs in your home. The possible answers are Never (1), Almost never (2), Sometimes (3), Often (4), Always (5). PLEASE ANSWER ALL ITEMS.

<table>
<thead>
<tr>
<th>#</th>
<th>Item</th>
<th>1 Never</th>
<th>2 Almost Never</th>
<th>3 Sometimes</th>
<th>4 Often</th>
<th>5 Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>You let your child know when he/she is doing a good job with something</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>You threaten to punish your child and then do not actually punish him/her</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Your child fails to leave a note or to let you where he/she is going</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Your child talks you out of being punished after he/she has done something wrong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Your child stays out in the evening after the time he/she is supposed to be home</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>You compliment your child after he/she has done something well</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>You praise your child if he/she behaves well</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Your child is out with friends you don’t know</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>You let your child out of a punishment early (like lift restrictions earlier than you originally said)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix E

Security Scales- child report

Security Scales

Now we are going to ask you some questions about your mom. Some people have had more than one mom or dad and some people have not.

Q1 Have you ever had more than one mom? Y/N
Q2 Who was your first mom? (primary caregiver from birth to age 5)
- BIO
- STEP
- FOUESTER
- AUNT
- GRANDMA
- COUSIN
- ADOPTED
- PARTNER
- NONE
Q3 Do you live with her now? Y/N
Q4 (IF NO) Do you still see her? Y/N

Each of these questions talks about two kinds of kids and we want to know which kid is most like you. First decide which kid is most like you and then decide if that kid is sort of like you or really like you. Only check one box for each question.

Here is an example:

**Really Sort Of**

**True True**

For ME For ME

<table>
<thead>
<tr>
<th>Some kids would rather play outdoors in their spare time</th>
<th>Other kids would rather watch t.v.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Security Scales (Mother Form)

**Really Sort Of**

**True True**

For ME For ME

1. Some kids find it easy to trust their mom, but other kids are not sure if they can trust their mom.

2. Some kids feel like their mom interferes a lot when they are trying to do things, but other kids feel like their mom lets them do things on their own.

3. Some kids find it easy to count on their mom for help, but other kids think it’s hard to count on their mom.

4. Some kids think their mom spends enough time with them, but other kids think their mom does not spend enough time with them.

5. Some kids do not really like telling their mom what they are thinking or feeling, but other kids do like telling their mom what they are thinking or feeling.
<table>
<thead>
<tr>
<th></th>
<th>REALLY</th>
<th>SORT OF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TRUE</td>
<td>TRUE</td>
</tr>
<tr>
<td>6</td>
<td>Some kids do not really need their mom for much, but other kids need their mom for a lot of things.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Some kids wish they were closer to their mom, but other kids are happy with how close they feel to their mom.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Some kids worry that their mom does not really love them, but other kids are really sure that their mom loves them.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Some kids feel like their mom really understands them, but other kids feel like their mom does not really understand them.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Some kids are really sure their mom would not leave them, but other kids sometimes wonder if their mom might leave them.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>REALLY</td>
<td>SORT OF</td>
</tr>
<tr>
<td></td>
<td>TRUE</td>
<td>TRUE</td>
</tr>
<tr>
<td>11</td>
<td>Some kids worry that their mom might not be there when they need her, but other kids are sure their mom will be there when they need her.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Some kids think their mom does not listen to them, but other kids do think their mom listens to them.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Some kids go to their mom when they are upset, but other kids do not go to their mom when they are upset.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Some kids wish their mom would help them more with their problems, but other kids think their mom helps them enough.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Some kids feel better when their mom is around, but other kids do not feel better when their mom is around.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix F

Diversity Questionnaire

Please identify the top 5 non-parent adults that your child spends the most time with (teacher, nanny/babysitter, extended family, etc.) and answer the following questions about these individuals:

1. **Person 1**
   a. Relationship to child: __________________________
   b. Gender: ________________________________
   c. Race: ________________________________
   d. Ethnicity: ________________________________

2. **Person 2**
   a. Relationship to child: __________________________
   b. Gender: ________________________________
   c. Race: ________________________________
   d. Ethnicity: ________________________________

3. **Person 3**
   a. Relationship to child: __________________________
   b. Gender: ________________________________
   c. Race: ________________________________
   d. Ethnicity: ________________________________

4. **Person 4**
   a. Relationship to child: __________________________
   b. Gender: ________________________________
   c. Race: ________________________________
   d. Ethnicity: ________________________________

5. **Person 5**
   a. Relationship to child: __________________________
   b. Gender: ________________________________
   c. Race: ________________________________
   d. Ethnicity: ________________________________
What is the teacher to student ratio (if known)? ____ teachers per _____ students

Now please think about how the COVID-19 pandemic influenced your child’s educational setting in the last year.

Did your child attend school remotely (e.g., through Zoom, Google Classroom, etc.)? Yes ☐ No ☐

How many months of instruction was fully remote? ________ months

Did your child’s school use a hybrid approach to instruction (i.e., some days in person, some remote learning days)? Yes ☐ No ☐

If yes, How many days per week were remote? ________ days

How long did your child’s school continue this hybrid approach to instruction? _____ months

Did your child’s school enforce mask wearing for teachers? Yes ☐ No ☐ N/A ☐

Did your child’s school enforce mask wearing for students? Yes ☐ No ☐ N/A ☐

Was your child’s classroom rearranged to support social distancing (i.e., desks 6 feet apart)? Yes ☐ No ☐ N/A ☐

Compared to past years, the extent of interaction between your child and their teacher(s) _______ over the past year. increased ☐ decreased ☐ stayed the same ☐

Compared to past years, the extent of interaction between your child and their classmates _______ over the past year. increased ☐ decreased ☐ stayed the same ☐

Please describe any other COVID-related changes that may impacted your child’s social interactions (e.g., frequency, duration, quality of interactions):

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________
Now please think about your child's interactions with other children and adults over the last year.

Among your child’s friends, what percentage (from 0 to 100%) are…

<table>
<thead>
<tr>
<th>Percentage (should add to 100% total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>...the same race as your child?</td>
</tr>
<tr>
<td>...a different race than your child?</td>
</tr>
</tbody>
</table>

Among your child’s neighbors, what percentage (from 0 to 100%) are…

<table>
<thead>
<tr>
<th>Percentage (should add to 100% total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>...the same race as your child?</td>
</tr>
<tr>
<td>...a different race than your child?</td>
</tr>
</tbody>
</table>

Does your child attend school (including preschool, homeschool)?  Yes ☐  No ☐

What is the name of the school your child attends? __________________________

Where is this school located (city and state)? __________________________

What type of schooling is this?

<table>
<thead>
<tr>
<th>Public ☐</th>
<th>Charter ☐</th>
<th>Montessori ☐</th>
<th>Homeschool ☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other ☐</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How many years has your child attended this school? __________

How many days a week do they attend? ______ days

How many hours a day? ______ hours

How old was your child when they began attending preschool/school? _____ years old

What is the approximate size of their class (if known)? ______ Students

Among your child’s current classmates (excluding your child), what percentage (0-100%) are…

<table>
<thead>
<tr>
<th>Percentage (should add to 100% total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>...the same race as your child?</td>
</tr>
<tr>
<td>...a different race than your child?</td>
</tr>
</tbody>
</table>
Appendix G

Bivariate correlations indicated that children’s perceived attachment security was related to age when we included all participants (age 6-10; \( r(24) = .35, p = .03 \)) but this link was only marginally significant when we excluded 6-year-old participants (\( r = .36, p = .052 \)). This result suggests that younger children may have systematically responded differently to the questions on the Security Scales questionnaire. Although our tests to evaluate the assumption of collinearity indicated that multicollinearity was not a concern (Tolerance = .69; VIF = 1.45), we also conducted the regression model while excluding these 6-year-old participants to ensure that they were not driving the observed link between perceived attachment security and attention orienting to caregiver faces.

We again entered the caregiver distractor index score (i.e., caregiver-related performance costs in response time) as the outcome variable in a linear regression. Predictors included centered age, parent-reported positive parenting scores, perceived attachment security, and the age x positive parenting and age x perceived attachment security interaction terms. Regression coefficients are presented in Table G1. The overall model was not significant, \( F(5, 24) = 1.25, p = .32, R^2 = .25 \). Perceived attachment security remained a marginally significant predictor of RT-based caregiver distraction indices (\( B = -78.05, SE = -37.72; t(24) = -2.07, p = .052 \); Figure G1) even after excluding the 6-year-old participants. As with the full sample, this negative relationship indicated that children who reported more secure relationships with their caregivers showed increased performance costs when the novel stranger face appeared as a distractor during the attention capture task. Unlike the primary analyses, positive parenting was no longer related to RT-based caregiver distraction indices after excluding the 6-year-old participants.
participants ($p = .14$). Overall, these results suggest that individual differences in the quality of child-caregiver relationships related to children’s attention orienting biases, with more robust effects observed for perceived attachment security rather than positive parenting behaviors.

Table G1. Regression coefficients for caregiver distraction index (RT) and child-parent relationship predictors for all 7-10-year-old participants

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$B(SE)$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-15.86 (183.53)</td>
<td>.315</td>
</tr>
<tr>
<td>Age</td>
<td>-47.95 (156.17)</td>
<td>1.55</td>
</tr>
<tr>
<td>Positive Parenting</td>
<td>21.80 (14.10)</td>
<td>3.55</td>
</tr>
<tr>
<td>Attachment Security</td>
<td>-78.05 (37.72)</td>
<td>-2.07</td>
</tr>
<tr>
<td>Age x Positive Parenting</td>
<td>5.88 (11.07)</td>
<td>.53</td>
</tr>
<tr>
<td>Age x Attachment Security</td>
<td>-3.48 (35.30)</td>
<td>.10</td>
</tr>
<tr>
<td>R²</td>
<td>.35</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

*Note. # indicates $p < .10$*

Figure G1. Partial regression plots depicting the relationship between caregiver distraction index and child-reported attachment security based on the Security Scales questionnaire for 7-10-year-old participants only.
References


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**Biography**

Brianna Hunter graduated *summa cum laude* with a Bachelor of Science in Behavioral and Cognitive Neuroscience from the University of Florida in 2017 and with a Master’s degree in Psychological Sciences from Tulane University in 2019. During her undergraduate research training, Brianna worked in rodent and human subjects research labs, exposing her to neuroscience research on multiple levels of analysis. She completed an Honor’s thesis in Dr. Lisa Scott’s Brain and Cognitive Development Lab investigating infant’s visual scanning of own- and other-race faces. Brianna then received a fellowship award from the Louisiana Board of Regents to continue studying infant attention at Tulane University under the supervision of Dr. Julie Markant. During her graduate training, Brianna presented research at several international conferences, designed and taught an undergraduate course, and received recognition by the Tulane Department of Psychology for her excellence in undergraduate mentoring. Brianna will begin her postdoctoral training with Drs. Lisa Oakes and Steve Luck at the University of California Davis in the Fall of 2022. In this role, she will learn computational modeling approaches to investigate how experience and cortical maturation influence infant gaze control.