

Preschoolers' Selective Attention Towards Emotional Information

by

Sara Seyed Nozadi

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Graduate Supervisory Committee:

Tracy L. Spinrad, Chair  
Nancy Eisenberg  
Scott Johnson  
Marilyn Thompson

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## ABSTRACT

In two separate publications, the average patterns of, and individual differences in, preschoolers' selective attention processes were investigated using a multilevel modeling framework. In Publication 1, using two independent samples ( $N_s = 42, 75$ ), preschoolers' selective attention towards different types of emotions (both positive and negative) was examined using two eye-tracking tasks. The results showed that, on average, children selectively attended to valenced emotional information more than neutral emotional information. In addition, a majority of children were able to detect the different emotional stimulus among three neutral stimuli during the visual search task. Children were more likely to detect angry than sad emotional expressions among neutral faces; however, no difference was found between detection of angry and happy faces among neutral faces. In Publication 2, the associations of children's anger and sadness proneness to their attention biases towards anger and sad emotional information, respectively, and the relations of these biases to various aspects children's social functioning and adjustment were examined among preschool-aged children ( $N = 75$ ). Children's predisposition to anger and sadness were shown to be related to attentional biases towards those specific emotions, particularly if children lacked the ability to regulate their attention. Similarly, components of attention regulation played an important role in moderating the associations of biases towards angry information to aggressive behaviors, social competence, and anxiety symptoms. Biases towards sadness were unrelated to maladjustment or social functioning. Findings were discussed in terms of the importance of attention biases and attention regulation as well as the implications of the findings for attention training programs.

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## **Introduction**

Selective attention or attention bias (AB) refers to an individual's preferential attention toward a specific stimuli when presented with multiple simultaneous information or stimuli (Wiers & Stacy, 2006). High attention biases (AB) towards certain negative emotional stimuli have been observed in individuals with clinical emotional disorders (e.g., anxious, depressed individuals) as well as individuals with behavior problems (e.g., children with aggressive behavior problems). Given these findings, attention biases towards specific negative information have been suggested to play a causal role in the emergence of behavioral problems and emotional disorders (Grafton & MacLeod, 2014; Weierich, Treat, & Hollingworth, 2008). Thus, examining factors relating to normative processes and individual variations in patterns of selective attention has clear value.

Few investigators have studied these processes during early childhood, when children's socio-cognitive abilities as well as regulation skills are rapidly developing. Thus, the goals of the two proposed articles were to (a) examine children's normative selective attention processes and to identify whether the valance of emotional information and children's sex relate to these processes, (b) examine individual differences in children's AB or selective attention towards negative emotions, focusing on the role of children's temperament and the potential moderating role of regulation, and (c) investigate the moderating role of children's regulation in relations of AB towards anger and sadness to children's social functioning (i.e., prosocial behaviors, social competence) and maladjustment (i.e., aggression) during the preschool years.

An important component of this work was the use of eye-tracking technology to measure children's selective attention. The use of eye-tracking technology allows researchers to measure children's selective attention processes without requiring children to provide explicit behavioral responses (e.g., reaction time), or to have adequate cognitive and motor abilities to perform the tasks.

There are two other unique features of this work. First, unlike other studies in this area that have focused on older children and/or children from clinical populations, the focus was on typically-developing young children. Second, selective attention towards several emotionally-valenced stimulus (i.e., happy versus angry, angry versus sad) was considered in each study. Thus, the current work may provide important new directions for researchers as well as implications for prevention/intervention programs.

**Publication 1: The Relation Between Emotional Valence and Young Children's Selective Attention Towards Emotional Information: An Eye-Tracking Study**

Emotional information represents one important component of data that individuals receive each day. The appropriate encoding and processing of emotional information have been found to play an important role in individuals' social and emotional well-being (Dodge et al., 2003). Thus, identifying the factors that may direct individuals' selective attention towards specific types of stimuli (an important step during the encoding process) has clear significance. Much research in the past decade has focused on examining individual variations in selective attention processes, mostly in adults and older children, and their relation to emotional disorders, including anxiety and depression (Monk et al., 2006; Pérez-Edgar et al., 2010). However, less attention has been paid to examining normative selective attention processes in young children and to identifying factors that may explain children's attention to or disengagement from emotional information.

Understanding and examining the typical patterns of selective attention and attentional responses to emotional information are especially important during early childhood, when children are beginning to understand and differentiate between different types of emotions. Thus, in this work, the role of valence of emotional stimuli on children's attentional processes was examined. Previous research has demonstrated that adults attend more to negative emotional information relative to neutral emotional information (e.g., Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Rozin & Royzman, 2001). However, few researchers have examined the role of negative valence in directing attention during childhood, and most of these studies have focused on infants

or older children (i.e., Tottenham, Phuong, Flannery, Gabard-Durnam, & Goff, 2013; Vaish, Grossman, & Woodward, 2008). In the current study, patterns of selective attention among 3- to 6-year old children were studied and expected to be similar to those observed in adults. That is, children from this age group were thought to show heightened attentional sensitivity (indicated by high attentional engagement and/or poor attentional disengagement) towards negative emotional stimuli compared to neutral emotional stimuli. Additionally, there is theory to suggest that the detection of threat-related stimuli/cues (i.e., angry and fearful signals) may be more important for individuals' survival than are sad or happy stimuli/cues (Pratto & John, 1991; Smith et al., 2006). Thus, it was expected that children would have higher probability to detect or fixate on angry than sad or happy stimuli and would be faster in detecting angry stimuli versus happy or sad stimuli when these stimuli are presented among neutral stimuli.

Furthermore, evidence from adult research has shown that females are inclined to pay more attention to and be faster at encoding and detecting negative emotional cues, especially threat-related emotional stimuli/cues, than are males (Hampson, van Anders, & Mullin, 2006). Thus, the final goal was to examine sex difference in variations of selective attention by valence. Specifically, it was expected that compared to males, females would show higher selective attention towards negative emotionally stimuli, especially threat-related emotional stimuli, than neutral stimuli.

A unique aspect of this study was its focus on preschool aged children, which is an understudied population in the selective attention literature. One possible explanation for scarce research on selective attention processes during early childhood is that traditional measures of selective attention (e.g., dot-probe task, emotional Stroop task)

are not appropriate for use with young children. For example, in the traditional dot-probe task (MacLeod, Mathews, & Tata, 1986), two stimuli (one emotional and one neutral) are presented on the top or bottom of a computer screen. These stimuli disappear after a brief time, and a probe appears in the location that was previously occupied by one of the stimuli. Participants are asked to press a button to determine whether the probe replaced the stimulus that is shown on the top or the bottom of computer screen. Fast reaction times for trials, in which the probe replaces the threatening stimuli, characterize facilitated attention toward negative stimuli (vigilance toward negative stimuli). In the emotional Stroop task, participants are presented with colored emotional words, and are asked to name the color of the emotional word, and response latency is measured. These measures are limited because they require participants to have sufficient cognitive, language (i.e., reading abilities in Stroop task), and motor abilities (i.e., response reaction in dot probe task) to complete the assigned tasks (e.g., Algom, Chajut, & Lev, 2004). Thus, these tasks may be inappropriate for young children (Pérez-Edgar et al., 2010). In addition, responses to these tasks may be confounded by the response execution (e.g., response freezing), and thus, may not provide an accurate index of selective attention (Armstrong & Olatunji, 2012). In response to these issues, eye-tracking technology has been considered a promising technique in assessing selective attention (Bar-Haim et al., 2007).

### **Relations between the Valence of Emotional Information and Attention**

Individuals are constantly exposed to a variety of emotional information. Because the brain does not have enough capacity to encode and process all information received, only a limited amount of information is further processed and singled out-- including

those stimuli that have attention grabbing qualities (e.g., unpleasantness or pleasantness of a stimulus).

The valence, the attractiveness or unpleasantness, of competing emotional information may be one defining factor in directing and modulating attention. For instance, an abundance of research has demonstrated that emotional information with negative valence, on average, receives preferential attention compared to neutral information/signals, likely due to the level of arousal that valenced information may induce (Hahn, Carlson, Singer, & Gronlund, 2006; Leclerc & Kensinger, 2008; Mather & Knight, 2006; Steinmetz, Muscatell, Kensinger, 2010). Furthermore, in a meta-analytic review, Costafreda, Brammer, David, and Fu (2008) found that, among adults, negative emotional facial expressions (e.g., anger, sadness) elicited higher activity in the amygdale -- a brain region responsible for processing of emotional information-- than did neutral emotional information, suggesting higher information processing for negative emotional than neutral stimuli.

It should be mentioned that most of the aforementioned studies have been conducted among adults or adolescents. However, eye-tracking studies using infant subjects also have demonstrated differential attention towards valenced emotional versus neutral stimuli. That is, the emergence of higher selective attention towards emotionally valenced than neutral stimuli may be evident in early infancy. For instance, Hamlin, Wynn and Bloom (2010) found that infants as young as three months showed biased attention towards negative emotional information. Furthermore, Peltora, Leppänen, Palokangas, and Hietanen (2008) assessed 7-month-olds' selective attention (i.e., looking duration) towards fearful and happy facial expressions and a control stimulus (a



scrambled face) and found that infants looked longer at fearful faces compared to control stimuli. No difference was found between infants' duration of looking time at happy facial expressions and control faces.

Overall, results from studies in adults and infants have provided support for differential attentional sensitivity towards emotionally-valenced and neutral stimuli. Yet, there is a gap in literature with regards to the normative course of selective attention towards distinct types of emotions among young children. Given that high levels of selective attention towards negative information have been linked to development of emotional disorders, it is important to understand how normative processes function. Thus, more research is needed to examine young children's selective attention by valence during early childhood, when children are beginning to learn about different emotions and to differentiate between types of emotions. In an attempt to add to the existing literature, the first goal of the study was to examine whether young children, on average, show heightened attentional sensitivity towards valenced emotional information (i.e., angry, and sad) compared to neutral emotional stimuli.

### **Differences in Selective Attention Towards Distinct Types of Emotions**

According to the evolutionary threat theory, the processing and detection of some negative emotional information (i.e., threatening information/signals) are more important for survival than other types of emotions because the detection and encoding of threatening cues is more critical for survival (Pratto & John, 1991; Schimmack, 2005). Indeed, there is support for this theory suggesting that threatening signals/cues in the environment get priority in drawing attention (than other negative or neutral information) because the detection of these types of signals/information is evolutionary adaptive and

has potential processing advantages (Dolan & Vuilleumier, 2003). For instance, detection and encoding of threatening information in the environment (e.g., a rattle snake in the grass) helps individuals to appropriately detect the source of threat to ones' survival and take the appropriate action (Mathews & Mackintosh, 1998). LoBoue (2009) also found that preschoolers detected angry faces faster than happy expressions. In addition, to the possibility of increased chances for survival, the effective detection of threatening social signals/cues (e.g., angry facial expressions) has potential advantages for the person's emotional and mental well-being. Imagine a person who walks into a room full of strangers and notices a person who is either talking or acting aggressively. The detection of anger cues in the stranger's actions/emotional expressions may help the individual avoid interaction with the angry person to protect himself from the potential consequences of exposure to anger (e.g., influencing the individual's mood) and maintain his/her well-being.

As discussed above, Peltora and colleagues showed that infants looked longer at faces that signaled threat (i.e., fearful faces) compared to neutral or happy faces (e.g., Peltora et al., 2009). However, the researchers only assessed happy and fearful facial expressions, and thus, did not differentiate between distinct negative emotions (e.g., attention towards anger versus sadness). Thus, the second goal of this study was to compare children's selective attention towards different types of emotional stimuli (e.g., angry versus sad, angry versus happy) when these stimuli are paired with neutral stimuli. It was expected that children of this age group would have higher likelihood to detect angry than sad or happy faces. Furthermore, children were expected to be faster in detecting angry than happy or sad among neutral emotional expressions.

## **Sex Differences in Selective Attention to Emotional Information**

Previous studies have shown that females may have greater ability to identify and detect valenced emotional information than do males (Russell, Bachorowski, & Ferná ndez-Dols, 2003). Different explanations have been provided for sex differences in identification and recognition of emotional information, including facial expressions (Hampson et al., 2006). For instance, the primary caretaker hypothesis (Babchuk et al., 1985) posits that because females are typically the primary caregiver of their offspring, they have evolved to be more aware of emotional signals and stimuli in the environment to protect and to ensure the survival of their offspring. Indeed, females are found to be more alert in detecting and encoding valenced emotional information and signals, especially threatening emotional information, than are males (Hampson et al., 2006). Sex differences in detection and identification of emotional information have been observed not only in adults but also in children from infancy to adolescence. For instance, significant differences have been found between female and male children and adolescents, favoring girls, in facial expression processing -- as indicated by amygdala activation in response to emotionally valenced stimuli/cues (McClure, 2000; Killgore, Oki, & Yurgelun-Todd, 2001). In addition, sex differences are found to be particularly strong for threat-related emotional stimuli (Killgore et al., 2001; Hampson et al., 2006).

The research evidence regarding females' dominance in detection and identification of emotionally-valenced stimuli, especially threat-related emotional information, suggests that perhaps females may show higher selective attention or attention bias towards negative emotional information. Indeed, females are found to encode the visual details of a stimuli quicker than males (e.g., Kim & Petrakis, 1998), and

to have higher speed in encoding visual details of negative emotional stimuli, including facial expressions (Hampson et al., 2006). Thus, the final goal of present study was to test sex differences in selective attention towards emotional information with valence.

Consistent with previous research, it was expected that females' selective attention towards negative emotionally valenced stimuli when paired with neutral stimuli would be higher than male counterparts. In addition, it was expected that, compared to males, females would be faster in detection of angry stimuli (threat-related stimuli) among neutral stimuli than detection of happy or sad among neutral stimuli.

### **Use of Eye-Tracking Technology in Assessment of Children's Selective Attention**

The use of non-invasive video-based corneal reflection eye trackers, which uses an infra-red light source to record the patterns of corneal reflections and eye movements, has shown promising advances in understanding and assessing the process of selective attention in adults and children from clinical populations (e.g., In-Albon & Schneider, 2011). The rationale is that information in the environment that directs one's visual attention is what the brain cognitively processes. In other words, there is no delay between what individuals see and what their brain processes (Just & Carpenter, 1980). Thus, eye tracking – which provides rich and detailed data on eye movements, eye position, the point of gaze, and the amount of time children spend on one emotional cue, stimuli, or region versus another, and the level of gaze fixation—has been found to be a promising measure to evaluate children's visual attention without requiring children to provide explicit behavioral responses (Balcetis & Dunning, 2006; Bögels & Mansell, 2004; Wadlinger & Isaacowitz, 2008).

Two examples of the eye tracking tasks that previously have been used among adults or older children to assess selective attentional processes are the free-viewing and visual search tasks (e.g., Armstrong et al., 2011; Calvo, & Lang, 2004; Fox et al., 2000; Lamy, Amunts, & Bar-Haim, 2008). In the free-viewing task, participants are presented with an emotional stimuli (e.g., angry, sad) paired with a neutral stimuli and are asked to freely view the pictures. In these studies, the initial orientation of gaze towards the emotional stimuli in the beginning of trial (initial fixation) and duration of looking time at emotional stimuli have been used as indicators of selective attention/attentional biases (reflecting high attentional engagement towards the stimuli and poor attentional disengagement away from the stimuli, respectively; Armstrong, et al., 2011; Calvo, & Lang, 2004). Specifically, 1) the higher tendency to attend and orient gaze towards emotional stimuli than neutral stimuli in the beginning of the trial (initial fixation), and 2) the higher proportion of looking time at emotional stimuli compared to neutral stimuli have been used to reflect selective attention/attentional bias towards emotional stimuli.

In the visual search task, participants are presented with pictures of emotional stimuli in an array of non-emotional stimuli (e.g., 2X2, 3X3 or 4X4 matrices with three, eight or fifteen neutral and one emotional stimulus; Derakshan & Koster, 2010; Ohman, Flykt, & Esteves, 2001; Rinck, Reinecke, Ellwart, Heuer, & Becker, 2005; Wolfgang et al., 2004). The lower latency to detect the emotional stimulus among neutral stimuli than to detect the neutral stimulus among emotional stimuli has been defined as selective attention towards the emotional stimuli (Derakshan & Koster, 2010). In these studies, the latency to detect the emotional stimulus (latency to fixate on the emotional stimuli in the eye-tracking studies) among neutral stimuli has shown to be faster than the latency to

detect neutral stimulus among emotionally valenced stimuli. In the current study, a modified version of the visual search task was used such that only pictures of emotional stimuli (i.e., angry, happy, and sad faces) among neutral expressions were shown to children because the goal was to compare differences in latencies to detect distinct emotional stimuli when these stimuli were presented among a number of neutral stimuli.

### **The Current Study**

The current study aimed to contribute to the existing literature on selective attention by testing differences in children's selective attention towards different valenced emotional stimuli, while taking into account the role of children's sex in such differences. It was expected that children would show a higher tendency to attend to negatively valenced emotional than neutral stimuli, and they would be faster to detect angry than happy or sad stimuli when these emotionally valenced information are presented with neutral stimuli. Moreover, sex differences were anticipated to be found in aforementioned hypotheses, such that girls were expected to display higher levels of selective attention towards emotional faces, particularly negative emotional faces, than were boys.

### **Method**

The data for the current study came from two cross-sectional studies conducted in two large southwestern metropolitan cities with diverse communities. The first study was conducted at the University of California, Los Angeles (UCLA), and the second study was conducted at the Arizona State University (ASU). The first study was considered a pilot study (hereafter named Study 1). The study that was followed up by the pilot was a larger study and was conducted at ASU (Study 2). Given that the two studies were

slightly different from each other in terms of how participants were recruited, and the lab procedures and measures, they are presented separately in the following section.

However, the eligibility criteria and screening procedure for recruiting participants in both studies were the same. In both studies, the families and their children were included if: 1) the child was between ages of 3 and 6 years old, 2) the child's parents were over 18 years old, and 3) the child was fluent in English.

### **Study 1**

**Participants.** Families were recruited using a database made available to research assistants that included the names and contact information for all families who had a child between 3 to 6 years of age and who previously had shown interest in participating in research conducted at UCLA. A research assistant contacted the parents of the child via email or phone, and invited the parent and the child to come to the laboratory and to participate in the study. The final sample included 42 preschool-aged children (19 males and 23 females,  $M_{age} = 4.87$  in years;  $SD = .59$ ;  $Range = 4.02 - 6.08$  years old). Two additional preschoolers were tested but were excluded either because of the child's restlessness that resulted in having too much missing data (one child), or due to experimenter/equipment failure (one child).

The family income ranged from (4 = \$50,000-\$60,000) to (7 = over \$100,000) with 10.0% reported having an income level between \$50,000-\$60,000, 6.7% having an income level between \$60,000-\$75,000, 26.7% an income level between \$75,000-\$100,000 and 56.7% reported having an income level over \$100,000. In terms of race/ethnicity, 46.3% children in the sample were Non-Hispanic Caucasians 17.1% were Hispanic, 4.9% were Asians, 4.9% were African American, and 26.8% were of mixed

racess (e.g., White/Asian; White/Black; White/Hispanic, White/Middle Eastern). Mothers' and fathers' educational attainment ranged from (4 = *Community college/Vocational school*) to (6 = *Graduate degree*) with the mean of 4-year college (for both mothers and fathers).

**Procedure.** If the parent agreed to participate in the study, a meeting was scheduled for the parent and the child to come to a laboratory located at the UCLA campus. Upon the parent's and child's arrival (the majority of parents who came to the laboratory were mothers), a trained research assistant reviewed the consent form and questionnaire with the parent and asked her/him to sign the consent form and complete the questionnaires. Upon completing the questionnaire, the parent and the child were escorted to a room in which three eye tracking tasks were administered (only 2 of which were used in the current investigation). The laboratory session lasted approximately 20 minutes. After parent completed the questionnaire, the child and parent were directed to a room where the child participated in the eye-tracking tasks. The parent was instructed to sit next to their child during the eye-tracking procedure and to remain uninvolved. The order of the eye tracking tasks was randomized across participants to remove potential order effects.

The eye tracking data were collected using SR Eyelink 1000 equipment, which recorded children's eye movement patterns at 500HZ. Children sat 65 cm away from a 22-inch widescreen monitor, surrounded by two black curtains, in a dimly light room. Prior to collecting children's eye movements, the eye calibration on five points on the screen was verified while children were watching slides from a cartoon clip.



For the eye-tracking tasks, no instruction was given to children. Children only were asked to remain still and to watch the pictures as they would normally watch TV at home. During the eye-tracking tasks, children's eye positions and movements were tracked by the experimenter, and children were instructed to look at the monitor if their eye positions were out of acceptable range (e.g., they looked away from the monitor). The stimuli used in the eye-tracking tasks included colored pictures of emotional facial expressions (on white background), taken from the NimStim-MacBrain Face Stimulus Set developed by the Research Network on Early Experience and Brain Development (Tottenham et al., 2009). This battery contains 6,464 facial expressions posed by different actors (young adults). The pictures from this set have been used in previous studies of attentional biases and have shown good validity and reliability (Amso, Fitzgerald, Davidow, Gilhooly, & Tottenham, 2010; Armstrong et al., 2012; Frank, Vul, & Saxe, 2011).

**Measures.** For both eye-tracking tasks, a central fixation point (a small attention getter) was presented in the center of eye-tracker screen before viewing the stimuli (Armstrong et al., 2010). The attention-getters were animated pictures with sound. Each attention-getter measured 5.64 cm (2.22 inch) and 5.61 cm (2.21 inch).

**Free-viewing task.** The Free-Viewing Task (Armstrong, Olatunji, Sarawgi, & Simmons, 2010; Armstrong, Sarawgi, & Olatunji, 2012) included 34 trials consisting of pictures of angry facial expressions paired with neutral faces of the same person. These 34 trials included two sets of 17 angry/neutral pairs such that the first 17 pairs were repeated with the location of angry and neutral expressions reversed. The pictures measured 5.15X6.67 cm; the distance of each picture from the center of screen was 7.29

cm. Each trial was presented for 3 seconds and was followed by an attention-getter. An example of the pictures shown to children is presented in Figure 1a. The trial was considered missing if: 1) no eye movement was made during the trial, and 2) the gaze was not fixated at the attention getter before the stimuli presentation (Armstrong et al., 2010). The number of missing trials across all participants was 113 trials (out of 1,428 total trials).

In line with previous research (Armstrong et al., 2010; Calvo & Lang, 2004), the following eye movement variables were calculated to measure heightened attentional sensitivity (selective attention) towards valenced emotional stimuli compared to neutral stimuli. The first one was a categorical variable designating whether the participant's first fixation landed on the emotional facial expression (named initial fixation at emotional face; 1= *child's first fixation was directed towards the emotional facial expression*, 0= *child's first fixation was not directed towards the emotional facial expression*). The second variable was the participants' proportion of looking time at the emotional face relative to total looking time at both faces (including neutral and emotional faces). If the proportion score for the negative emotional facial expression was above .50, it indicated that the child spent more than 50% of the total time looking at the negative emotional facial expression.

**Visual search task.** During the laboratory assessment, children also completed a modified version of the visual search task. The 32 trials in this paradigm included happy or angry pictures paired with neutral emotional faces of the same person such that one of the pictures was either angry or happy, whereas the remaining three pictures were neutral faces. All four facial expression images were 5.194X6.667cm and each picture was 8.564

cm away from the center of screen. The number of happy and angry emotions and the number of females and males presenting the emotions were counterbalanced across all trials. Furthermore, the location of the target emotion (happy or angry facial expression) was randomized across trials and across participants. Each trial was presented for the duration of 3 seconds followed by an attention-getter presented at the center of computer screen. An example of a stimulus shown to children is presented in Figure 1b.

Trials in which child's gaze was not directed at the fixation point before the appearance of stimulus or the child did not look at any of the faces were considered missing. A total number of 150 trials were considered missing across all participants (out of 1,344 total trials). Three variables were computed during this task to measure child's selective attention. First, a categorical variable was computed for each trial to show whether the child detected the emotion of interest. This variable was named detection score and was coded as follows: 0 = *the child did not fixate on angry or sad facial expression*, 1 = *the child fixated on angry or sad facial expression*. The second variable that was calculated for each trial was the latency to detect the emotional face, which was defined as time (in seconds) the child took to fixate at the target emotional face since the onset of stimulus presentation. For trials in which the child did not fixate on the emotional face, the latency score was coded as 3s. Additionally, because the 32 trials included 16 angry and 16 happy emotional expressions, a binary variable termed emotion type was created to indicate what emotion was presented (0= *Angry*, and 1= *Happy*).

## **Study 2**

**Participants.** The children who participated in the ASU study were recruited from three preschools located at ASU by sending consent forms to their parents. The

consent forms were emailed to the parents or a hard copy was left in their mailbox. Children of parents who returned the consent forms participated in the study (verbal assents were received from children before starting the laboratory assessment). The final sample included 77 children (41 males and 36 females;  $M_{age} = 4.25$  years old,  $SD = .58$ ,  $Range = 3.13- 5.31$  years old).

The family income ranged from (2 = \$15,000-\$30,000; 5.1% of the sample) to (7 = over \$100,000; 46.2% of the sample). Other income levels were also represented with 2.6% of the sample reported having an income level of \$30,000-\$45,000, 10.3% having an income between \$45,000-\$60,000, 7.7% reported having an income level between \$60,000-\$75,000, and 28.2% reported having an income level between \$75,000-\$100,000. In terms of ethnicity, 22.4% of children were of Hispanic origin and 77.6% were non-Hispanic. In terms of race, the majority of children in the sample were Caucasians (67.2%) but African-Americans (5.2%), Asians (5.2%) and mixed races (22.4%) were also represented. Mother's education ranged from (3 = 2 year college) to (7 = Graduate degree) with the mean of 5.34 (5 = College degree (e.g., BA, BS degree), and 6 = Masters' degree or equivalent).

**Procedure.** Children were taken to a research room located at each preschool center. Upon the child's arrival, a trained research assistant received verbal consent from the child to participate in the study (2 out of 79 children with parental permission did not agree to participate in the study). Children participated in several tasks, including three eye tracking tasks to measure selective attention or attention bias, and tasks to assess child's emotional understanding, attentional control and regulation. The laboratory session lasted about 30 minutes. Only details about two of the eye-tracking tasks are

provided in the following section. The eye-tracking paradigms were similar to those used in the Study 1 with slight modifications. Thus, only the aspect of measures that were different from Study 1 are described below. At the end of the laboratory session, children received age-appropriate toys. Following children's laboratory participation, an online questionnaire was sent to teachers asking them to report on children's temperament and social functioning (these data were not included in the current study). Teachers were paid for their participation and for filling out the questionnaires.

**Measures.** For the eye-tracking tasks, children were taken to a dimly light room and were asked to sit 65 cm away from the high-resolution 24-inch computer screen of a portable Tobii T120 eye tracker on which the stimuli were presented. The computer screen included an integrated camera that recorded children's eye movements. Children's eyes were leveled with the center of the monitor. The Tobii T120 eye tracker uses an infrared light to create reflection patterns on the corneas of children's eyes. Children's eye movements were recorded by the eye tracker during the tasks.

Children's eyes were calibrated by asking children to follow a black dot inside a red circle, which was moving around five locations on the computer screen. Similar to Study 1, children were instructed to remain still and watch the stimuli as if they were watching T.V. at home. The stimuli (i.e., emotion pictures) were the same as Study 1 (NimStim-MacBrain Face Stimulus Set; Tottenham et al., 2009). The attention-getters were also the same as those used in previous study; however, they were presented for 1500ms instead of 2000ms. The order of the tasks was randomized to remove potential order effects. The duration of stimulus presentation was shortened from 3000 ms in Study 1 to 2000ms in Study 2 to improve the study due to children's limited attention span.

**Free-viewing task.** The free-viewing task was similar to the one used in the Study 1 except that the paradigm used in Study 2 also included pairs of sad-neutral facial expressions, as opposed to only angry-neutral pairs. Specifically, the 28 trials in this paradigm consisted of either angry or sad facial expressions (14 angry and 14 sad) paired with neutral faces of the same person. The size of facial expression images in each stimulus was 3.97 cm X 5.87 cm, and the distance of each image from the center of screen was 4.44cm. Each stimulus was shown for 2000ms and the attention-getter was presented for 1500ms. The criteria for missing trials mirrored those in study 1. There were 94 trials missing (43 and 51 for angry and sad missing out of a total of 2,100 trials across all participants). The data for two children were excluded from analyses due to experimenter/equipment failure (total number of 75 participants). The selective attention variables that were calculated in Study 2 for the free-viewing task were the same as those calculated in Study 1. In addition, because the free-viewing task used in the Study 2 also considered sad emotional facial expressions, a categorical variable was also calculated to reflect whether angry or sad emotional expressions was paired with the neutral face (emotion category; 0 = *Angry*, 1 = *Sad*) in the trial.

**Visual search task.** The number and design of trials used in the modified visual search task was also similar to the visual search task in Study 1 with three exceptions: 1) sad facial expressions replaced happy expressions (16 sad and 16 angry pictures were paired with neutral expressions), 2) each stimulus was shown for 2000ms, and 3) the four images in each stimulus measured 5.75x4.458 cm. There were 128 missing trials (61 and 67 trials missing for angry and sad out of a total of 2,464 trials) across all participants. Given aforementioned changes, the emotion type variable was coded as follows: 0 =

*Angry* and 1= *Sad*. Further, the latency score for trials in which the child did not look at the emotional face was coded as 2s instead of 3s.

### **Data Analyses**

First the descriptive statistics and correlations for the study variables were calculated using the SPSS software, Version 22.0. Next, because of the nested structure of the data given that multiple eye-movement observations during each trial (at level 1) were nested within children (at level 2), a series of regression analyses were conducted with each eye-movement variable as the dependent variable using a multilevel modeling (MLM) framework. The MLM analyses were conducted using *Mplus* Version 6.0 (Muthén, & Muthén, 1998-2010) using full information maximum likelihood (FIML) estimation.

For Aim 1, the goal was to examine whether children first fixated on and spent more time looking at the emotional faces, compared to neutral faces, during the free-viewing task. For Aim 2, the goal was to examine the likelihood of detecting the emotional faces among neutral faces and to test whether there were differences in detecting angry versus sad or happy emotional faces during the modified version of visual search task. A series of two-level models were computed for each eye-movement variable. Specifically, first an intercept-only model (a model with no covariate) was estimated to determine the degree of correlations among observations within each child and to examine whether the variations in eye-movement variables differed across children using the likelihood ratio test (Raudenbaush & Bryk, 2002). Specifically, in the intercept-only model, the level 2 variance, which reflected the variability in the mean of eye-movement variables across children, was freely estimated. This model was then

compared to a baseline model, in which the variance was set to be zero, using the likelihood ratio (LR) test to examine whether the model that accounted for the variability in the mean of eye-movement variable fit the data better than the baseline model (Peugh, 2010).

Next, if the trials contained varying emotions (i.e., happy or angry paired with neutral faces in Study 1, angry or sad paired with neutral faces in Study 2), a random intercept model that included emotion type and an observation-level predictor (i.e., at level 1) was computed to examine the relation between emotion type and selective attention (the focal eye movement variable) across trials. Lastly, a random slope model was estimated to examine whether the relation between emotion type and selective attention varied across participants. The random slope model was compared to the random intercept model using the LR test. If the result of the LR test was significant, suggesting that the random slope model significantly improved the fit, the results of the random slope model were reported; otherwise a random intercept model with emotion type category as an observation-level predictor was reported as final model.

Finally, random intercept and random slope models were estimated for each eye-movement variable with sex as a child-level predictor, emotion type as an observation-level predictor, and the interaction between sex and emotion type to test sex differences in selective attention processes and detection of distinct emotions. The details about random intercept and slope models and the interpretation of parameter estimates are described in the following section. Similar to previous sections, LR model testing was used to examine differences between models. Statistically significant interactions were probed using procedures outlined by Aiken and West (1991).



## Results

### Study 1

Descriptive statistics and correlations among the eye-movement variables from the free-viewing and visual search paradigms and study variables are presented in the first and second sections of Table 1. For computing the correlations, the means for the first fixation variable and proportion of looking time at negative emotional faces across trials were calculated. No outliers were detected and none of the variables had skewness or kurtosis greater than 2 or 7, respectively (Curran, West, & Finch, 1996).

For the free-viewing task, initial fixation to an emotional (as opposed to neutral) face was positively related to proportion of looking time at non-neutral faces (95% confidence interval for the first fixation mean was [95% CI]: .50 to .56, and for the proportion of looking time mean was [95% CI]: .52 to .57. An independent samples *t*-test was computed (with the full dataset that included all participants and trials: 42 participants X 34 trials = 1428 rows of data) to test whether there were differences between trials in which children's initial fixation was directed and not directed at emotional faces in terms of proportion of looking time at emotional faces. The results showed that for trials in which the initial fixation was directed at the emotional face, children also spent more time looking at the emotion face,  $t(1313) = -10.41, p < .01$  ( $M_s = .47$  and  $.61$  for the proportion of looking time for trials in which children initially fixated at the neutral faces and initially fixated at the emotional face, respectively; see Figure 2).

Children's age was unrelated to the eye-movement variables during the free-viewing task, but it was marginally and positively related to detection of emotional faces and was negatively related to latency to detect the emotional faces. In other words, older

children had higher means for the detection scores (detecting happy and angry faces) than did younger children and were faster in detecting the emotional faces. None of the eye-movement variables obtained from the free-viewing and visual search tasks was related to children's sex.

**Aim 1: Relations between the valence of emotional information and attention.** Recall that for Study 1, we used a free-viewing task that included angry (emotion with valence) paired with neutral faces. To test whether children, on average, would show heightened selective attention towards angry faces relative to neutral facial expressions, two intercept-only models (with no covariate) were computed with the following eye-movement variables: initial fixation at angry face and proportion of looking time at angry faces. These intercept models were computed to examine whether there was significant variability in the mean of initial fixations or proportion of looking time variables across children. An example of the model with proportion of looking time (as an outcome) is presented below. In this model,  $\gamma_0$  is the grand mean or the average proportion of looking time at negative emotions across all children,  $u_{0j}$  is variability in the mean of proportion scores across children, and  $r_{ij}$  is variability in the proportion scores across trials for each child, which is assumed to be equal for all children.

$$\text{Proportion score}_{ij} = \gamma_0 + u_{0j} + r_{ij} \quad (1)$$

For the intercept-only model examining initial fixation, the threshold was  $-.13$  ( $p = .02$ ) suggesting that, on average, the probability of first fixation landing on the emotional face was  $.53$ ,  $p < .05$ . These results suggested that on average, children had a greater tendency to fixate on the angry versus neutral faces. Next, the model in which the variability in the mean of initial fixations across children was set to be freely estimated

was compared to the model with no variability using the LR test. The results showed that there was no variation among children in terms of initial fixation on the emotional faces,  $\chi^2(1) = .00, p = .96$ .

For the proportion of looking time, the grand mean (or weighted) proportion of looking time at the emotional faces (relative to neutral faces) was  $\gamma_0 = .55, p < .001$ , suggesting that on average participants spent 55% of the total trial time looking at angry faces. Given the threshold was .50, one sample  $t$ -test was calculated and the results showed that the estimate was significantly different from .50,  $t(40) = 4.24, p < .01$ . The results also showed that there was within-child variability across observations,  $r_{ij} = 0.06, p < .001$ . However, the results of LR test showed that the model in which the variability in mean proportion scores across children was accounted for did not significantly improve the fit of the baseline model (in which across-children variability was set to be zero),  $\chi^2(1) = 3.57, p = .06$ . Overall, these results suggest that there were no mean differences among children in terms of proportion of looking time.

**Aim 2: Differences in detection of negative emotions.** In the visual search task, the trials included angry faces among a group of neutral faces and happy faces among a group of neutral faces because the goal was to examine differences in detecting angry and happy facial expressions. Recall that detection of the emotional expression was indicated by 0 or 1 where a score of 1 showed that the child fixated on the emotional face during the trial. In addition, the time the child took to fixate at the emotional faces since the onset of stimulus presentation was calculated as the latency score and was a continuous variable. Thus, to compare differences in children's detection of distinct emotional faces (i.e., angry versus happy) when presented with neutral stimuli, the following three models

were estimated for detection scores and latency scores: 1) an intercept-only model, 2) a random intercept model with emotion type as an observation-level (i.e., level 1) predictor, and 3) a random slope model. The results of the three models are presented in Table 2 (three models for each eye-movement variable).

First, an intercept-only model was conducted to examine whether there were mean differences among children in detecting emotional faces (i.e., angry and happy faces among neutral). On average, the probability of detecting emotional faces among neutral facial expressions was .89 (Threshold was -2.10,  $p < .001$ ). There was also variability among children in the mean of detection scores as indicated by the LR test,  $\chi^2(1) = 15.58, p < .01$ .

Next, the emotion type category was added to the model as a level 1 predictor. The model is illustrated below in Equation 2, where  $\gamma_0$  is the average detection score for trials with emotion category coded as zero (angry), and  $\gamma_1$  represents the incremental difference between the average detection score for the emotion coded zero (angry) and the emotion code 1 (happy). In addition,  $u_{0j}$  represents the variation in the mean of detection scores between children after accounting for the emotion type, whereas  $r_{ij}$  represents within-child variability for detection scores.

$$\text{Detection score}_{ij} = \gamma_0 + \gamma_1 (\text{Emotion}_{ij}) + u_{0j} + r_{ij} \quad (2)$$

Results indicated that detection of the emotional face was not dependent on the emotion type category (angry or happy facial expressions among neutral faces), suggesting that children were able to detect the face that was “different” from the neutral faces, but didn’t show preference for either anger or happy expressions (see the second column of Table 2). The result of an independent sample  $t$ -test, conducted using the full

data set, also showed that there was no difference in detecting happy and angry faces,  $t(1192) = -.13, p = .90$  (see Figure 3).

Next, a random slope model was conducted to examine whether the relations between emotion type and detection scores varied across children (see Equation 3 below). In this model,  $\gamma_1$  is the average slope representing the relation between emotion type (level-1 predictor) and detection scores,  $u_{0j}$  is the variability in mean detection scores across children, and  $u_{1j}$  represents whether the within-child slopes (for the relation between emotion type and detection scores) differed from the average slope. The random slope model was compared to the random intercept model with emotion type category; the results of LR test showed that the random slope model did not have a better fit than the baseline model. This suggested that the relation between emotion type category and detection of emotional faces did not vary across children. The results obtained from this model are presented in the last column of Table 2, first section involving detection scores as outcome.

$$\text{Detection score}_{ij} = \gamma_{0+} + \gamma_1 (\text{Emotion}_{ij}) + u_{0j} + u_{1j} (\text{Emotion}_{ij}) + r_{ij} \quad (3)$$

Three models were also estimated using the latency scores (time to detect the emotional faces). The results of the unconditional model showed that there were differences across children in terms of latency to detect emotional faces,  $\chi^2(1) = 12.61, p < .01$ . The results of random intercept and random slope models also showed that: 1) there was no relation between emotion type and latency to detect the emotional faces, and the relation between emotion type and latency to detect the emotional faces did not vary across children (see the second section of Table 2 for the results of three models).

**Aim 3. Sex differences in selective attention to emotional information.** Sex differences in eye-movement variables were examined using both the free-viewing and visual search tasks. To test the effect of children's sex in selective attention towards negative emotional information during the free-viewing task (i.e., initial fixation at the emotional faces, proportion of looking time), a random intercept model was computed with sex (level 2 variable). The model is presented below in Equation 4, where  $\gamma_0$  reflects the conditional grand mean for or the group coded zero (average proportion of looking time for males), and  $\gamma_1$  indicates whether being female would increase the mean of proportion of looking time at emotional faces:

$$\text{PROPI}_{ij} = \gamma_0 + \gamma_1(\text{Sex}_j) + u_{oj} + r_{ij} \quad (4)$$

The relation of sex on initial fixation at emotional face was not significant ( $\gamma_1 = .19, p = .08$ ), suggesting that being female did not increase the likelihood of initial fixation being directed at the angry facial expressions (compared to neutral faces). Sex was unrelated to the proportion of looking time ( $\gamma_1 = .01, p = .46$ ).

Using the visual search task, sex differences in detection of distinct emotions (i.e., angry and happy) as well as in the latency to detect distinct emotional faces were examined using two random intercept models. An example of a random intercept model with detection scores is presented below in Equation 4. In this model,  $\gamma_1$  refers to relation between emotion type and detection scores for males (group coded as zero),  $\gamma_2$  indicates the relation between sex and detection scores across participants (main effect of sex), and  $\gamma_3$  indicates whether the change (increase or decrease) in the emotion type slope (the relation between emotion type and detection scores) was dependent on the child's sex.

$$\text{Detection score}_{ij} = \gamma_0 + \gamma_1(\text{Emotion}_{ij}) + \gamma_2(\text{Sex}_j) + \gamma_3(\text{Emotion} * \text{Sex}) + u_{oj} + r_{ij} \quad (5)$$

Sex was not related to detection of emotional faces,  $\gamma_2 = -.05$  ( $p = .86$ ). In addition, the relation between emotion type and detection score was not dependent on the child's sex,  $\gamma_3 = .12$ ,  $p = .74$ . Similar to the models involving detection scores, sex was not related to the latency scores, and the relation between emotion type and latency scores was not dependent on the child's sex,  $\gamma_2 = -.13$  ( $p = .18$ ), and  $\gamma_3 = .14$  ( $p = .16$ ), respectively.

Two random slope models were also estimated with sex and the interaction between sex and emotion type, and these models were compared to the previous models. The results of the LR tests showed that the random slope models did not significantly improve the models' fit,  $\chi^2(2, 2) = .01$  and  $.08$ ,  $ps = .99$  and  $.96$ , for models involving detection and latency scores, respectively.

## **Discussion**

The results of Study 1 demonstrated that children (on average) fixated first on angry emotional expressions (as opposed to neutral faces) and spent more time looking at angry faces than neutral faces. Specifically, when children were given a choice of looking at either an angry face or a neutral face, a majority of children fixated first towards and spent more time looking at the emotional rather than neutral information. These selective attention patterns suggest that perhaps negative facial expressions (especially angry facial expressions that signal threat) have more attention-grabbing qualities than do neutral faces because these faces have an evolutionary adaptive purpose (Ohmen, Flykt, & Esteves, 2001; Schimmack, 2005). Given the adaptive value of threatening emotional information, this information also has the potential to increase individuals' level of

arousal, and hence, signaling them to direct their attention towards the threat (e.g., Lang, Greenwald, Bradley & Hamm, 1993; Schimmack, 2005).

In terms of detecting different types of emotions, most children were able to detect emotional faces (the face that was “different”) among neutral facial expressions (on average 89% of the time). However, there was no difference in terms of detecting angry versus happy facial expressions among neutral faces (neither in terms of whether angry and happy faces were detected nor in the latency to detect angry and happy expressions). This result was inconsistent with previous research demonstrating differences in detection or latency to detect angry versus positive emotional information among young children (LoBue, 2009; LoBue, Mathhews, Harvey, & Thrasher, 2014). However, there are a number of differences between the procedures and stimuli used in the current study versus previous studies. First, the method of studying detection of emotional information varied across studies. Specifically, in the previous studies with young children, researchers used latency of behavioral reactions (e.g., touching the screen on which the stimuli were presented) rather than visual orientation of attention as a measure of selective attention. Reaction time as a measure of selective attention has been found to be problematic because such scores can be influenced by other factors such as response execution (e.g., response freezing; Armstrong & Olatunji, 2012). This limitation is particularly true for young children who have not yet developed adequate motor abilities. Given lack of differences in visual detection of happy and angry faces in the current work, further research needs to be conducted with both measures to compare the results obtained using the reaction time and visual attention measures.



Further, in most prior studies, the participants were instructed to look for the target stimulus (e.g., snakes, angry) among non-target stimuli (e.g., flowers, neutral), whereas no instructions were given in the current work. Thus, it is likely that priming has contributed to finding differences in prior work. Both facial expressions of angry and happy convey complex information and are relevant to day-to-day functioning and adaptation. That is, detecting the happy facial expressions and signals may be as salient for positive social functioning and survival (social survival) as detecting angry signals (Bublitzky, Gerdes, White, Riemer, & Alpers, 2014; Schupp et al., 2004). Thus, under a normal and usual condition, the individuals may be motivated to look and search for either angry or happy information. However, under a condition in which the individuals have become aware of the type of stimuli that needs to be found, children may show more vigilance in detection of threat-related information (important for survival) rather than happy information (important for positive functioning).

Although there was variability in the detection of facial expressions as well as latency to detect emotional faces among participants, the variability in detection of emotional faces was not explained by sex differences. The rationale for examining sex differences in the current study was based on the primary caregiver hypothesis. Specifically, the theory posits that because females are the primary caregivers and would be responsible for protecting and caring for their offspring, they may show more attention to negative emotional information than are men. Although sex differences have been reported in children's facial expression processing as well as emotion recognition and (with girls at a higher advantage than males; McClure, 2000; Hampson et al., 2006), these results showed that sex difference in visual attention towards different emotional

information may be negligible. However, it is likely that although females may be better at identifying and paying attention to multiple cues (e.g., facial expression, verbal information provided about the situation or event) to recognize and identify emotions, they may not differ from males in visual attention towards different types of emotion. Indeed, sex differences often have not been found in studies of emotion recognition that have utilized eye-tracking methodology (e.g., Wolf, Philippi, Motzkin, Baskaya & Koenigs 2014). Alternatively, it is also possible that understanding and awareness about expectations that society has for women does not emerge or develop until later during adolescence when children enter bigger complex social units.

The results of Study 1 showed that compared to neutral faces, emotional faces attract more attention. Given that no difference was found in visual detection of happy and angry faces, one question remains unanswered. That question was whether the same pattern of selective attention processes would have been found if another type of negative emotional face (i.e., sad) was paired with neutral faces. Study 2 was conducted to answer this question.

## **Study 2**

Descriptive statistics and correlations among the study variables for the free-viewing and visual search tasks are presented in the first and second sections of Table 3. Similar to Study 1, for computing the correlations among study variables, the means for the eye-movement variables were computed and then the correlations were calculated between the means for eye-movement variables and other study variables (i.e., age and sex). The results of correlations showed as children fixated on emotional faces, they tended to look longer at the emotional faces. The results of a *t*-test comparing the mean of

proportion of looking time based on first fixations (using the full data set that included all trials separately) also supported these results,  $t(2003) = -17.12, p < .01$  (see Figure 4). In terms of correlations between eye-movement variables during the visual search task, higher detection means were related to lower latencies to detect the emotional faces. However, the eye-movement variables during the free-viewing task were not related to eye-movement variables during the visual search task.

For the correlations among sex, age, and eye-movement variables during free-viewing and visual search tasks, age was positively related to whether children detected the emotional face and was negatively related to the latency to detect emotional faces. These results suggested that older children were more likely to detect the emotional face and also had lower latency to detect the emotional faces.

**Aim 1: Relations between the valence of emotional information and attention.** Recall that, unlike Study 1 (in which only angry emotions were paired with neutral faces), children were exposed to two different emotions (i.e., angry and sad). To test whether children would show heightened attention towards emotional faces, two intercept-only models with initial fixation at emotional faces (a dummy variable coded as 0 and 1) and proportion of looking time at emotional faces were computed. For the model involving initial fixation at the emotional face, the probability of children initially fixating on the emotional face, on average, was .53 (the value of Threshold was -.10,  $p < .01$ ). In addition, the LR test comparing the model with between-child variance freely estimated and the model in which between-child variance was set to be zero was not significant,  $\chi^2(1) = 0, p = 1.00$ . Taken together, these results suggest that there was no

difference between models, and that there were no variations in the mean of initial fixation across children.

For the intercept only model involving the proportion of looking time, the average number of trials with data (or no missing data) was 26.73 and the child-level interclass correlation (ICC) reflecting the proportion of total variability in proportion scores across children was .01. Furthermore, the LR test comparing the model with between-child variance freely estimated and the model with between-child variance set to zero was not significant,  $\chi^2(1) = .27, p = .61$ . This result, along with the small value of ICC, suggested that there was little between-children variability in the mean of proportion of looking time at emotional faces. The average proportion score was  $\gamma_0 = .57, p < .001$ , suggesting that on average children spent more time looking at negative emotional stimuli (angry and sad faces) relative to neutral faces. The within-child variance (level-1 variance) was significant, suggesting that there was within-child variability in the proportion of looking time at emotional faces (see first column in the second section of Table 4).

Next, for both eye-movement variables, two random intercept models with the emotion type (as level-1 predictor) were computed to examine whether the emotion type [angry versus sad] predicted differences in the first fixation scores and proportion scores across trials. The results for both models are presented in the second column of Table 4. The results showed that the emotion type category was not related to children's initial fixation or proportion of looking time at emotional faces. The random slope models were also computed and were compared to the models with no random slopes using LR test. The results of LR test showed that the random slope models did not improve the fit of the

baseline models,  $\chi^2(2, 2) = .31$  and  $.01$ ,  $ps = .86$  and  $.99$ , for the models involving initial fixation and proportion of looking time, respectively.

To summarize the results, children (on average) initially fixated on negative emotional expressions than neutral faces, and children spent more time looking at the negative faces compared to neutral faces. However, there was no difference in selective attention towards distinct negative emotions (i.e., angry, sad).

**Aim 2: Differences in detection of angry and sad facial expressions among neutral faces.** To test whether children were more likely to detect angry among a group of neutral faces than sad faces (among neutral faces), the following models were computed. First, an intercept-only model was computed to test whether there was significant variability between subjects in the mean of detection scores (detecting the negative emotional faces). The results of the intercept-only model revealed that the probability of detecting the negative emotional faces among neutral faces was  $.78$  (see the first column of Table 5). The result of LR test suggested that there was significant variability in the mean of detection scores across participants,  $X^2(1) = 62.24$ ,  $p < .01$  (there were differences among children in the mean of detection scores).

Next, a random intercept model was estimated with the emotion type category as a level-1 predictor in the model. Given the correlation between age and the mean of detection scores was marginally significant, age (a level 2 variable) was controlled in the model. The results of this model suggested a negative relation between emotion type and detection of emotional faces, and a positive relation between age and detection of emotional faces. Specifically, children were less likely to detect sad than angry facial expressions, and older children were more likely to detect emotional faces than were

younger children (see the first column of Table 5). Lastly, a random slope model was computed to test whether the relation between emotion type and detection scores varied across children. Age (a level 2 variable) was used as the covariate in the model. The results of LR test comparing the random intercept and random slope model was not significant,  $X^2(2) = .29, p = .87$ , which suggested that the random slope model did not significantly improve the fit of model.

The same procedures and models were estimated using the latency scores (latency to detect emotional faces) to examine: 1) whether there were differences in latencies to detect emotional faces across children (intercept-only model), and 2) whether there were differences in latency to fixate on angry versus sad emotional faces (random intercept model with emotion type as the level-1 predictor), and 3) whether the relation between emotion type and latency scores varied across children (random slope model). Given that the relation between age and latency score mean was marginally significant, age was controlled in the random intercept and random slope models.

The results of all three models are presented in the second section of Table 5. The results showed that the emotion type was related to latency scores such that sad emotions were detected slower than were angry faces (second column in Table 5 for models involving latency scores). Furthermore, there were variations among children in the mean of latency scores and this variation was related to children's age. That is, older children were faster to detect emotional faces.

**Aim 3. Sex differences in selective attention to emotional information.** Four random intercept models with four eye-movement variables (two variables during the free-viewing task and two variables during the visual search task) were computed with

sex, emotion type and the interaction between sex and emotion type; age was used as a covariate in models involving detection scores and latency score. An example of the random intercept model with the latency to detect emotional face, as the outcome, is presented below in Equation 6. In this model,  $\gamma_1$  indicates the relation between emotion type and latency to detect emotional face,  $\gamma_2$  indicates the relation between sex and mean latency scores across children, and  $\gamma_3$  indicates whether the emotion type slope would differ based on the child's sex, and  $\gamma_4$  indicates the relation between age and mean of latency scores across children. Further, in this model,  $u_{oj}$  represents the variability in the mean of latency scores among children after controlling for the effects of sex, emotion type and age, and  $r_{ij}$  reflects the variability in the latency scores across trials (assumed to be the same for all children). Please note that age was not controlled for in the models involving initial fixation and proportion of looking time.

$$\text{Latency}_{ij} = \gamma_0 + \gamma_1(\text{Emotion}_{ij}) + \gamma_2(\text{Sex}) + \gamma_3(\text{Emotion}_{ij} * \text{Sex}_j) + \gamma_4(\text{Age}_j) + u_{oj} + r_{ij} \quad (6)$$

In the free-viewing task, sex was not related to mean differences in children's initial fixation or the proportion of looking time at negative emotional faces,  $\gamma_2 = -.04$  and  $.01$ ,  $ps = .73$  and  $.79$ , respectively. In addition, the relation between emotion type and initial fixation or proportion of looking time was not dependent on the child's sex,  $\gamma_3 = .04$  and  $.01$ ,  $ps = .84$  and  $.70$ , respectively. Further, in the visual search task, there were no sex differences in the mean of detection scores across children,  $\gamma_2 = -.28$  ( $p = .21$ ), or in the mean of latency scores,  $\gamma_2 = -.09$  ( $p = .33$ ). In addition, the interaction between sex and emotion was not related to individual differences in the detection scores,  $\gamma_3 = .14$  ( $p = .48$ ), or to individual differences in the latency scores,  $\gamma_3 = .14$  ( $p = .16$ ).

Four random slope models, with sex, emotion type, and the interaction between sex and emotion type category, were also computed (age was used as a covariate for in models involving eye-movement variables during the visual search task). Child's sex was not related to the initial fixation at emotional faces,  $\gamma_2 = -.05$ , nor the proportion of looking time at the emotion faces,  $\gamma_2 = -.05$ ,  $p = .65$ . Sex also was not related to the detection of emotional faces,  $\gamma_2 = -.14$ ,  $p = .68$  nor to the latency to detect emotional faces,  $\gamma_2 = -.10$ ,  $p = .33$ . Furthermore, the relation of emotion type to first fixation, proportion of looking, detection scores and latency to detect emotional faces did not vary based on children's sex,  $\gamma_3$  s=.04, .08, .18, and .14,  $ps = .59$ , and .16, respectively.

### **Discussion**

The results of Study 2 supported what was found in Study 1, such that children, on average, showed higher selective attention towards negative emotional faces (angry and sad facial expressions) than neutral faces. More specifically, during the free-viewing task, children's initial fixation was more likely to be directed towards an emotional (angry or sad) versus neutral face, and the proportion of time looking at the emotional faces was higher than the time spent looking at neutral faces. Because negative facial expressions were paired with neutral information, these results partially supported the categorical negativity theory (Pratto & John, 1991), which posits that negative emotional information may attract more attention than non-negative emotional information. Indeed, the same preferences in orientation and allocation of attention on negative emotional stimuli rather than neutral stimuli have been reported among typically developing older children (e.g., Ahmadi, Judi, Khorrami, Mahmoudi-Gharaei, Tehrani-Doost, 2011).



Despite differences in selective attention towards negative emotional expressions and neutral faces, no differences were found in orientation of attention or in proportion of looking time at angry versus sad facial expressions. These results could be due to the design of this particular measure, in which angry or sad facial expressions were paired with only one neutral face (rather than being presented among several neutral faces or rather than being paired with one another). Thus, children had 50/50 chance to look at either face (angry or sad versus neutral). Perhaps it would have been more appropriate to test differences in allocation of attention towards different negative emotional information when they are presented with multiple non-target stimuli or paired with each other.

Indeed, a difference in detection of angry versus sad facial expressions in the second part of study, where angry and sad faces were paired with three neutral faces (rather than only one face), was found. Similar to Study 1, the probability of detecting negative emotional expressions among neutral faces was high for all children. Of interest, however, is that children were more likely to detect an angry face than a sad face from a group of neutral faces, and the time to detect angry faces was shorter than the time to detect sad facial expressions. This result may provide support for the evolutionary threat hypothesis. That is, because angry expressions signal threat, these faces have priority in allocating attention over other negative emotional stimuli (Pratto & John, 1991; Schimmack, 2005). Another explanation for this finding may be due to the physical resemblance of the sad and neutral faces. It has been found that sad faces are harder to detect than happy faces, especially when appearing among a number of neutral faces as more focus is needed on the mouth to differentiate between the two faces (Joormann &

Gotlib, 2006). Given that findings of Study 1 indicated no differences in detection of angry facial expressions compared to happy facial expressions, this explanation also seems plausible.

In addition, females did not show any preferential attention towards negative emotional information than did males. Taken together, the results of Study 2 confirmed the results obtained in Study 1 with one exception. Whereas angry faces drew more attention than sad faces, no difference was found in detection of happy and sad faces. Given these results, no firm conclusion can be made about supporting the evolutionary threat hypothesis.

### **General Discussion**

Much research in the past decade has focused on how selectively attending to some emotional information, particularly negative emotional information, while ignoring other types of emotional information (i.e., neutral or positive) may contribute to the emergence and/or development of emotional disorders (see Kindt & Van Den Hout, 2001 for a review). However, less attention has been paid to examining how normative or typical selective attention processes may function among typically-developing children, and especially during childhood. Thus, the primary goal of the current study was to present and demonstrate a descriptive summary of the normative selective attention processes during early childhood.

An important conclusion drawn from results of the two studies (using two independent samples) is that attention is guided by the emotional stimuli that are most salient or relevant for the survival or positive functioning/well-being (i.e., reproduction, and procreation; Schupp et al., & 2007). Indeed, the salience of the emotional

information/stimuli for positive social and emotional functioning has been suggested to be associated with increases in the level of arousal induced by emotional stimuli, and hence, guiding and directing attentional resources (Junghofer, Bradley, Elbert, & Lang, 2001; Schupp et al., 2007).

The first support for this conclusion comes from the results related to the first goal that showed, on average, emotional information would attract more attention than neutral information. Indeed, in both studies, emotional information (or facial expressions with valence) was found to be more potent or dominant in directing attention than neutral emotional information, as indicated by initially fixating and spending more time on the emotional faces than neutral faces. Although these results replicated those found in other studies with adults and older children from different populations (e.g., individuals from clinical population or infants, e.g., Fox et al., 2000; LoBue & DeLoache, 2010; Serrano, Iglesias, & Loeches, 1992), less attention has been paid to testing this hypothesis among typically developing preschool-aged children.

The second rationale for the conclusion that salience and relevance of an emotional stimulus for either survival or well-being may be important in directing attentional resources comes from the results obtained from detection of specific emotional information during the visual search task. Despite differences in detection of angry and sad faces, differences were not observed in detecting angry versus happy emotions among neutral faces. These results may suggest that survival is not the only determining factor in directing and guiding the visual attention. Indeed, it has been suggested that emotional signals also may be evaluated given their importance for positive adaptation and their relevance (e.g., how relevant the emotional stimuli or event

is for the person) for daily functioning given the situation and circumstances surrounding the person (Schimmack, 2005; Schup et al., 2007; Strauss & Allen, 2009). Thus, because happy faces are relevant to positive and adaptive social functioning (especially in the life of a young child), they may induce the same level of arousal in children and attract their visual attention as do angry and threatening emotional information (that are important for survival). In contrast, sadness detection may not be as relevant for either survival or positive functioning, and thus, may attract less attention than angry stimuli.

Further research needs to be conducted among young children to examine whether happy stimuli or signals can attract as much visual attention as angry stimuli. This information can have important implications for attention training programs that have shown to be effective in reducing young children's heightened bias towards negative emotions (e.g., see Bar-Haim, Morag, & Glickman, 2011; Waters, Pittaway, Mogg, Bradley, & Pine, 2012 ). One implication would be to create computerized programs, in which angry or threat-related stimuli and objects are presented among happy stimuli (rather than other negative or neutral stimuli/objects).

Age was related to detection of emotional stimulus when presented with neutral emotional information such that older children were more likely to detect emotional faces among neutral stimuli than younger children. The relation between age and detection of emotional faces is not surprising especially given that the attentional and cognitive processes as well as children's understanding of emotions are rapidly developing during the preschool period (Denham & Couchoud, 1990). Thus, it is likely that because older children have better executive attention and attentional control skills than do younger children, they are better in detecting the one stimulus that is dissimilar from others

(Mezzacappa, 2004). Further, age differences also could be due to increases in children's recognition and understanding of specific emotions and in their ability to differentiate between distinct emotions (Denham & Couchoud, 1990; Widen, 2012). For instance, children's understanding of facial expressions initially begins with differentiation based on broad categories such as feeling good or feeling bad and develops to become more complex to allow for differentiation of specific and distinct emotions as children age (Widen, 2012). This change in understanding of distinct emotions and facial expressions indeed may be responsible for better detecting the different emotional face among neutral ones.

Across both studies, the proportion of looking time and initial fixation at emotional faces were related to each other such that children who fixated first on emotional faces as opposed to neutral faces also spent more time looking at the emotional expressions rather than neutral faces. This result was consistent with previous research as these two indicators of selective attention, although distinct, are thought to be related (e.g., Derryberry & Reed, 2002; Fox, Russo, Bowles, & Dutton, 2001). The initial fixations at negative emotional information and looking time are suggested to tap onto different components of selective attention, with the former showing vigilance towards emotional information and the latter suggesting a difficulty in the disengaging or shifting attention away from the stimuli. The results from two different samples also showed that the two components of selective attention relate to each other in preschool-aged children.

### **Sex differences in selective attention processes**

Conflicting with account of primary caregiver hypothesis, children's sex was not related to the indicators of selective attention (initial fixation and proportion of looking

time) as well as to the detection of emotional faces. The foundation of the primary caregiver hypothesis is based on the role of females as caregivers, which requires women to be more sensitive to detecting and attending to negative emotional information, particularly threatening such as angry emotional information, than are men. Furthermore, females have lower power and status in the society than do men, and thus, they may be more motivated or may feel more obligated to encode and attend to negative emotional information especially when coming from the higher status people in the social group (Brody, 2000). However, it is likely that these expectations (need to protect and care for offspring) or understanding and awareness about belonging to a marginalized and low status group do not emerge or become evident until later in life (when children enter larger social groups or until adolescence years). It is also likely that females do not differ from males in visual attention towards different emotions, but they differ from men on their reactions in response to detection of them as well as the way they process and understand these emotions. Indeed, the studies that have used eye-tracking methodology to study selective attention, often have not found sex differences in individuals' selective attention (Wolf et al., 2014).

### **Strengths and Limitations**

The two studies conducted had several strengths. First, unlike other studies that have focused on maladaptive selective attention processes, the focus of the current studies was on average or normative/typical selective attention processes. Next, most previous studies have been conducted among adults or infants, and thus, the current work is one the few studies that have been conducted among preschool-aged children. Examining the normative and typical selective attention processes is especially important

during this developmental stage that is considered to be marked by rapid development of children's attentional processes as well as emotion understanding skills. Further, in the current study, the eye tracking methodology was used—which could provide a direct measure of attention and orientation of attention -- compared to traditional measures of selective attention (see Armstrong & Olatunji, 2012 for a review).

Besides these strengths, the current study had several limitations that need to be considered. First, the visual search task, used in the current study, was a modified version of the traditional visual search task. If the traditional visual search task was used, emotional faces (e.g., angry, sad, happy) would have been presented in an array or crowd of neutral faces, and neutral faces would have presented in an array or crowd of emotional faces. This modified version was chosen due to children's short attention span and to reduce children's fatigue during the experiments, and also because the goal was to compare differences in detection of angry versus happy and sad emotional information to test evolutionary threat hypothesis. However, future work may include angry pictures among neutral faces and again neutral faces among angry faces to compare the latency to detect angry or neutral. Then, the probability to detect and latency to detect emotional faces among neutral faces may be compared to the probability to detect and latency to detect neutral faces among emotional expressions to examine differences in detecting different emotional facial expressions compared to neutral faces. Moreover, future researchers should consider including different combinations (e.g., neutral faces among angry and sad facial expressions and vice versa, angry among sad faces and sad among angry faces) to examine children's sensitivity towards detection of different emotional information. Second, given that inconsistent with prior studies, differences were not

found in detecting angry and happy faces, future work needs to employ a multimethod approach in studying children's selective attention processes (using eye-tracking with measures of behavioral reaction in response to emotional stimuli or with physiological measure to assess children's level of arousal during stimuli presentation). Using various methods enables researchers to compare the differences between children's different responses to happy versus angry emotional stimuli obtained from various methodologies.

Lastly, although individual differences was found in detection of emotional faces than neutral faces, the variability in detecting emotional faces was not attributed to sex (that was the variable of interest in the current study). Thus, future research also needs to examine other variables that may contribute to individual differences in selective attention processes, such as temperamental characteristics or parenting practices that have been shown to be related to selective attention processes.

Nevertheless, the current study has significant implications for studies examining atypical selective attention processes among children from clinical population (e.g., children with autism, attention deficit disorder, or anxiety). Understanding how selective attention processes function in typically-developing children can inform researchers who examine atypical selective attention processes among at-risk children for developing emotional disorder.



## **Publication 2: Relations of Emotion-Related Temperamental Characteristics to Attentional Biases and Social Functioning**

Attentional bias towards negative stimuli (AB), defined as a tendency to focus attention on a negative stimulus when a person is confronted with different types of stimuli (Wiers & Stacy, 2006), has been found to play an important role in the emergence and development of behavior problems (Waldinger & Issacowitz, 2010). Individual differences in AB towards negative emotions can be contributed to a number of different factors, including individual characteristics (e.g., individuals' current affective states, age, or trait-like emotional profiles; see Bar-Haim et al., 2007, for a review). Theoretical and empirical evidence is somewhat limited but suggests that children's temperamental negative emotionality may positively relate to children's AB (e.g., Gray & McNaughton, 2000; Lonigan & Vasey, 2009); however, this relation is suggested to be moderated by emotion regulation (Lonigan, Vasey, Phillips, & Hazen, 2004). Despite theoretical evidence for the moderating role of regulation in the relations of temperament to AB and relations of AB to adjustment, little attention has been paid to empirically testing the moderating role of regulation in aforementioned relations –especially among young children. Thus, the first goal of this study is to examine the moderating role of attention regulation in the relations between children's proneness to negative emotions (i.e., anger, sadness, and fear) and AB towards negative emotions.

Moreover, high AB towards negative stimuli has been found to play an important role in the emergence and development of emotional disorders (e.g., anxiety, depression), and behavioral problems, including aggressive behaviors (Waldinger & Issacowitz, 2010). However, most of the studies that have examined the relations between children's

AB and maladjustment have focused on older children from clinical populations. In addition, few studies have considered the role of attention regulation as a potential moderator of such relations. Given the significance of regulation skills in reducing children's behavior problems and increasing adjustment, the second goal was to examine the relations of children's AB towards negative emotional stimuli to their social functioning (i.e., prosocial behaviors, social competence) and maladjustment (i.e., anxiety, aggressive behaviors).

Identifying the individual factors that may be related to emerging and developing high levels of attentional sensitivity or bias has clear importance given that AB has been found to play a role in the emergence and development of behavior problems. Furthermore, considering moderating factors (i.e., components of attention regulation including attention focusing and shifting) that may prevent the occurrence of such relations has important implications for intervention/prevention programs.

### **The Role of Temperamental Negative Affectivity to Children's Selective Attention**

There is both theoretical and empirical evidence to suggest that individuals' negative emotional experiences, both individuals' transitory affective states and predisposition to negative emotions, are related to AB toward negative emotional information. From a theoretical standpoint, the hedonic contingency and mood maintenance theories (Wegner & Petty, 1994; Clark & Isen, 1982) posit that individuals are motivated to attend to emotional information congruent with their emotional states. That is, people with positive affective states are motivated to orient their attention towards positive emotional information to enhance their moods, whereas individuals with negative affective states are inclined to attend to negative information in their

environments to maintain their negative emotional states. Indeed, a rich body of research suggests that affective experiences, whether temporary or trait-like, predict what information individuals choose to encode and attend to when they are confronted with emotional stimuli/situations (Stewart et al., 2010; Tamir & Robinson, 2007). In terms of temporary affective experiences, the results of experimental research studies has demonstrated that children who were induced to experience negative emotions were more likely to attend to negative aspects of emotional stimuli than were children who did not experience the negative mood induction (e.g., Kujawa et al., 2011).

Research has shown that trait-like individual differences in affective experiences and arousal predicts the information individuals choose to attend to and encode when they are confronted with various types of simultaneously occurring emotional stimuli (see Bar-Haim et al., 2007, for a review; Stewart et al., 2010; Tamir & Robinson, 2007). For example, research on adult populations has shown that high levels of trait-like negative affectivity predict individuals' higher selective attention towards negative emotional stimuli (e.g., Rutherford, MacLeod, & Campbell, 2004). There is also evidence from studies with older school-aged children, albeit limited, suggesting that individual differences in temperamental reactivity may positively relate to AB toward negative stimuli (e.g., Helzer, Connor-Smith, Reed, 2009; Pérez-Edgar et al., 2010). For example, it has been found that children with high levels of state anxiety were more likely attend to threatening emotional stimuli (e.g., angry facial expressions) than children with low levels of state anxiety (e.g., Muris, de Jong, & Engelen, 2004; Vasey, El-Hag, & Daleiden, 1996).

It should be mentioned, however, that the relations between reactive temperamental characteristics (i.e., proneness to negative emotions) and high sensitivity or AB toward negative information has been suggested to be moderated by emotion regulation (Lonigan et al., 2004; Vervoot et al., 2011). The process of emotion regulation involves the ability to modulate or maintain the intensity and frequency of affective experiences by altering and directing attention to and away from particular situations/stimuli (Eisenberg, Hofer, & Vaughn, 2007; Rothbart & Bates, 2006). Researchers have distinguished between the involuntary and voluntary components of emotion regulation known as reactive and effortful control. Effortful control (EC), the voluntary component of emotion regulation, has been conceptualized as “the efficiency of executive attention, including the ability to inhibit a dominant response and/or to activate a subdominant response, to plan, and detect errors (Rothbart & Bates, 2006, p. 129).” Thus, it has been proposed that under conditions of low EC, there should be strong negative relation between aforementioned temperamental risk factors and AB (Lonigan et al., 2004). In other words, when children are dysregulated, proneness to negative emotions may increase children’s risk of focusing on negative stimuli and diminish their abilities to redirect attention away from aversive stimuli. On the other hand, when children are highly regulated, this negative relation may be weaker. For example, regulated children may be more likely to inhibit attention towards negative stimuli (dominant response) and to redirect their attention towards the non-negative stimuli, regardless of their levels of negative emotionality.

Support has been found for the moderating role of regulation in the relation between temperament and attention bias toward threat, albeit for older children (Helzer et

al., 2009; Lonigan & Vasey, 2009). For example, in a sample of 4<sup>th</sup> through 12<sup>th</sup> graders, a positive relation between negative emotionality and attention bias was found only for children with low levels of EC (Lonigan & Vasey, 2009). Helzer et al. (2009) also found positive association between sixth-graders' fearful temperament and AB towards social threat only for children with poor attentional control (a temperamental characteristics described as the individual's ability to monitor attention allocation, and focus and/or shift attention as needed; Rothbart, Ellis, & Posner, 2004; Rueda, Posner, Rothbart, & Davis-Stober, 2004). Overall, the aforementioned body of research suggests that although temperamental risk factors may increase children's risk for AB towards negative emotions, EC or components of it (i.e., attentional focusing and shifting) may act as a protective factor for highly reactive children enabling them to regulate their emotions and to direct their attention away from the negative stimuli.

Previous research has shown that there are substantive individual differences in EC and control of attentional resources during preschool and elementary school years, and that these skills develop rapidly between 3 and 7 years of age (Kochanska, Murray, & Harlan, 2000; Rothbart, Ahadi, & Fisher, 2001). More research needs to be done to further examine the moderating role of regulation in the relations between children's temperament and AB, especially during the developmental stage when regulation abilities are developing. Given lack of research on the relations between temperamental negative reactivity and AB during early childhood, the first goal of this study was to examine the moderating role of attention regulation, more specifically the attentional shifting and attentional focusing components of EC, in the relation between children's temperamental characteristics (i.e., predisposition to negative emotions) and children's AB among

children between ages of 3 to 6 years old. Consistent with limited research evidence conducted among older children, it was expected that the relations between negative emotionality and AB would be stronger for children with low levels of regulation.

Furthermore, unlike other studies that have focused on AB towards one type of negative emotion (e.g., threatening emotional stimuli or sad), in the current study, the relations between children's proneness to distinct negative emotions (i.e., anger, sadness) and AB towards relevant emotions (i.e., anger and sad emotional information) were examined. The mood maintenance hypothesis (Clark & Isen, 1982) posits that individuals are motivated to attend to the emotional information that is congruent with their emotional states in order to maintain their current affective states. There is some limited evidence supporting this hypothesis in adults. For instance, adults high in trait anger have found to show AB towards angry stimuli (e.g., angry words or faces; Smith & Waterman, 2003; Smith & Waterman, 2004; Van Honk, Tuiten, de Haan, van den Hout, & Stam, 2001; Van Honk, Tuiten, van den Hout, et al., 2001). Using eye-tracking technology, Matthews and Antes (1992) also found that dysphoric individuals (high in sadness) spent more time looking at sad faces (paired with happy pictures) than non-dyphoric individuals. Based on aforementioned evidence, in the current study, children's proneness to distinct emotions of anger and sadness, as well as AB towards related emotional stimuli (i.e., angry and sad facial expressions), was disentangled. Specifically, it was expected that children high in anger proneness would show heightened sensitivity to angry stimuli, particularly under the condition of low attentioanl regulation. Furthermore, children with high proneness to sadness were expected to show heightened sensitivity towards sad stimuli, particularly if they had low attention regulation.

## **The Role of Attentional Biases in Children's Social Functioning and/or**

### **Maladjustment**

Negative cognitive and attention biases have been found to be a significant cognitive vulnerability factor for emergence and development of behavioral problems, including externalizing and internalizing behavioral problems (e.g., social withdrawal, aggressive behaviors, anxiety; Chan, Raine, & Lee, 2010; Crick & Dodge, 1994). For instance, biases in allocation of attention towards negative and hostile emotional cues in the environment are shown to be related to aggressive behaviors (e.g., Chan et al., 2010). Chan et al., (2010), using the emotional Stroop task, which is a commonly used task to assess AB, found that the male batterers (perpetrators of spouse abuse), who reported to have high levels of aggression, had lower latency to allocate their attention towards aggressive words than non-batterer males in the control group. Moreover, Gouze (2003) found that compared to non-aggressive boys, aggressive male preschoolers had higher attention towards aggressive social interactions. Furthermore, a body of research has demonstrated that anxious children show more sensitivity towards encoding and processing of threat-related emotional information, such as angry facial expressions, compared to their non-anxious counterpart (e.g., Amir, Elias, Przeworski, 2003; Carlson & Reinke, 2008; Cisler & Olatunji, 2010; Fox et al., 2001). Thus, AB towards threat-related stimuli – indicated by fast detection of the threatening stimuli and delayed disengagement from fear-evoking stimuli -- has been identified as a vulnerability factor for the emergence and/or development of anxiety problems (see Shechner et al., 2012 for a review).

Few researchers to date have taken into account the role that children's regulation may play in the associations of AB toward angry social cues to aggressive behaviors and anxiety symptoms (e.g., Susa, Pitică, Benga, & Miclea, 2012). Under the condition of high regulation, children who display AB towards anger are able to regulate negative emotions associated with encoding and processing of angry information, and as a result, are able to control their subsequent behavioral responses (generating fear or aggressive reactions in response to threat-related stimuli). Indeed, it has been found that regulation moderates the relation between AB towards negative stimuli and subsequent behavioral symptoms (Lonigan et al., 2004; Derryberry & Reed, 2002; Susa et al., 2012). However, several gaps remain in the literature. First, more attention has been given to the relations between attention biases towards anger and anxiety problems than to the associations of AB to aggressive behaviors. Next, AB often have been measured using the traditional measures (i.e., Stroop task), which requires behavioral reactions in response to different emotional stimuli that may not be appropriate to be used among young children. Third, the moderating role of attention control in AB towards anger often has been tested among adults or older children. Thus, the goal of this study was to examine the moderating role of attention regulation (i.e., attentional shifting and focusing) in the relations of AB towards threatening information to aggressive behaviors/social competence and internalizing behavior problem symptoms. Specifically, the relations between AB to angry stimuli and aggressive behaviors or anxiety symptoms as well as the negative relation between AB to angry stimuli and social competence were expected to be significant or stronger for children with low levels of attention regulation. However, for



children with high attention regulation, AB towards anger was expected to be unrelated to aggression, anxiety, and/or social competence.

The relations of children's AB towards sadness to prosocial behaviors and sympathy (the ability to feel sorrow and compassion for another person's suffering; Eisenberg, 2000; Eisenberg, Fabes & Spinrad, 2006) were also examined. Children's AB towards sad information/stimuli often has been studied in the context of maladaptive behaviors/outcomes such as depression (Gotlib & Joorman, 2010; Siegle, Ingram, & Matt, 2002). For example, compared to non-depressed counterparts, depressed children have been found to show more AB towards sad emotional information/stimuli; thus, AB toward sad stimuli has been suggested to play a causal role in the emergence or maintenance of depressive symptomology (Joorman & Gotlib, 2007). Despite this evidence, AB towards sadness might also have some positive aspects. That is, individuals who are sensitive to (pay attention to and detect sad emotional information in their environment and social interactions) may be more likely to feel sympathy for others in need and to engage in helping and prosocial behaviors. Indeed, children's concerned attention in response to watching other children in need has been related high levels of prosocial engagement (Hastings, Zahn-Waxler, Robinson, Usher, & Bridges, 2000; Vaish, Carpenter, & Tomasello, 2009).

Perspective taking, a precursor of helping and prosocial behaviors, is a meta-cognitive skill defined as the ability to understand others' as well as one's own feelings/thoughts and to recognize that others' feeling can be different from one's own feelings/thoughts (Nickerson, 1999). Perspective taking entails cognitive investigation and evaluation of the social affective cues, both facial and situational cues, in the

environment that can help the individual to make the differentiation between own and others' feelings (Carlo, Knight, Eisenberg, & Rotenberg, 1991; Eisenberg, 2000). Thus, the first stage of the perspective-taking includes paying attention and being attentive to the facial and situational affective cues (i.e., paying attention to sad facial expressions of a person who is in need). Children who pay attention to others' sad facial expressions and accurately identify sadness in others are likely to feel sympathy and initiate helping other people (engage in prosocial behaviors). Indeed, perspective taking has been related to helping and prosocial behaviors as well as sympathy (Eisenberg, 2000; Eisenberg, Zhou, & Koller, 2001). In the current study, children with relatively high AB towards sadness were expected to exhibit high levels of sympathy and prosocial behaviors. However, this relation was expected to be stronger for children who were well-regulated. Children who have a tendency to attend to the sad cues in the environment but are well-regulated (i.e., shift their attention when needed) may be more likely to feel sorrow for a needy person without feeling "personal distress"- which is a self-focused emotional response that negatively affect prosocial behaviors (Eisenberg et al., 2007). Thus, these children were expected to engage in more prosocial behaviors than children who attend to sad faces but become aroused and distressed. Indeed, research evidence suggests that regulated children experience more empathic arousal and engage in prosocial behaviors after attending to and interpreting the sad cues (Liew et al., 2011). In the present study, the moderating role of attention regulation in the associations of AB towards sad stimuli to sympathy and prosocial behaviors were examined such that the aforementioned relation were expected to be stronger for children who were high in attention regulating (i.e., attentional shifting and focusing).

## **Assessment of Attentional Biases**

In the current study, children's AB was assessed using eye tracking technology, which has shown to be a promising alternative in measuring attention biases in adults and children from clinical populations (e.g., In-Albon & Schneider, 2011). The rationale for use of eye-tracking rather than traditional measures of AB (e.g., emotional Stroop task, dot-probe task) was that the population of interest in this study was preschool-aged children. Details and explanations about use of eye-tracking in assessment of AB among young children are provided elsewhere (Nozadi, 2014; Publication #1).

The two common tasks that have been used in measuring AB include “free-viewing” and “visual search” tasks. In free viewing tasks, participants are required to freely view a series of stimuli (e.g., fear-inducing stimuli paired with neutral or happy stimulus; Mogg & Bradley, 2004) for a short period of time (e.g., 1 to 60 seconds) without receiving any instruction. In the visual search task; however, participants are asked to search for a negative stimulus in an array of neutral stimuli (see Armstrong & Olatunji, 2012, Cisler & Koster, 2010, for the review of literature). In the present study, children's AB was assessed using both free-viewing and a modified version of visual search tasks using the facial expressions as stimuli (see Publication 1, for details).

It should be mentioned that most studies that have used eye-tracking to examine attentional processes in young children have focused on children from clinical populations (e.g., children with autism; Chawarska, Volkmar, & Klin, 2010) and there are few studies that have used this method to examine AB among young children from non-clinical populations. Around 4 years of age has been marked as an important, critical period for development of regulatory skills and attentional processes such as attentional

control (Bar-Haim et al., 2007). Thus, it is important to identify factors that relate to AB during this developmental period, as well as to examine how such biases may relate to children's behavioral problems.

### **The Current Study**

Using a multi-method approach (e.g., adult-reports, eye-tracking), the present study builds on the recent interest in understanding the roles of temperamental characteristics (i.e., proneness to negative emotions of anger and sadness, regulation) in children's AB and their relations to behavior problems and social functioning. Specifically, it was expected that children's proneness to experience distinct negative emotions (i.e., anger, sadness) would be related to AB towards relevant emotional stimuli; however, this relation was expected to be stronger for children with low levels of attention regulation. Additionally, this study aimed to test the relations of AB towards distinct emotions to children's social functioning and maladjustment. Specifically, children's high levels of AB towards anger were expected to be associated with high levels of aggressive behaviors, anxiety symptoms, and low levels of social competence, whereas children's high levels of AB towards sadness were expected to be associated with high levels of sympathy and prosocial behaviors. However, the aforementioned relations were expected to be moderated by attention regulation. Specifically, the positive relations of AB towards angry facial expressions to aggressive behaviors and anxiety as well as the negative relation between AB towards angry faces and social competence were expected to be significant only for children with low levels of regulation. On the other hand, the positive relations of AB towards sad facial expressions to prosocial behaviors and sympathy were expected to be significant only for children with high

levels of attention regulation. Furthermore, because regulatory skills are rapidly developing during the preschool years, age was used as a covariate in all aforementioned hypotheses.

## **Method**

### **Participants**

The children who participated in this study were recruited from three ASU preschools by sending consent forms to their parents. The details about participants are provided elsewhere (see Publication 1). The final sample included 77 children (37 males and 40 females,  $M_{age} = 54.96$ ,  $SD = 7.30$ ).

The average family income ranged from (2 = \$15,000-\$30,000) to (7 = over \$100,000) with the mean of (6 = \$75,000-\$100,000;  $SD = 1.46$ ). In terms of ethnicity, 21.7% of children were of Hispanic origin and 78.3% were non-Hispanic. In terms of race, the majority of children in the sample were Caucasians (70%) but African-Americans (5%), Asians (5%) and mixed races (20%) were also represented. Mothers' education ranged from (3 = 2 year college) to (7 = Graduate degree) with the mean of 4-year college.

### **Procedure**

Children were taken to a room, located at each preschool center. Upon receiving verbal assent from children, they participated in several tasks including the eye tracking tasks to measure AB (for seven minutes), and a task to assess children's attentional control (for four minutes). At the end of the laboratory session, children received age-appropriate toys. More details about the procedure are outlined in Publication 1.

Following the children's participation in the laboratory session, an online questionnaire was sent to teachers asking them to report on children's temperamental characteristics (i.e., proneness to negative emotions, attention regulation), as well as children's aggressive and prosocial behaviors, anxiety symptoms, sympathy and social competence. Teachers were paid for completing the online questionnaires.

## **Measures**

**Eye-tracking measures.** Children were taken to a dimly lighted room and were asked to sit 65 cm away from the high-resolution 24-inch computer screen of a portable Tobii T120 eye tracker on which the stimuli were presented. The Tobii T120 includes an integrated camera placed underneath the computer screen, which sends an infra-red light to the pupil to create reflection patterns on the corneas of children's eyes to record the eye movement patterns.

Children's eyes were calibrated by asking children to follow a black dot inside a red circle moving around the computer screen. Following eye calibration, children participated in the eye-tracking tasks. Children were asked to remain still during both tasks and to freely watch the stimuli as they would watch a movie. The stimuli were colored photos of facial expressions of people (i.e., angry, sad, and neutral expressions) taken from the NimStim-MacBrain Face Stimulus Set (Tottenham et al., 2009). The order of the tasks was also randomized across different participants to remove the order effects.

The free-viewing eye-tracking task included pictures of angry or sad facial expressions paired with neutral expressions. There were 28 trials in this task consisting of 14 angry and 14 sad pictures paired with neutral stimuli with neutral faces of the same person (Figure 1a). Each stimulus was shown for 2000ms and was followed by an

attention-getter (an animated picture with sound), which was shown for 1500ms. Each facial expression image measured 3.97X5.87cm; the distance of each image from the center of screen was 4.44cm.

In agreement with previous studies, trials were considered missing if 1) no eye movement was made during the trial, 2) the gaze was not fixated at the attention getter before the stimuli presentation, or 3) the fixation on any of the target areas (emotion face) occurred within 80ms of the stimuli presentation (Armstrong et al., 2010). The number of missing trials across all participants was 94 trials. The following eye movement variables were calculated during each trial to measure children's selective attention: 1) a binary variable to reflect whether the target emotion (i.e., angry or sad) captured the child's initial fixation (Initial fixation; 1 = *the first fixation landed on the emotion of interest*, 0 = *the first fixation did not land on the emotion of interest*), and 2) the proportion of viewing time on angry or sad facial expressions across all trials (values greater than .50 represented AB; Armstrong et al., 2010; Calvo & Lang, 2004).

The other eye-tracking task was a modified version of visual search task. In the traditional visual search task, participants are presented with pictures of emotional facial expression among neutral faces, and then with pictures of neutral stimuli among emotional stimuli. The latency to detect emotional stimulus among neutral stimuli is compared to the latency to detect neutral stimulus among emotional stimuli. The lower latency to detect emotional face among neutral faces than to detect neutral face among emotion faces is considered to reflect AB towards emotional stimuli (Muller & Krummenacher, 2006). In the present study, only pictures of emotional faces among neutral faces were presented to children because the goal was not to compare differences

in latency towards detecting emotional stimulus among neutral stimuli versus neutral among emotional stimuli.

The paradigm included thirty-two stimuli consisting of three neutral faces paired with one sad or angry facial expression (16 angry and 16 sad facial expressions; for an example see Figure 1b). Each stimulus was presented for 2 seconds and was followed by an attention getter (shown for 1.5 seconds), similar to those used in the free-viewing task. The size of each facial expression image (see Figure 1b) was 5.75x4.458cm. Trials in which the child's gaze was not directed at the fixation point before the stimulus was presented or the child did not look at any of the four pictures were considered missing; the number of missing trials was 128 out of 2,464 trials across all participants. A categorical variable was computed to reflect whether the child detected the emotion of interest (i.e., angry or sad facial expressions) and was used as a measure of AB ( $I$  = emotion of interest was detected,  $0$  = the emotion of interest was not detected). In addition, for each trial, the latency to detect the emotional face (time that the child took to detect the emotional face once the stimulus was presented) was calculated. If the child did not detect the emotional face, then the latency was coded as 2 seconds (the total trial time).

**Temperamental negative emotionality.** On a 7-point scale (1 = “*Extremely Untrue*” to 7 = “*Extremely True*”), teachers reported on children's display of distinct negative emotions using the anger/frustration (6 items; e.g., “Gets quite frustrated when prevented from doing something s/he wants to do.”), and sadness (4 items; e.g., “Rarely cries when s/he hears a sad story.”) subscales of Child Behavior Questionnaire Short Form (CBQ; Putnam & Rothbart, 2006). The anger, fear and sadness composites were



calculated by averaging items within each subscale. The Cronbach's alphas for anger and sadness subscales in the current study were .83 and .70, respectively.

**Attention regulation.** Teachers reported on children's attention regulation, using the attentional focusing subscale from the teacher version of the Child Behavior Questionnaire Short Form (CBQ; Putnam & Rothbart, 2006 — 6 items each) and using the attentional shifting subscale from the teacher version of the Child Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001 --14 items). Example of an item representing attentional focusing was: "When practicing an activity, has a hard time keeping her/his mind on it.", and an example item representing attentional shifting was: "Can easily shift from one activity to another." Each item was rated using a 7-point scale (1 = *Extremely Untrue* to 7 = *Extremely True*). The Cronbach's alphas for the attentional shifting and attentional focusing were .75 and .80, respectively. The correlations of attentional focusing to attentional shifting was  $r = .42, p < .01$ .

**Sympathy and prosocial behaviors.** Teachers reported on children's sympathy and prosocial behavior using eight and four items from the Empathy Index for Children and Adolescent Scale (Byrant, 1982; Eisenberg et al., 1991). The response scale for each item ranges from 1 (Really false) to 4 (Really True) for the Sympathy scale and from 1 (this is never true of this child) to 5 (this is always true of this child) for the prosocial subscale. An example item from the sympathy subscale was "My child often feels sorry for others who are less fortunate," and an example of the item for prosocial behaviors was "This child says supportive things to peers." The Cronbach alphas for the sympathy and prosocial behaviors subscales in the current study were .83 and .65, respectively.

**Social competence and behavioral problems.** Children’s social competence, aggression and anxiety symptoms were rated by teachers using the social competence, anger-aggression, and anxiety-withdrawal subscales of the short form of Social Competence and Behavior Evaluation (SCBE-30; LaFreniere, & Dumas, 1996). Item examples were: 1) “Negotiates solutions to conflicts with other children” for the social competence subscale, 2) “Gets angry when interrupted” for the aggression subscale, and “Worries” for the anxiety subscale. The reliabilities for the three subscales in the current study were .85, .87, and .91 for social competence, aggressive behaviors and anxiety symptoms, respectively.

### **Data Analyses**

First, the descriptive statistics for the variables of interest and the correlations among study variables were computed using SPSS software, version 22.0. Hierarchical linear models (Raudenbush & Bryk, 2002) were used to estimate the moderating role of attentional regulation components (separately) in the relations between temperament (i.e., proneness to negative emotions) and AB (four eye-movement variables during the two tasks). Two-level models were specified considering that eye-movement variables (at level 1) were nested within children (at level 2). The four eye-movement variables (at level 1) were separately regressed onto the level 2 predictors (i.e., anger, sad reactivity or the dispositional negative reactivity composite, run in separate models), teacher-reported attentional shifting and focusing (separate models) and the interactions of negative reactivity by attention focusing and shifting. The negative reactivity (i.e., anger, sadness) and attentional focusing or shifting variables (moderators) were grand mean centered prior to analyses and the interaction term was computed using the centered variables. If

any of the interactions were significant, the model was recomputed at one standard deviation above and below the mean of attention regulation components to examine simple slopes (Aiken & West, 1991; Hayes & Mattes, 2009).

To test for the moderating roles of attentional focusing and shifting in the relations of AB towards negative emotions to social functioning, several regression models were computed (MLM could not be used because the outcome variables were not nested data and instead were composite scores). Because each child had eye-movement data for multiple trials, the mean of each eye-movement variable across trial was computed. Thus, the final dataset included 75 rows of data (for the free-viewing task) and 77 rows of data (for the visual search task), with each subject having one row of data. In each model, the outcome (i.e., aggressive behaviors, social competence, anxiety, sympathy or prosocial behaviors) was regressed on the mean of the eye-movement variable and the moderator(s); both predictors and moderator(s) were centered prior to the analyses. For the significant interactions, the simple slopes were probed (Aiken & West, 1991; Hayes & Mattes, 2009). All models were computed using *Mplus*, version 6.0 (Muthén, & Muthén, 1998-2010) with the Full information maximum likelihood (FIML) estimation.

## **Results**

### **Aim 1: Relations of Temperament to AB**

**Preliminary analyses.** Descriptive statistics and correlations among temperament variables, age, sex, and eye-movement variables (during the free-viewing and visual search tasks) are presented in Table 6. The mean of each eye-movement variable was computed for each child to compute the correlations between temperament measures,

age, sex and means of eye-movement measures. The results of correlations analyses revealed that temperamental anger was positively related to sadness and was negatively related to teacher-reported attentional focusing and shifting, and sadness was positively related to age and was negatively related to teacher-reported attentional focusing and shifting. Children with higher sad reactivity also had lower latency to detect negative emotional faces and children who had higher attentional focusing had lower detection mean (were more likely not to detect emotional faces). None of other temperament measures was related to eye-movement variables during the free-viewing and visual search tasks. As reported in “Publication 1,” the initial fixation was positively related to proportion of looking time.

In terms of the relations of temperament, age and sex to visual search variables, age was positively related to the detection of emotional faces, and was negatively related to latency to detect emotional faces. These results suggested that older children were more likely to detect emotional faces and were faster to detect the emotional faces than younger children. Females were less likely to detect emotional faces than males (although this relation was only marginally significant), and had higher teacher-reported attentional focusing than did males.

**The relations of anger reactivity to AB towards anger and the moderating role of regulation.** To examine the moderating role of attentional focusing and shifting on the relation between anger reactivity and components of AB towards anger during the free-viewing and visual search paradigms (initial fixation, proportion of looking time, detection of angry among neutral faces and latency to detect angry faces), only a subset of the eye-tracking data (14 and 16 trials that included anger facial expressions during the

free-viewing and visual search tasks, respectively) was selected and used in the following analyses. Six two-level random intercept models (random slope models could not be computed because all the predictors were level 2 variables) were estimated. In each model, the eye-movement variables (first fixations or proportion of looking time at angry faces during the free-viewing task, or detection of angry expressions, or latency to detect angry facial expressions during the visual search task) at level 1 was regressed on to the level 2 variables: teacher-reported anger proneness, moderator (attentional focusing or attentional shifting; two separate models were run with each eye-movement variable) as well as the interaction between anger and the moderator. The predictor (eye-movement variable) and attentional focusing and shifting were grand mean centered. Given that between 3 to 5 years of age has been marked as a critical period for development of and change in attentional processes, age (a level 2 variable) was controlled for in all analyses. As an example, the model with proportion of looking time (as the dependent variable) and anger proneness and attentional focusing as predictors is illustrated below. In this model,  $\gamma_0$  indicates the intercept for attentional focusing =0 and anger proneness= 0,  $\gamma_1$  reflects whether the relation between anger proneness and proportion of looking time would vary across children controlling for attentional focusing and age effects,  $\gamma_2$  reflects whether the relation between attentional focusing and proportion of looking time varies across children controlling for anger proneness and age effects,  $\gamma_3$  is the regression coefficient for the relation between the interaction term and proportion of looking time, and finally,  $\gamma_4$  is the regression coefficient for the relation between age (the covariate) and proportion of looking time. Furthermore,  $u_{ij}$  reflects the variability in the mean proportion

scores across children, and  $r_{ij}$  represents the variability in proportion scores within each child.

$$\text{Prop}_{ij} = \gamma_0 + \gamma_1(\text{Anger}_j) + \gamma_2(\text{Focusing}_j) + \gamma_3(\text{Anger}*\text{Focusing}) + \gamma_4(\text{Age}_j) + u_{0j} + r_{ij} \quad (1)$$

The results of the eight models examining the moderating role of attentional focusing and shifting in the relation between children's anger proneness and four eye-movement variables (while controlling for age at the child level) are presented in Table 7. For the models involving first fixation at emotional face variable, no significant results was found. For the model involving the proportion of looking time, teacher-reported anger (at the child level) and attentional focusing were positively related to proportion of looking time at anger expressions. Age was unrelated to children's initial fixation and proportion of looking time at angry faces.

For the models involving detection scores (from the visual search task), only one significant relation was found. That is, age was positively related to children's detection of angry faces, suggesting that older children were more likely to detect angry faces among neutral faces than younger children. When predicting latency to detect angry faces, results demonstrated that older children had lower latency to detect angry emotional faces; in other words, older children detected angry faces faster than younger children. In addition, the interaction between anger and attentional shifting was significant. This significant interaction was further examined by estimating and testing the simple slopes at the mean and +/- 1 SD of the moderator. The results showed that higher anger proneness was related to lower latency to detect angry facial expressions for children with low levels of attentional shifting,  $b = -.04$ ,  $p = .08$ , but not for children with

moderate and low levels of attentional shifting,  $bs = -.01$  and  $.02$ ,  $ps = .63$  and  $.31$ , respectively (see Figure 5).

**The relation of sad reactivity to AB towards sad faces and the moderating role of attention regulation.** To examine the moderating role of attentional focusing and shifting in the relation between sad reactivity to components of AB towards sad facial expressions during the first and second eye-tracking tasks, similar procedures as mentioned above were employed with one exception. Trials that contained sad facial expressions (a total number of 14 and 16 trials during the free-viewing and visual search tasks, respectively) were selected for data analyses. Thus, eight two-level models were computed to examine the moderating role of teacher-reported attentional focusing and shifting in the relations between sad proneness and AB towards sadness (four eye-movement variables). Similar to previous models, age was used as a control variable in all models. An example of a model with proportion of looking time, teacher-reported sadness and attentional focusing and the interaction between sad reactivity and attentional focusing (while controlling for age at the child level) is illustrated below.

$$\text{Prop}_{ij} = \gamma_0 + \gamma_1(\text{Sad}_j) + \gamma_2(\text{Focusing}_j) + \gamma_3(\text{Sad}*\text{Focusing}) + \gamma_4(\text{Age}_j) + u_{0j} + e_{ij} \quad (2)$$

The results of all models are presented in Table 8. For the models involving the initial fixation at sad faces (versus neutral faces), no significant results were found. For the models with proportion of looking time, no main effect of sad proneness was found; however, the interaction between teacher-reported sadness and attentional shifting was significant. The interaction effect was examined by testing the simple slopes at the mean as well as one standard deviation above and below the mean of attentional shifting. The results showed that children who were prone to sadness spent less time looking at sad

faces if they had high levels of attentional shifting ( $b = -.04, p = .03$ ) but not if they had low or moderate levels of attentional shifting,  $bs = .01$  and  $-.02, ps = .58$  and  $.18$ , respectively (see Figure 6).

For the models involving detection scores and latency scores (as dependent variables), age was positively related to detection of sad faces and was negatively related to latency to detect sad faces. Specifically, older children were more likely to detect sad facial expressions among neutral faces than younger children and were more likely to detect sad faces faster than younger children. In addition, the interaction between sadness and attentional focusing was significant in predicting detection and latency scores. The significant interactions were estimated at the mean and  $\pm 1$  SD of attentional focusing. The results revealed that children who were prone to sadness were more likely to detect sad faces if they had low attentional focusing,  $b = .36 (p = .03)$ , but not if they had high and moderate levels of attentional focusing,  $bs = -.12$  and  $.12, ps = .50$  and  $.35$ , respectively (see Figure 7). For the model involving latency scores, children who were prone to sadness had lower latency to detect sad faces only if they had had low levels of attentional focusing,  $b = -.08, p = .02$  (see Figure 8).

**The relation of dispositional negative emotionality composite to AB and the moderating role of regulation.** Given the positive correlations between anger and sad reactivity, a composite was created with average of anger and sadness, and the moderating roles of attentional shifting and attentional focusing in the relation between negative reactivity and eye-movement variables during four tasks were tested. For estimating these models, the full dataset (consisting of trials that included angry and sad



facial expressions) was used and analyzed. The results of eight models are presented in Table 9.

No significant results was found for the relations between negative emotionality and attentional components (attentional shifting and focusing), and for the interaction between attentional components to negative emotionality to first fixation and proportion of looking time at emotional faces.

For the models involving detection and latency scores, age was positively related to children's detection of negative emotional faces and was negatively related to latency to detect emotional faces. In terms of relations with temperament measures, the interaction between negative emotionality and attentional focusing was significant in both models --involving detection and latency scores as dependent variables. The results showed that: 1) children with high levels of negative emotionality were more likely to detect negative emotional faces, only if they also had low levels of attentional focusing,  $b = .22$ ,  $p = .05$ , but not if they had high or moderate levels of attentional focusing,  $bs = -.10$  and  $.06$ ,  $ps = .40$  and  $.52$ , respectively, and 2) children with high levels of negative emotionality had lower latency to detect the emotional faces if they had low levels of attentional focusing,  $b = -.04$ ,  $p = .04$ , but not if they had high or moderate levels of attentional focusing,  $bs = .03$  and  $-.01$ ,  $ps = .20$  and  $.70$ , respectively.

## **Aim 2: Relations between AB and Social Adjustment**

**Preliminary analysis.** The correlations among study variables and among eye-movement variables as well as descriptive statistics are shown in Tables 10 and 11. This aim involved testing the relations of 1) AB towards angry to aggressive behaviors, social competence, and anxiety, and 2) AB towards sadness to prosocial behaviors and

sympathy. Because angry and sad subgroups of data were considered in further analyses (e.g., angry subgroup which included only trials with angry facial expressions paired with neutral faces was used for testing relations with aggressive behaviors and social competence), the correlations between eye-movement variables and other study variables are also presented using related subgroup of eye-movement data. Specifically, correlations in Table 10 are computed using angry trials only and correlations in Table 11 are computed using the sad trials only.

For the relations among eye-movement variables during free-viewing task and five outcome variables (i.e., aggressive behaviors, social competence, prosocial behaviors, sympathy, and anxiety symptoms), only two significant relations were found. Children who spent more time looking at angry faces had higher aggressive behaviors. None of the other outcomes was related to initial fixation and proportion of looking time at angry or sad faces.

In terms of relations between eye-movement variables during the visual search task and the five outcomes, detecting angry faces was related to low levels of social competence, and detecting sad faces was related to low levels of prosocial behaviors. Furthermore, higher latency to detect angry faces was related to higher social competence, whereas higher latency to detect sad faces was associated with higher prosocial behaviors. Higher latencies to detect angry faces were also associated with lower levels aggressive behaviors.

Children who had higher attentional focusing also spent more time looking at sad faces and were less likely to detect sad faces. Children's age was also related to detection of both angry and sad faces such that older children were more likely to detect the

emotional faces among neutral faces than younger children. In addition, age was related to lower latencies to detect angry and sad faces, such that older children were faster to detect emotional faces among neutral faces.

**The moderating role of regulation in the relations of AB towards anger to aggressive behaviors, social competence, and anxiety symptoms.** To examine the moderating roles of attentional focusing and shifting in the relations of AB towards anger to aggressive behaviors, social competence, and anxiety symptoms (three outcomes, four eye-movement variables, and two moderators), twenty-four path models were run in *Mplus* using FIML estimation. In each model, the teacher-reported aggressive behaviors, social competence, or anxiety symptoms was regressed onto the mean of each eye-tracking variable (two eye-movement variables during the free-viewing task and two variables during the visual search task) and attentional shifting or attentional focusing, and the interaction between them. The eye-movement variables and attentional shifting and focusing were centered.

The results of path models involving aggressive behaviors (as an outcome) are presented in the first columns of Tables 12 and 14. For the models that included eye-movement variables during free-viewing task (as predictors), proportion of looking time at angry faces was positively related to aggressive behaviors. The interaction between proportion of looking time and attentional shifting in predicting aggressive behaviors also was marginally significant. This interaction was estimated at the mean as well as one standard deviation below and above the mean of attentional shifting. The results showed that children who spent more time looking at angry faces had higher aggressive behaviors if they had moderate or low levels of attentional shifting,  $bs = 4.09$  and  $2.75$ ,  $ps < .01$ , but

not if they had high levels of attentional shifting,  $b = 1.42, p = .25$ ; see Figure 9. For the models involving aggressive behaviors and eye-movement variables during visual search task (see first column of Table 14), higher latency to detect angry faces was associated with lower aggressive behaviors. In addition, the interaction between latency to detect angry faces and attentional shifting was significant. The results showed that children who had lower latency to detect angry faces had higher levels of aggressive behaviors, but this relation was only significant for children who had low levels of attentional shifting,  $b = -1.68, p < .001$  (see Figure 10).

Children's initial fixation and proportion of looking time at angry faces during the free-viewing task were not related to social competence (see the second column of Table 12). However, one significant interaction was found. That is, the interaction between initial fixation at angry faces and attentional shifting was significant. The significant interaction was probed, and the results showed that children who were more likely to fixate first at angry faces (rather than neutral) had higher social competence if they had high levels of attentional shifting but not if they had low or moderate levels of attentional shifting. The interaction is presented in Figure 11. In the models involving social competence as outcome and eye-movement variables during visual search task, higher latency to detect angry facial expressions was associated with higher social competence (see the second column of Table 14). In addition, the interaction between detection score and attentional shifting to predict social competence was marginally significant. The interaction was probed and the results showed that higher probability to detect angry faces was related to lower social competence, but only at low levels of attentional shifting,  $b = -1.75, p < .05$  (see Figure 12).

Finally, eight path models were estimated using anxiety symptoms as the outcome; the models are presented in the third columns of Tables 12 and 14. The results showed that children who spent more time looking at angry faces had lower anxiety symptoms. Furthermore, the initial fixation by attentional focusing interaction was significant, and the results showed that children who initially fixated at angry faces had lower anxiety symptoms only if they had high attentional focusing,  $b = -3.112$ ,  $p < .001$ . However, the aforementioned relation was not significant if children had low or moderate levels of attentional focusing,  $bs = 1.24$  and  $-.94$ ,  $ps = .20$  and  $.20$ , respectively (see Figure 13). No significant results were found for models predicting anxiety symptoms from the eye-movement variables during the visual search task (see the third column of Table 14).

**The moderating role of regulation in the relations of AB towards sadness to prosocial behaviors, sympathy and anxiety.** Eight regression models were estimated to test for the moderating role of children's attentional focusing and shifting on the relations of four eye-movement variables (two variables during the free-viewing task, and two variables during the visual search task) to prosocial behaviors (see the first columns of Tables 13 and 15). The interaction of proportion of looking time by attentional focusing was significant in predicting prosocial behaviors. The interaction was probed and the results showed that children who spent more time looking at sad faces had lower prosocial behaviors; however, this result was only marginally significant at low levels of attentional focusing,  $b = -3.25$ ,  $p = .07$ .

Similarly, eight models were estimated with sympathy as the outcome, the four eye-movement variables as predictors, attentional focusing or shifting as moderators, and

the interaction between eye-movement variables and moderator(s) (see second columns of Tables 13 and 15). The interaction of initial fixation at sad emotional faces by attentional shifting predicting sympathy was significant. The results showed that children who had higher likelihood to initially fixate on the sad emotional rather than neutral faces had higher sympathy only if they had low levels of attentional shifting,  $b = 1.91$ ,  $p = .04$  (see Figure 14). No other significant direct or interaction effects were found.

For the eight models with anxiety symptoms as the outcome (see third columns of Tables 13 and 15), only one significant relation was found in terms of relations of eye-movement variables or the interaction between eye-movement variable and regulation components to anxiety symptoms. That is, the interaction between initial fixation at sad faces and attentional shifting was marginally significant. The interaction was probed but none of the simple slopes was significant.

## **Discussion**

Guided by Lonigan's et al. (2004) model for understanding the associations among temperamental characteristics, attentional biases and (mal)adjustment, the current study employed eye-tracking technology to examine the moderating role of attentional regulation in the relations between temperament and AB, as well as in the associations of AB to social functioning. Specifically, the current study examined whether preschoolers' attentional regulation moderated the associations of 1) anger and sad reactivity to children's selective attention towards angry and sad emotional information, respectively, 2) AB towards anger to behavior problems (i.e., aggressive behaviors and anxiety symptoms) and social competence, and 3) AB towards sadness to prosocial behaviors and sympathy. Results supported the moderating role of attentional regulation on the

associations of dispositional negative affectivity and AB towards negative emotions. Attention regulation also appeared to moderate the relations of AB to behavior problems and social functioning. In addition, attentional focusing and shifting differentially played a role in the associations of negative reactivity to AB towards distinct negative emotions and their relations to social functioning. Particularly, attentional shifting was, in general, an important factor in the associations among anger proneness and AB towards anger and social functioning (i.e., social competence, aggressive behaviors). In contrast, attentional focusing was found to play an important role in moderating the associations of sad proneness to AB toward sadness and the relations between AB towards angry faces and internalizing behavior problems (i.e., anxiety).

### **Temperament to AB: Moderating Role of Attention Regulation**

Sensitivity in attention towards negative emotional stimuli (attentional biases; AB) has been suggested to be related to the emergence and development of internalizing and externalizing symptoms (Grafton et al., 2014; Weierich et al., 2008). Thus, understanding the predictors of AB and factors that may protect children from the potential risks of such biases during early childhood has clear value. The current study aimed to examine individual differences in the associations of children's dispositional anger and sad reactivity to AB towards anger and sadness, respectively. It was expected that children who were prone to anger and sad reactivity would selectively attend to these emotions because they have awareness or vulnerability towards these specific emotions. However, it was expected that attention regulation would moderate the aforementioned associations.

Consistent with theory and hypotheses, children prone to anger were found to be more sensitive towards angry facial expression as indicated by faster detection of angry faces and higher proportion of looking at angry facial expressions. These results suggested that sensitivity towards angry emotional information for children prone to anger may appear in two stages: encoding and processing. In the encoding phase, individuals with high levels of anger may look for threatening information in their environment, and thus, they may detect this information faster than those with low levels of anger. According to McKinnon, Lamb, Belskey, and Baum (1990), attending to threatening cues in the environment during the encoding phase is affected by the individual's prior personal and social experiences (e.g., exposure to anger). Given that anger-prone children may have relatively high levels of exposure to anger (both through experiencing anger in themselves and/or other people's reactions to them), these children may be more alert towards detecting angry cues.

The association between anger and faster detection of angry information was particularly true for children who did not have adequate attentional control and were not able to shift their attention away from unpleasant stimuli/signals and instead to attend to and focus on other relevant signals in their surroundings. The moderating role of attentional shifting was consistent with Lonigan's et al. (2004) model and limited evidence suggesting that regulation or attentional control may moderate the relation between negative affectivity (e.g., fear reactivity, global negative reactivity) and sensitivity to negative emotional information (e.g., Lonigan & Vasey, 2009; Susa et al., 2014 ). However, to my knowledge, the present study was the first study to examine the



moderating role of attentional control/regulation in the relations of anger proneness to AB towards angry facial expressions among preschoolers.

Further, the sensitivity towards anger was also found in the processing phase, as children with higher levels of dispositional anger spent more time looking at angry faces. This result was also consistent with previous research showing that following the detection of angry emotional cues, children with high levels of anger take more time to process, ruminate about, and interpret angry information (e.g., Lochman & Dodge, 1994; Tiedens, 2001). There was no evidence for the moderating role of attention in this relation. This result suggested that perhaps the regulation of attention is more important in the encoding phase (when the person has the ability to control his/her attention not look at the angry stimuli) than during the processing phase.

Similar to results obtained above, sad-proneness was related to higher sensitivity towards sad facial expressions, as indicated by a higher probability to detect sad faces and faster detection of these faces. In addition, attention regulation was found to moderate these relations. That is, the positive relation between temperamental sadness and detection of sad facial expressions was significant only for children who had low, but not for those with moderate or high, attentional focusing skills. The attentional focusing component of regulation includes sustaining attention in order to regulate negative emotions and to plan and complete the goal-oriented actions (Rothbart & Bates, 2006; Rothbart, Ellis, Rueda, & Posner, 2003). Thus, under conditions of low attentional focusing skills, sad prone children would not be able to regulate their negative emotions, and as a result, may show inclination to search for and vigilance towards detection of sad cues. Furthermore, dispositional sadness was positively related to dwelling on sad faces,

only under conditions of low attentional shifting skills. In literature involving clinical samples, individuals with high levels of depression (chronic levels of sadness) spent more time looking at sad facial expressions than did non-depressed individuals, likely due to their poor ability to employ attentional deployment and shift their attention away from the sad cues to regulate their negative emotions (Compton, Heller, Banich, Palmieri, & Miller, 2000; Gotlib & Joormann, 2010). The relation between dispositional sadness and looking time was not evident for children who could deploy their attention away from stimuli.

Overall, the results of analyses regarding the relations of temperament and AB suggested that individual differences in temperament predict differences in AB towards distinct negative emotions. Specifically, children's predisposition towards distinct negative emotions was shown to direct and guide children's heightened selective attention towards relevant emotional information. However, for the most part, these relations were found to be dependent on children's levels of attentional control.

### **Attention Bias to Social Functioning: Moderating Role of Attention Regulation**

High AB towards negative emotional information has been found to play an important role in the emergence and development of various clinical disorders, including anxiety, depression, and conduct disorders. Nevertheless, less attention has been paid to examining how AB towards negative emotions may relate to children's social functioning and (mal) adjustment during early childhood. Thus, in the current study, the associations of AB towards distinct negative emotions to various aspects of children's social functioning were examined.

The results indicated that vigilance towards angry facial expressions was related to high aggressive behaviors and low social competence, particularly in the absence of low attention regulation. High allocation of attention towards angry emotional information (e.g., words, aggressive social interactions) has been found in aggressive adults and children (Chan et al., 2008; Gouze, 2003). The results of the current study, however, showed that the relations of high sensitivity towards angry faces to high aggressive behaviors and low social competence were found only for children with low attentional shifting skills. Children who search for angry cues without being able to disengage their attention are more likely to become aroused by the threat-related cues, and consequently, to process this information in a hostile way and generate hostile reactions.

Nevertheless, high vigilance, as indicated by higher probability to detect angry faces, was found to be associated with positive outcomes (i.e., social competence) if children had high and moderate levels of attentional shifting skills. Consistent with this result, attentional focusing also was found to moderate the relation between high attention orientation towards angry faces (initially fixating on angry faces) and high social competence and low anxiety symptoms. Two components of social competence are the abilities to initiate and maintain interpersonal relations as well as to efficiently plan to achieve social goals, which require children to have higher self- and other- awareness (Spence, 2003). As a result, socially competent children may be more likely to have awareness and alertness towards threat signals and cues in their environments than their less socially competent children. However, once these emotional signals (such as threatening signals) are detected, socially competent children are also able to deploy their

attention away from the threat and to focus on more positive aspects of their surroundings and social interactions. Taken together, these results suggest that vigilance towards anger and threat per se may not be related to negative outcomes (i.e., high aggressive behaviors and anxiety symptoms or low social competence) if children have the ability to employ their attentional resources to focus and disengage attention away from negative emotional information and to possibly regulate the negative emotions and distress induced by them.

Whereas vigilance towards negative emotions was found to be related to negative outcomes (i.e., aggressive behaviors) only under condition of low attention regulation, proportion of looking time at angry faces was directly and positively related to aggressive behaviors and this relation was not dependent on the level of attention regulation.

Evidence suggests that most humans and non-humans (primates) initially orient their attention towards the threat to encode fairly basic details of it. This initial orientation of attention towards threat, which is rapid, automatic and evolutionary-based, is followed by the next phase involving detailed processing of threatening stimuli (see Shechner, et al., 2012 for a review). Thus, the initial orientation of attention is not maladaptive (and indeed has evolutionary adaptive value), especially if individuals have high attention regulation and are able to orient their attention towards pleasant stimuli once they detect the threat. Indeed, it is likely that the regulated individuals' initial attention is directed towards the threat so that they can plan for appropriate actions. Nevertheless, once the attention has been engaged (and if the individual has not been able to shift attention and regulate negative emotions), maintaining attention on the threat-related stimuli, which occurs during the second phase when individuals are processing the stimuli in depth, may put children at risk for aggressive behaviors. Taken together, these results suggest

that if the regulation of attention does not occur in the initial stage (the encoding stage), the individuals may have less control on attentional resources during the processing stage.

Unexpectedly, children's AB towards sadness was not related to prosocial behaviors, but children who had more likelihood to initially fixate on the sad emotional faces were more likely to show sympathy if they had low attentional shifting but not if they had high or moderate attentional shifting. Being attentive to others' facial expressions and cues has been associated with higher levels of sympathy and engagement in prosocial behaviors (e.g., Edwards et al., 2014; Eisenberg et al., 1989). Furthermore, the attention and sensitivity towards others' sadness often is accompanied by physiological, facial or behavioral reactions (e.g., Eisenberg et al., 1989; Zahn-Waxler et al., 2001). In the current study, it was found that this association is especially true for children who have low attentional shifting. However, this result should be noted with extra caution because this interaction was the only significant result that was obtained from computing sixteen models involving sympathy and prosocial behaviors as outcome variables. Thus, it is possible that this significant interaction has occurred by chance. More research needs to be conducted to examine the associations of AB towards sadness to prosocial and sympathy behaviors.

Taken together, the aforementioned results indicate that AB towards negative emotional information, particularly vigilance towards these information, may not be related to (mal)adjustment if children have high attention regulation abilities. Indeed, the results of the present study revealed that even though children may attend to and process

emotional information, they may not act on these biases if they can efficiently employ their attentional resources and be able to focus or shift their attention when needed.

### **Strength, Limitations and Directions for Future Research**

The current study contributed to the understanding of 1) early temperamental risk markers of AB during early childhood and the relations of these biases to social functioning, including externalizing and internalizing behavior problems as well as social competence and anxiety symptoms, and 2) a resilience factor (i.e., attentional control) that may prevent the emergence of AB and maladjustment. Unlike other studies that have focused on older children and adults (and especially from clinical populations), the aforementioned relations were tested during a developmental stage that is marked by rapid development of emotion understanding and attentional processes (Rothbart et al., 2001). Further, rather than using the traditional measures of AB that use behavioral reactions (which are suggested to be confounded by response execution such as response freezing; Armstrong & Olatunji, 2012), eye-tracking methodology was used to measure AB. Lastly, the children who participated in the current study were typically-developing children.

Despite its strengths, the current study had several limitations that need to be taken into account when interpreting the results. First, children's temperamental characteristics, including children's negative reactivity and attention control, as well as children's behavior problems and social functioning were assessed using teachers' reports. Thus, future researchers need to consider using other methodological approaches, such as asking multiple reporters to rate children's temperament and social functioning or including observational measures of social functioning. Utilizing behavioral and/or

physiological measures to assess prosocial behaviors and sympathy is particularly recommended in future research given that both constructs are best assessed using these types of methodological approaches. Lastly, in the current study, AB towards a distinct emotion in some instances was related to both children's temperamental predisposition to that emotion as well as social functioning/or maladjustment. Thus, in these cases, it is likely that AB mediated the relation between temperament and later behavior problems/social functioning. Although given the concurrent nature of the data, the test of mediation was not advisable, future longitudinal research is needed to examine the mediating role of AB in the relations between early temperamental characteristics and later behavior problems or social functioning.

In addition to associations of temperamental characteristics to AB, a number of parent-related factors, including parents' verbal and non-verbal modeling of fear/anxiety and intrusive/controlling parenting behaviors, have been suggested to positively relate to children's AB toward negative stimuli (e.g., threat; Field, 2006; Rachman 1991). Research evidence has demonstrated that through observations of others' verbal or non-verbal expressions of fear and anxiety (observational/vicarious learning), human and non-human primates may learn what stimuli/situations to avoid or to be sensitive toward (Field & Purkis, 2011; Hadjikhani, et al., 2008). Thus, future research needs to also take into account the role that parenting factors, including parents' regulatory skills as well as AB towards negative emotions, may play in the emergence of children's AB during early childhood.

Nevertheless, the current study contributed to limited research on the relations of temperament and AB, and their relations to social functioning. Understanding the

important role that attentional control/regulation play in the these associations has potential to improve identification of high-risk children for developing AB as well as maladjustment, and to help shape effective prevention/intervention programs (including attention training programs that have found to be effective for reducing attentional biases; Julian, Beard, Schmidt, Powers, Smits, 2012, Najmi & Amir, 2010). Although many attention training programs have focused on modifying individuals' biases towards negative emotional information (once these biases have emerged), the results of this study suggested that perhaps prevention programs can intervene early to reduce the risk for developing these biases by teaching children how to control and regulate their attention and improving their regulatory abilities.



## **Dissertation Conclusion**

This work focused on typical and average patterns as well as individual differences in children's selective attention processes during the preschool years. The two articles contributed to the limited existing literature on young and typically-developing children's selective attention processes. Moreover, both studies provided examples for how eye-tracking technology can be used to examine selective attention processes among very young children that can be utilized by future researchers.

The results of the two publications revealed that: 1) some emotional information may have features that attract more attention than others (e.g., some have more attention grabbing qualities or evolutionary adaptive value than others), and 2) children's heightened attention towards negative emotion that can be influenced by certain temperamental characteristics (i.e., predisposition to negative emotions) may be maladaptive to social functioning, particularly if not accompanied by high regulation. This knowledge can provide direction for improvement of attention training programs that have been shown to be effective in reducing children's biases (Julian et al., 2012; Najmi & Amir, 2010; Yang et al., in press), and intervention prevention programs that aim to decrease children's behavior problems or promote social competence.

Specifically, the results of first publication advanced our understanding of what can be considered typical and normative when examining patterns of selective attention. In addition, the results provided some evidence about how attention training programs can benefit from including positive emotional information with other negative emotional information (as some positive information may have the same attention grabbing qualities as negative emotional information).

The results of second publication, which was the first study to examine the differential relations of distinct types of emotions (i.e., anger and sad proneness) to AB towards those emotions and further to distinguish between AB towards distinct emotions and their relations to various related outcomes, also had important implications for attention training programs. Particularly, the results demonstrated that improvement of attention regulation and control is important for protecting children against the emergence of attention biases and further protecting them against developing behavior problems once these biases have emerged.

Given the important implications that attention regulation/control may have for preventing biases, further longitudinal research needs to be conducted to test for the associations between temperament and attention biases in predicting future behavior problems. Conducting such research can help prevention programs to intervene as early as possible to prevent the emergence and/or development of attentional biases, and consequently preventing behavior problems.

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Table 1

*Zero-order Correlations, Means, and Standard Deviations for Study Variables in Study 1*

Measure	1	2	3	4	5	6
1. Mean of Initial Fixation	----	.48**	-.12	.04	-.07	.26
2. Mean of Proportion of Looking Time		----	-.04	-.05	.06	.14
3. Mean of Detection Score			----	-.79**	.29 <sup>†</sup>	.01
4. Latency to Fixate on the Emotional Face				----	-.39**	-.15
5. Age					----	.27 <sup>†</sup>
6. Sex						----
<i>N</i>	41	41	42	42	42	42
<i>M</i>	.53	.55	.87	1.34	4.87	.55
<i>SD</i>	.09	.07	.10	.34	.60	.50

*Notes.* <sup>†</sup> $p < .10$ , \* $p < .05$ , \*\* $p < .01$ ; *N* ranged from 41 to 42 for correlations.



Table 2.

*Model Summaries for the Detection Scores and Latency Scores in Study 1 (Publication 1)*

Parameters	Random Intercept Model with no Covariate	Random Intercept Model with Level-1 Predictor	Random Slope Model
Models Predicting Detection Score			
Regression Coefficients (Fixed Effect)			
Threshold ( $\gamma_0$ )	-2.10** (.16)	-2.09** (.18)	-2.11** (.19)
Emotion Type ( $\gamma_1$ )	---	.02 (.18)	-.01 (.19)
Variance Components (Random Effect)			
Within-child Variability in Detection Mean ( $r_{ij}$ )	---	---	---
Between-Children Variability in Detection Mean ( $u_{oi}$ )	0.59** (.23)	.59** (.23)	.59* (.24)
Emotion Type Slope ( $u_{1j}$ )	---	---	<.001 (.00)
Deviance Statistics (Number of parameters)	-443.44 (2)	-443.43 (3)	-443.445 (5)
Models Predicting Latency Score			
Regression Coefficients (Fixed Effects)			
Intercept ( $\gamma_0$ )	1.35** (.04)	1.34** (.05)	1.34** (.05)
Emotion Type ( $\gamma_1$ )	---	.04 (.05)	.04 (.05)
Variance Components (Random Effect)			
Within-Child Variability in Latency Mean ( $r_{ij}$ )	.75** (.03)	.75** (.03)	.74** (.03)
Between-Children Variability in Latency Mean ( $u_{oi}$ )	.04** (.02)	.04** (.02)	.05* (.02)
Emotion Type Slope ( $u_{1j}$ )	---	---	.01 (.03)
Deviance Statistics (Number of parameters)	-1537.80 (3)	-1537.55 (4)	-1537.37 (6)

Notes. †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ ; Standard errors are presented in parentheses.

Table 3.

*Descriptive Statistics and Correlations for Study Variables in Study 2 (Publication 1)*

Measure	1	2	3	4	5	6	
1. Mean of Initial Fixation	----	.26*	-.01	-.02	.11	-.04	
2. Mean of Proportion of Looking Time at Emotional Face		----	.03	-.05	.06	.09	
3. Mean of Detection Score			----	-.86**	.43*	-.20 <sup>†</sup>	
4. Latency in Seconds to Fixate on the Emotional Face				----	-.52**	.15	
5. Age					----	-.14	
6. Sex						----	
	<i>N</i>	75	75	75	65	75	75
	<i>M</i>	.53	.57	.75	1.21	4.30	.47
	<i>SD</i>	.07	.06	.16	.18	.58	.50

Notes. <sup>†</sup> $p < .10$ , \* $p < .05$ , \*\* $p < .01$ ; *N* for estimated correlations ranged from 65 to 75.

Table 4.

*Model Summaries for the Eye-movement Variables During the Free-viewing Task in Study 2 (Publication 1)*

Parameters	Random Intercept Model with no Covariate	Random Intercept Model with Level-1 Predictor	Random Slope Model
<b>Models Predicting Initial Fixation</b>			
Regression Coefficients (Fixed Effects)			
Threshold ( $\gamma_0$ )	-.10*(.05)	-.10 (.06)	-.07 (.06)
Emotion Type ( $\gamma_1$ )	---	.02 (.09)	.07(.09)
Variance Components( Random Effect)			
Within-Child Variability in Mean Initial Fixation ( $r_{ij}$ )	---	---	---
Between-Children Variability in Mean Initial Fixation ( $u_{oi}$ )	<.001 (.00)	<.001 (.00)	<.001 (.01)
Emotion Type Slope ( $u_{lj}$ )	---	---	.01 (.04)
Deviance Statistics (Number of parameters)	-1387.11 (2)	-1387.10 (3)	-1387.10 (5)
<b>Models Predicting Proportion of Looking Time</b>			
Regression Coefficients (Fixed Effects)			
Intercept ( $\gamma_0$ )	.57 **(.01)	.57**(.01)	.57**(.01)
Emotion Type ( $\gamma_1$ )	---	-.01(.01)	-.01(.01)
Variance Components( Random Effect)			
Within-Child Variability in Mean Proportion Scores ( $r_{ij}$ )	.08**(.00)	.08**(.00)	.08**(.00)
Between-Children Variability in Mean Proportion Scores ( $u_{oi}$ )	<.001 (.00)	<.01 (.00)	<.001 (.00)
Emotion Type Slope ( $u_{lj}$ )	---	---	<.001 (.00)
Deviance Statistics (Number of parameters)	-347.89 (3)	-347.39 (4)	-347.40 (6)

Notes. †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ . Standard errors are listed in parentheses.

Table 5.

*Model Summaries for the Eye-movement Variables During the Visual Search Task*

Parameters	Random Intercept Model with no Covariate	Random Intercept Model with Level-1 Predictor	Random Slope Model
Models Involving Detection Scores			
Regression Coefficients (Fixed Effects)			
Threshold ( $\gamma_0$ )	-1.28** (.11)	1.12 (.74)	.59 (.75)
Emotion Type ( $\gamma_1$ )	---	-.27**(.10)	-.21 <sup>†</sup> (.11)
Age	---	.60**(.17)	.46**(.18)
Variance Components( Random Effect)			
Within-Child Variability in Detection Mean ( $r_{ij}$ )	---	---	---
Between-Children Variability in Detection Mean ( $u_{oj}$ )	.63**(.15)	.50**(.13)	.42**(.14)
Emotion Type Slope ( $u_{ij}$ )	---	---	.02 (.04)
Deviance Statistics (Number of parameters)	-1227.00 (2)	-1276.58 (6)	-1276.18 (8)
Models Involving Latency Scores			
Regression Coefficients (Fixed Effects)			
Intercept ( $\gamma_0$ )	1.20** (.02)	1.76** (.13)	1.76** (.13)
Emotion Type ( $\gamma_1$ )	---	.08** (.03)	.08** (.03)
Age	---	-.14** (.03)	-.14** (.01)
Variance Components( Random Effect)			
Within-Child Variability in Latency Mean ( $r_{ij}$ )	.39** (.01)	.39** (.01)	.39** (.01)
Between-Children Variability in Latency Mean ( $u_{oj}$ )	.02**(.01)	.01* (.00)	.01 (.01)
Emotion Type Slope ( $u_{ij}$ )	---	---	.01 (.01)
Deviance Statistics (Number of Parameters)	-2245.51 (3)	-2290.34 (7)	-2288.62 (9)

Notes. <sup>†</sup> $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ . Standard errors are listed in parentheses.

Table 6

*Zero-order Correlations, Means, and Standard Deviations for Study Variables in Publication 2*

Variable	1	2	3	4	5	6	7	8	9	10
1. Anger	1.00									
2. Sadness	0.54**	1.00								
3. Age	.23 <sup>†</sup>	.26*	1.00							
4. Sex	-.19	-.06	-.14	1.00						
5. Attentional Focusing	-.34**	-.37**	-.16	.28*	1.00					
6. Attentional Shifting	-.55**	-.25*	-.02	.06	.44**	1.00				
7. Initial Fixation	.13	-.13	.11	-.04	.20 <sup>†</sup>	-.09	1.00			
8. Proportion of Looking Time	.12	-.10	.06	.09	.27*	-.09	.26*	1.00		
9. Detection of Emotional Face	.12	.20 <sup>†</sup>	.43**	-.21 <sup>†</sup>	-.21 <sup>†</sup>	-.10	-.01	.03	1.00	
10. Latency to Detect Emotional Face	-.14	-.25*	-.52**	.15	.18	.04	-.02	-.05	-.86**	1.00
<i>M</i>	3.30	3.37	4.30	.47	5.01	4.27	.57	.53	1.21	.75
<i>SD</i>	1.56	.90	.58	.50	1.21	.72	.06	.07	.18	.16

Notes. <sup>†</sup> $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$ ; Sample size ranged from 65-75 for variables

Table 7

*Unstandardized Parameter Estimates (and Standard Errors) For the Random Intercept Models Examining the Moderating Roles of Attentional Focusing and Shifting in the Relations of Anger Proneness to AB*

Moderator: Attentional Focusing	Dependent Variables (Outcomes)			
	Initial Fixation <sup>b</sup>	Proportion of Looking <sup>a</sup>	Detection Scores <sup>b</sup>	Latency to detect <sup>a</sup>
Intercept <sup>a</sup> or Threshold <sup>b</sup> ( $\gamma_0$ )	-.05 (.23)	.51 **(.08)	1.03 (.72)	1.72** (.15)
Anger ( $\gamma_1$ )	.03 (.04)	.01*(.01)	.03(.06)	-.01 (.01)
Attentional Focusing ( $\gamma_2$ )	.09 (.06)	.02*(.01)	-.06(.08)	.00 (.02)
Anger x Attentional Focusing ( $\gamma_3$ )	.01(.05)	.00 (.01)	-.08 <sup>†</sup> (.04)	.01 (.01)
Age ( $\gamma_4$ )	.01(.05)	.02 (.02)	.56**(.17)	-.13** (.04)
Within-Child Variations ( $r_{ij}$ )	-----	.08**(.00)	-----	.39**(.02)
Between- Child Variations ( $u_{oj}$ )	<.001 (.00)	<.001 (.00)	.22 <sup>†</sup> (.12)	<.001 (.01)
Moderator: Attentional Shifting				
Intercept or Threshold ( $\gamma_0$ )	-.07 (.51)	.49**(.08)	1.21 (.76)	1.79** (.15)
Anger ( $\gamma_1$ )	.00 (.05)	.01(.01)	-.01(.08)	-.01 (.02)
Attentional Shifting ( $\gamma_2$ )	.01(.11)	.01 (.02)	-.13(.17)	-.00 (.03)
Anger x Attentional Shifting ( $\gamma_3$ )	<.001 (.06)	-.02 <sup>†</sup> (.01)	-.11 (.09)	.04 *(.02)
Age ( $\gamma_4$ )	.01(.11)	.02 (.02)	.59**(.18)	-.14** (.04)
Within-Child Variations ( $r_{ij}$ )	-----	.08 **(.00)	-----	.39**(.02)
Between- Child Variations ( $u_{oj}$ )	<.001 (.01)	<.001 (.00)	.23 *(.08)	.00(.01)

Note. <sup>†</sup>  $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$ . N ranged from 1050 to 1232 (total number of trials).

Table 8

*Unstandardized Parameter Estimates (and Standard Errors) Models Examining the Moderating Roles of Attentional Focusing and Shifting in the Relations between Proneness to Sadness to AB*

Moderator: Attentional Focusing	Dependent Variables (Outcomes)			
	Initial Fixation <sup>b</sup>	Proportion of Looking <sup>a</sup>	Detection Scores <sup>b</sup>	Latency to detect <sup>a</sup>
Intercept <sup>a</sup> or Threshold <sup>b</sup> ( $\gamma_0$ )	-.06 (.51)	.53** (.07)	1.21 (.85)	1.83** (.18)
Sad ( $\gamma_1$ )	.03 (.06)	.00 (.01)	.12 (.13)	-.01 (.03)
Attentional Focusing ( $\gamma_2$ )	.01 (.06)	.02 (.01)	-.12(.09)	.02 (.02)
Sad x Attentional Focusing ( $\gamma_3$ )	.03 (.06)	-.01 (.01)	-.20* (.09)	.05 ** (.02)
Age ( $\gamma_4$ )	.02 (.12)	.01 (.02)	.54**(.20)	-.13** (.04)
Within- Child Variations ( $r_{ij}$ )	-----	.08** (.00)	-----	.39**(.02)
Between- Child Variations ( $u_{oj}$ )	<.001 (.01)	<.001 (.00)	.44** (.15)	.01(.07)
<b>Moderator: Attentional Shifting</b>				
Intercept or Threshold ( $\gamma_0$ )	-.07 (.50)	.54** (.08)	1.01 (.87)	1.79** (.19)
Sad ( $\gamma_1$ )	.01 (.08)	-.02 (.01)	.20 (.13)	-.04 (.03)
Attentional Shifting ( $\gamma_2$ )	-.06 (.09)	-.01 (.01)	-.10 (.16)	-.01 (.03)
Sad x Attentional Shifting ( $\gamma_3$ )	-.02 (.10)	-.03 (.02)*	.23(.17)	-.02 (.04)
Age ( $\gamma_4$ )	.01(.12)	.00 (.02)	.52* (.20)	-.13** (.04)
Within- Child Variations ( $r_{ij}$ )	-----	.08** (.00)	-----	.39**(.02)
Between- Child Variations ( $u_{oj}$ )	<.001 (.02)	<.001 (.01)	.49 **(.16)	.02 (.03)

Note. †  $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$ .  $N$  ranged from 1050 to 1232.

Table 9

*Unstandardized Parameter Estimates (and Standard Errors) for Models Examining the Moderating Roles of Attentional Focusing and Shifting in the Relations Between Negative Emotionality and AB*

	Dependent Variables (Outcomes)			
	Initial Fixation <sup>b</sup>	Proportion of Looking <sup>a</sup>	Detection Scores <sup>b</sup>	Latency to detect <sup>a</sup>
<b>Moderator: Attentional Focusing</b>				
Intercept <sup>a</sup> or Threshold <sup>b</sup> ( $\gamma_0$ )	-.09 (.36)	.53** (.05)	1.19 (.73)	1.83** (.18)
Negative Emotionality ( $\gamma_1$ )	.04 (.05)	.01 (.01)	.06 (.09)	-.01 (.02)
Attentional Focusing ( $\gamma_2$ )	.05 (.04)	.02 <sup>†*</sup> (.01)	-.09(.08)	.01 (.02)
Negative Emotionality x Attentional Focusing ( $\gamma_3$ )	.02 (.03)	-.01 (.01)	-.13* (.06)	.03** (.01)
Age ( $\gamma_4$ )	.01 (.08)	.01 (.01)	.57**(.17)	-.14**(.03)
Within- Child Variations ( $r_{ij}$ )	-----	.08** (.00)	-----	.39 **(.01)
Between- Child Variations ( $u_{oj}$ )	<.001 (.04)	<.001 (.00)	.43** (.12)	.01 <sup>†</sup> (.00)
<b>Moderator: Attentional Shifting</b>				
Intercept or Threshold ( $\gamma_0$ )	-.08 (.35)	.53** (.05)	1.15 (.79)	1.79** (.14)
Negative Emotionality ( $\gamma_1$ )	.01 (.05)	-.02 (.01)	-.11 (.16)	-.01 (.02)
Attentional Shifting ( $\gamma_2$ )	-.04 (.07)	-.01 (.01)	-.02 (.13)	-.01 (.03)
Negative Emotionality x Attentional Shifting ( $\gamma_3$ )	.02 (.06)	-.02* (.01)	.57 (.18)	.01 (.02)
Age ( $\gamma_4$ )	.01 (.08)	.01 (.01)	.52** (.20)	-.14** (.03)
Within- Child Variations ( $r_{ij}$ )	-----	.08** (.00)	-----	.39**(.01)
Between- Child Variations ( $u_{oj}$ )	<.001 (.04)	<.001 (.00)	.48 **(.13)	.01 <sup>*</sup> (.00)

Note. <sup>†</sup>  $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$ .  $N$  ranged from 1050 to 1232.



Table 10

*Descriptive Statistics and Zero-Order Correlations Among Age, Sex, AB, Attention Regulation Components, and (mal)adjustment in Publication 2*

Variable	1	2	3	4	5	6	7	8	9	10
1. Aggressive Behaviors	1.00									
2. Social Competence	-.65**	1.00								
3. Age	.25*	-.20	1.00							
4. Sex	-.27*	.27*	-.14	1.00						
5. Attentional Focusing	-.26**	.54**	-.16	.28*	1.00					
6. Attentional Shifting	-.49**	.50*	-.02	.06	.44**	1.00				
7. Initial Fixation	.04	.03	.06	-.05	.20 <sup>†</sup>	.00	1.00			
8. Proportion of Looking Time	.40**	-.06	.10	.03	.18	-.10	.33**	1.00		
9. Detection of Emotional Face	.16	-.27*	.41**	-.19	-.19	-.14	.05	.00	1.00	
10. Latency to Detect Emotional Face	-.30**	.26*	-.50**	-.02	.04	.06	-.22 <sup>†</sup>	-.15	-.70**	1.00
<i>M</i>	2.13	4.09	4.30	.47	5.01	4.27	.52	.57	.78	1.17
<i>SD</i>	0.74	.81	.58	.50	1.21	.72	.12	.08	.15	.19

Notes. <sup>†</sup> $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$ ;  $N$  ranged from 65 to 75.

Table 11

*Descriptive Statistics and Zero-Order Correlations Among Age, Sex, AB, Attention Regulation Components, Prosocial Behaviors, Sympathy, and anxiety in Publication 2*

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Prosocial Behaviors	1.00										
2. Sympathy	.19	1.00									
3. Anxiety	-.08	-.06	1.00								
4. Age	-.27*	.02	.05	1.00							
5. Sex	.14	.25*	.21	-.12	1.00						
6. Attentional Focusing	.21 <sup>†</sup>	.34**	-.28*	-.15	.29**	1.00					
7. Attentional Shifting	.29*	.20	-.09	-.02	.06	.44**	1.00				
8. Initial Fixation	-.12	.09	.08	.13	.04	.03	-.12	1.00			
9. Proportion of Looking Time	-.01	.21 <sup>†</sup>	-.14	-.02	.11	.24**	-.05	.19	1.00		
10. Detection of Emotional Face	-.23*	-.02	.09	.39**	-.17	-.24**	-.10	-.03	.00	1.00	
11. Latency to Detect Emotional Face	.26*	.00	.08	.15	.21	.22 <sup>†</sup>	.01	.06	-.01	-.82**	1.00
<i>M</i>	3.25	2.71	2.05	4.31	.47	5.01	4.27	.53	.56	.73	1.25
<i>SD</i>	.85	.54	.80	.58	.50	1.20	.72	.11	.08	.18	.22

Notes. <sup>†</sup> $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$ ;  $N = 466$ . Sample size ranged from 65-75 for variables.

Table 12.  
*Unstandardized Parameter Estimates for the Moderating Role of Regulation in the Relations between Initial Fixation and Proportion of Looking Time to Aggressive behaviors/Social Competence and Anxiety*

	Aggressive Behaviors	Social Competence	Anxiety
<b>Moderator: Attentional Focusing</b>			
Initial fixation/ Proportion of looking time	.46 (4.03**)	-.31 (-1.48)	-.94 (-2.82**)
Teacher-Reported Attentional Focusing	-.11 (-.16 <sup>†</sup> )	.36**(.33**)	-.27**(-.28**)
Initial Fixation (Proportion) X Attentional focusing	.34 (.13)	.69 (-.31)	-1.80** (-1.02)
Age	.22 (.18)	-.16 (-.12)	.14(.10)
Sex	-.27 (-.26 <sup>†</sup> )	.18 (.18)	.49** (.51**)
Fit Indices with initial fixation	$X^2(1) = 2.13, p = .14$ SRMR = .04	$X^2(1) = 1.20, p = .16$ SRMR = .04	$X^2(1) = 1.96, p = .16$ SRMR = .04
Fit Indices with Proportion	$X^2(3) = 5.45, p = .14$ SRMR = .07	$X^2(3) = 5.35, p = .15$ SRMR = .06	$X^2(3) = 5.35, p = .15$ SRMR = .06
<b>Moderator: Attentional Shifting</b>			
Initial fixation (Proportion)	-.02 (2.75**)	.75 (.11)	-1.38 <sup>†</sup> (-3.70**)
Teacher-Reported Attentional Shifting	-.50**(-.54**)	.57**(.56**)	-.13 (-.21)
Initial Fixation (Proportion) X Attentional shifting	-.76 (-1.85 <sup>†</sup> )	2.03* (.24)	-1.33 (-1.29)
Age	.28*(.24*)	-.27* (-.23*)	.17(.18)
Sex	-.31*(-.31*)	.39*(.35)	.34 <sup>†</sup> (.40*)
Fit Indices with initial fixation	$X^2(1) = 1.92, p = .17$ SRMR = .04	$X^2(1) = 1.71, p = .19$ SRMR = .03	$X^2(1) = 1.79, p = .18$ SRMR = .03
Fit Indices with Proportion	$X^2(3) = 4.60, p = .20$ SRMR = .05	$X^2(3) = 4.43, p = .22$ SRMR = .05	$X^2(1) = 1.84, p = .18$ SRMR = .03

Notes. <sup>†</sup> $p < .10$ , \* $p < .05$ ; \*\* $p < .01$ ; The numbers in the parentheses are for proportion scores as predictor; Models were estimated using angry trials.

Table 13.

*Unstandardized Parameter Estimates for the Moderating Role of Regulation in the Relations between Initial Fixation and Proportion of Looking Time to Prosocial Behaviors, Sympathy and Anxiety*

	Prosocial Behaviors	Sympathy	Anxiety
<b>Moderator: Attentional Focusing</b>			
Initial fixation/ Proportion	-.54 (-.61)	.04 (-.95)	.76 (-1.04)
Teacher-Reported Attentional Focusing	.11 (.15 <sup>†</sup> )	.13* (.10)	-.24** (-.24**)
Initial Fixation (Proportion)X Attentional focusing	-.77 (2.18*)	-.19 (-.52)	.26 (-.78)
Age	-.34 (-.32 <sup>†</sup> )	.05 (.07)	.06 (.06)
Sex	.11 (.11)	.15 (.15)	.53** (.53**)
Fit Indices with initial fixation	$X^2(4) = 3.89, p = .42$ $SRMR = .05$	$X^2(1) = 1.94, p = .16$ $SRMR = .04$	$X^2(1) = 2.12, p = .15$ $SRMR = .04$
Fit Indices with Proportion	$X^2(1) = 1.73, p = .19$ $SRMR = .03$	$X^2(3) = 5.45, p = .14$ $SRMR = .06$	$X^2(1) = 2.08, p = .15$ $SRMR = .04$
<b>Moderator: Attentional Shifting</b>			
Initial fixation (Proportion)	-.29 (.01)	.36 (-.17)	.54 (-2.24 <sup>†</sup> )
Teacher-Reported Attentional Shifting	.33** (.31*)	.13 (.16 <sup>†</sup> )	-.09 (-.08)
Initial Fixation (Proportion) X Attentional shifting	-1.13 (1.76)	-2.16* (.36)	2.02 <sup>†</sup> (-2.59)
Age	-.35*(-.38)	-.02 (.02)	.11 (.12)
Sex	.17 (.15)	.21 (.23 <sup>†</sup> )	.39** (.43)
Fit Indices with initial fixation	$X^2(1) = 1.55, p = .21$ $SRMR = .03$	$X^2(1) = 1.80, p = .18$ $SRMR = .03$	$X^2(1) = 1.93, p = .16$ $SRMR = .04$
Fit Indices with Proportion	$X^2(1) = 1.64, p = .20$ $SRMR = .03$	$X^2(3) = 4.62, p = .15$ $SRMR = .05$	$X^2(1) = 2.05, p = .15$ $SRMR = .04$

Notes. <sup>†</sup>  $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$ ; The numbers in the parentheses are for proportion scores as predictor; Models were estimated using sad trials.

Table 14.

*Unstandardized Parameter Estimates for the Moderating Role of Regulation in the Relations between Detection and Latency Scores to Aggressive behaviors/Social Competence and Anxiety*

	Aggressive Behaviors	Social Competence	Anxiety
<b>Moderator: Attentional Focusing</b>			
Detection Score (Latency to Detect)	.36 (-.98*)	-1.08 <sup>†</sup> (1.10*)	.81 (-.09)
Teacher-Reported Attentional Focusing	-.05 (-.03)	.25** (.34**)	-.18* (-.27*)
Detection Score/ (Latency) X Attentional Focusing	-.51 (.25)	.71 (.19)	-.49 (-.24)
Age	.22 (.10)	.13 (.04)	.00 (.04)
Sex	-.26 (-.31 <sup>†</sup> )	-.05 (.20)	.56** (.53**)
Fit Indices with Detection Score	$X^2(1) = 2.07, p = .15$ SRMR = .04	$X^2(1) = 2.05, p = .15$ SRMR = .04	$X^2(1) = 2.09, p = .15$ SRMR = .04
Fit Indices with Latency	$X^2(1) = 2.59, p = .11$ SRMR = .04	$X^2(1) = 2.66, p = .10;$ SRMR = .04	$X^2(1) = 2.58, p = .11;$ SRMR = .04
<b>Moderator: Attentional Shifting</b>			
Detection Scores (Latency to Detect)	-.08 (-.66 <sup>†</sup> )	-.08 (.84 <sup>†</sup> )	.79 (-.14)
Teacher-Reported Attentional Shifting	-.48** (.12)	-.45** (.38*)	-.05 (-.33)
Detection Score (Latency) X Attentional Shifting	-.38 (1.43*)	1.37 <sup>†</sup> (-.62)	-.86 (-.79)
Age	.25* (.15*)	-.09 (.08)	.03 (.09)
Sex	-.28 <sup>†</sup> (-.32*)	-.27 <sup>†</sup> (.36*)	.44* (.39**)
Fit Indices with Detection Scores	$X^2(1) = 1.96, p = .16$ SRMR = .04	$X^2(1) = 1.96, p = .16$ SRMR = .04	$X^2(1) = 1.10, p = .16$ SRMR = .04
Fit Indices with Latency	$X^2(1) = 2.34, p = .13$ SRMR = .04	$X^2(1) = 2.34, p = .13$ SRMR = .04	$X^2(1) = 2.35, p = .13$ SRMR = .04

Notes. <sup>†</sup> $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$ ; The numbers in the parentheses are for proportion scores as predictor; Models were estimated using angry trials.

Table 15.

*Unstandardized Parameter Estimates for the Moderating Role of Regulation in the Relations between Detection and Latency Scores to Prosocial Behaviors, Sympathy and Anxiety*

	Prosocial Behaviors	Sympathy	Anxiety
<b>Moderator: Attentional Focusing</b>			
Detection Scores (Latency)	-.50 (.48)	.02 (-.07)	.44 (.25)
Teacher-Reported Attentional Focusing	-.11 (.67)	-.02 (.24)	-.05(-.45)
Detection Scores (Latency) X Attentional focusing	.41(-.57)	.26 (-.12)	-.29 (.22)
Age	-.26 (-.28)	.05 (.16)	.02(.09)
Sex	.12 (.11)	.15 (.04)	.54** (.52**)
Fit Indices with Detection Scores	$X^2(1) = 2.11, p = .15$ SRMR = .04	$X^2(1) = 2.20, p = .14$ SRMR = .04	$X^2(1) = 2.17, p = .14$ SRMR = .04
Fit Indices with Latency Scores	$X^2(1) = 2.45, p = .12$ SRMR = .04	$X^2(1) = 2.57, p = .11$ SRMR = .04	$X^2(1) = 2.44, p = .12$ SRMR = .04
<b>Moderator: Attentional Shifting</b>			
Detection Scores (Latency)	-.46 (.54)	.02 (-.03)	.25 (.14)
Teacher-Reported Attentional Shifting	.04 (1.04*)	-.23 (.36)	-.45 (-1.05)
Detection Scores (Latency)X Attentional shifting	.49 (-.70)	.69 (-.21)	.22 (.89)
Age	.15 (.14)	.06 (.04)	.09 (.06)
Sex	-.27 (-.22)	.20 (.22)	.51 (.39)
Fit Indices with Detection Scores	$X^2(1) = 2.15, p = .14$ SRMR = .04	$X^2(1) = 2.29, p = .13$ SRMR = .04	$X^2(1) = 2.44, p = .12$ SRMR = .04
Fit Indices with Latency Scores	$X^2(1) = 2.29, p = .13$ SRMR = .04	$X^2(1) = 2.43, p = .12$ SRMR = .04	$X^2(1) = 2.37, p = .12$ SRMR = .04

Notes. †  $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$ ; The numbers in the parentheses are for proportion scores as predictor; Models were estimated using sad trials.

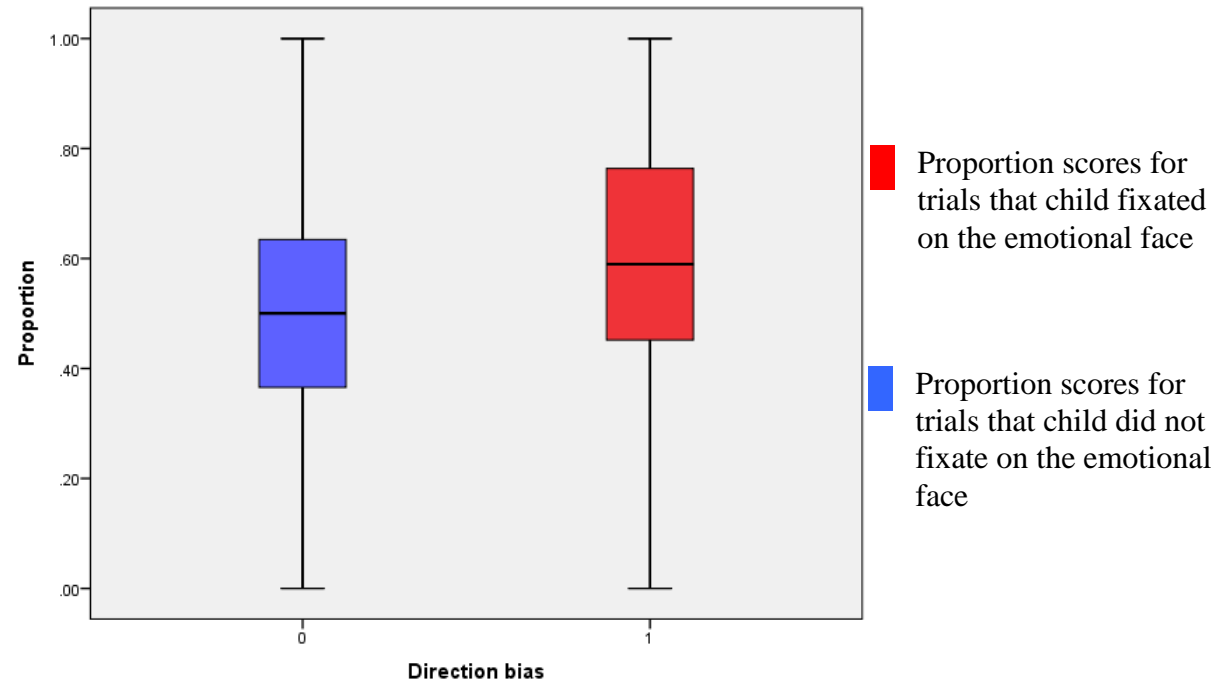


*Figure 1a.* Example of an image shown during the free-viewing task



*Figure 1b.* Example of an image presented during the visual search task

Example of pictures shown in the free-viewing and visual search task



*Figure 2.* Mean of proportion scores based on initial fixation for Study 1



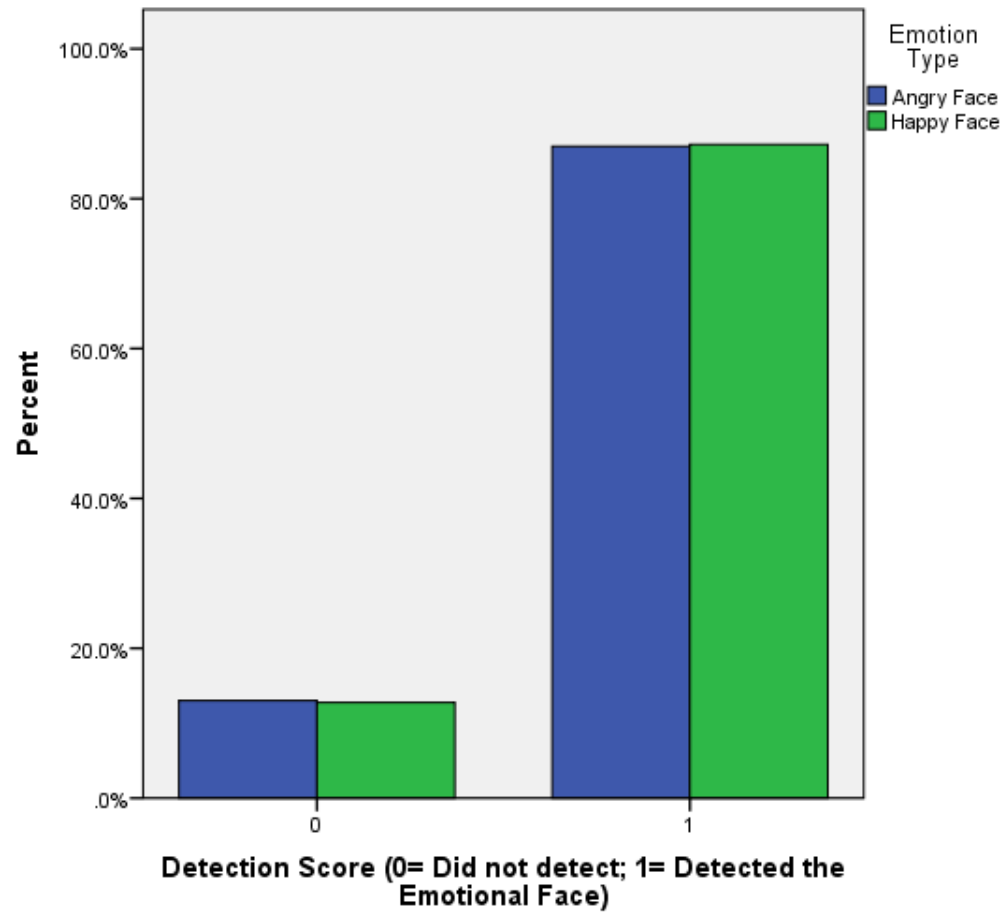
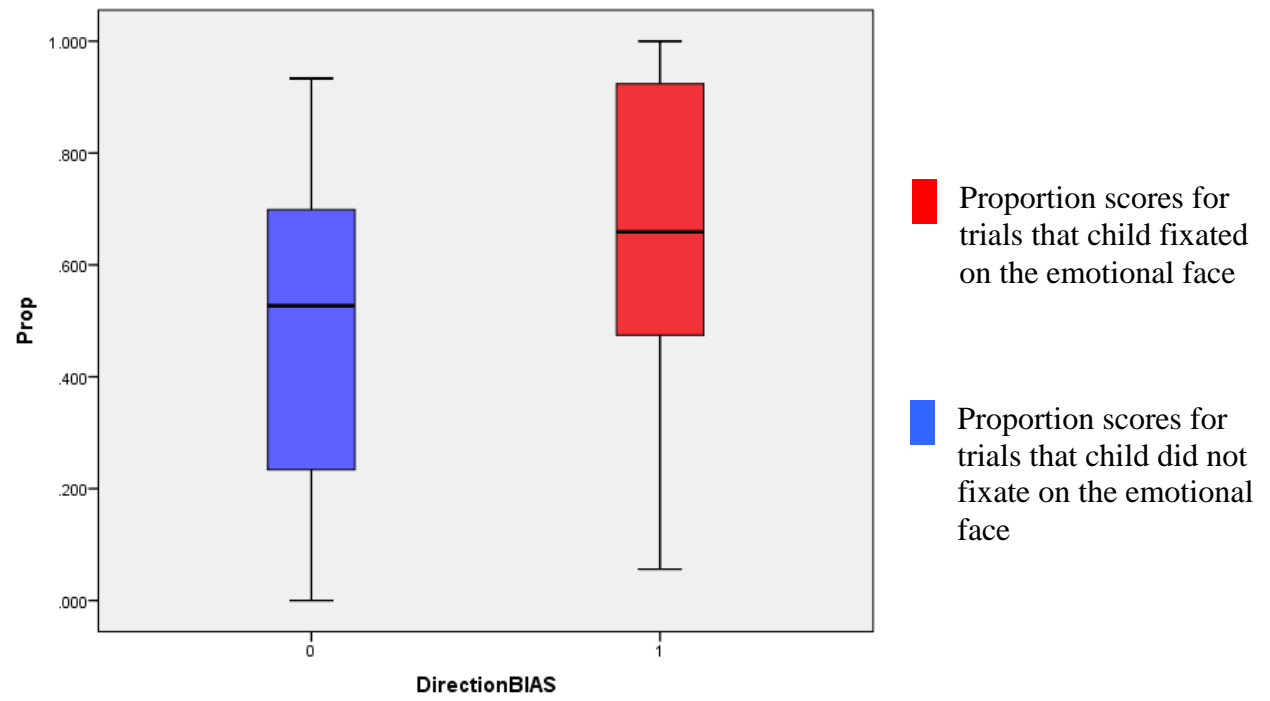


Figure 3. Probability of detecting happy and angry faces in Study 1



*Figure 4.* Mean of proportion scores based on initial fixation for Study 2

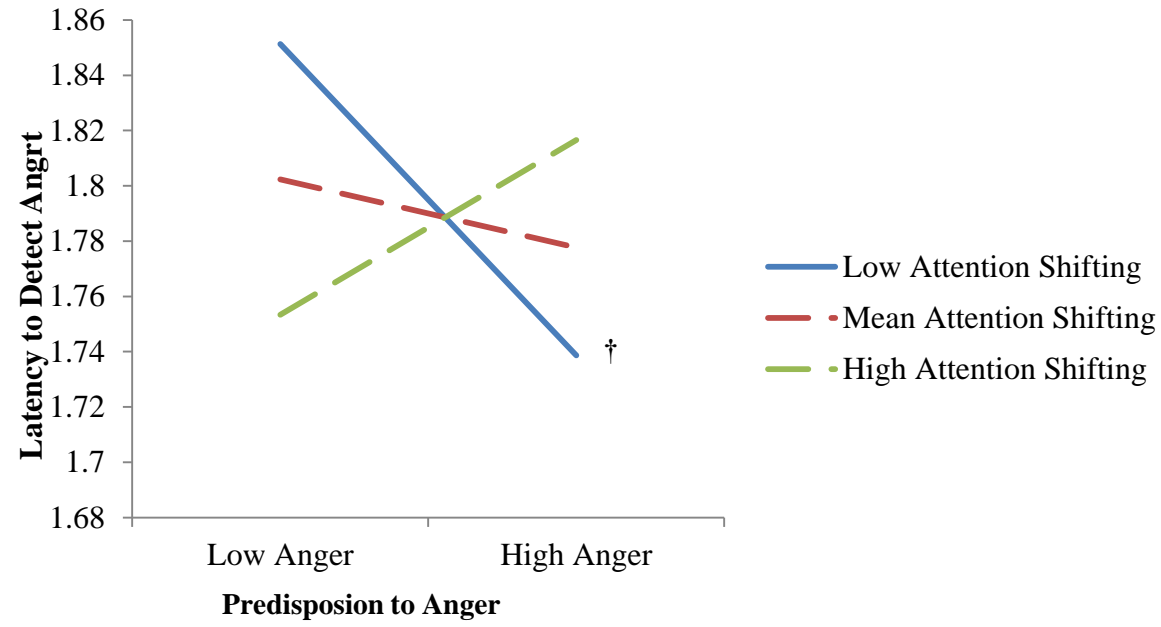


Figure 5. Predisposition to anger X attentional shifting to latency to detect anger  
Note. † $p < .10$ , \* $p < .05$ ; \*\* $p < .01$

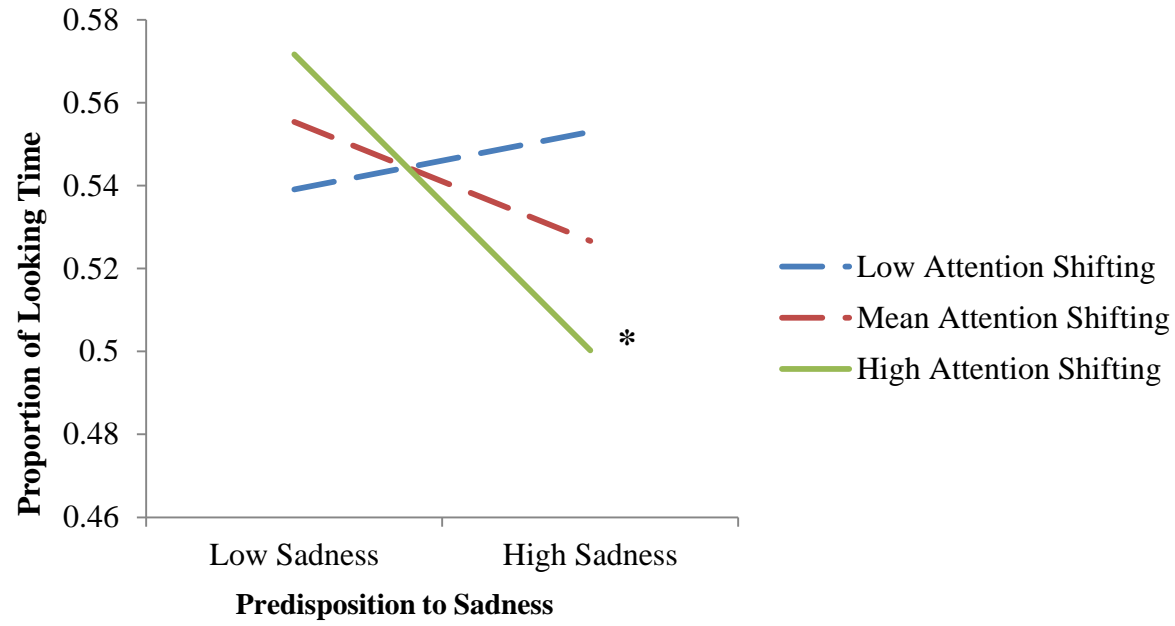


Figure 6. Predisposition to sadness X attentional shifting to proportion of looking time  
Note. †  $p < .10$ , \*  $p < .05$ ; \*\*  $p < .01$

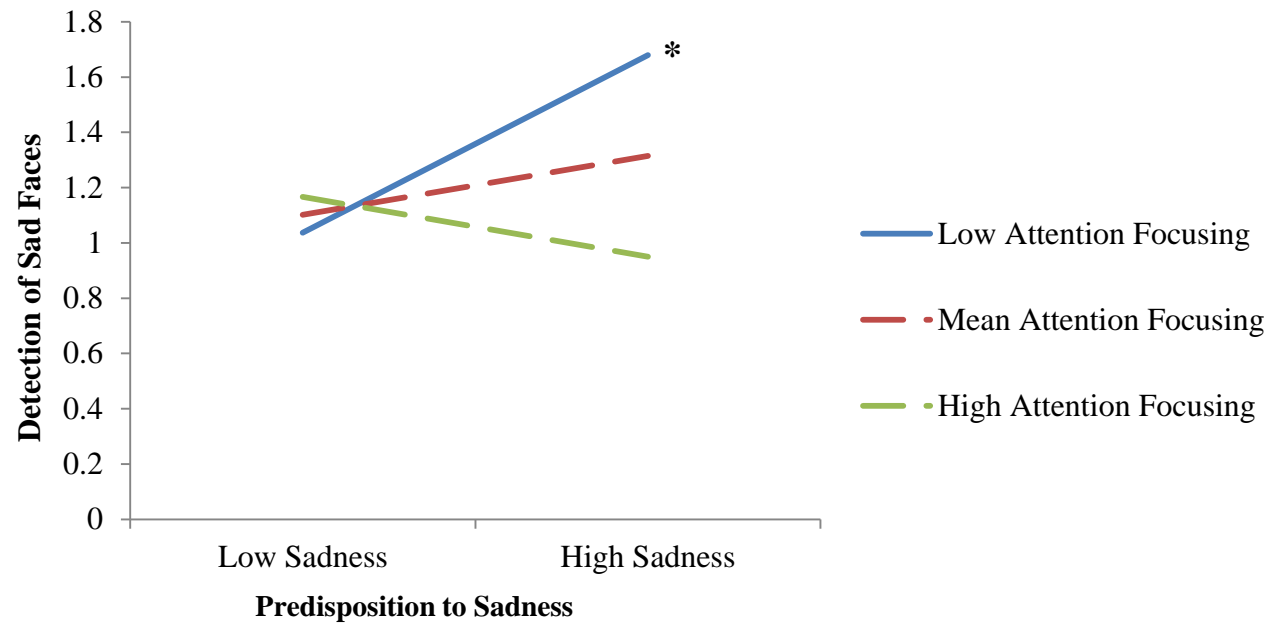


Figure 7. Predisposition to sadness X attentional focusing to detection of sad Faces

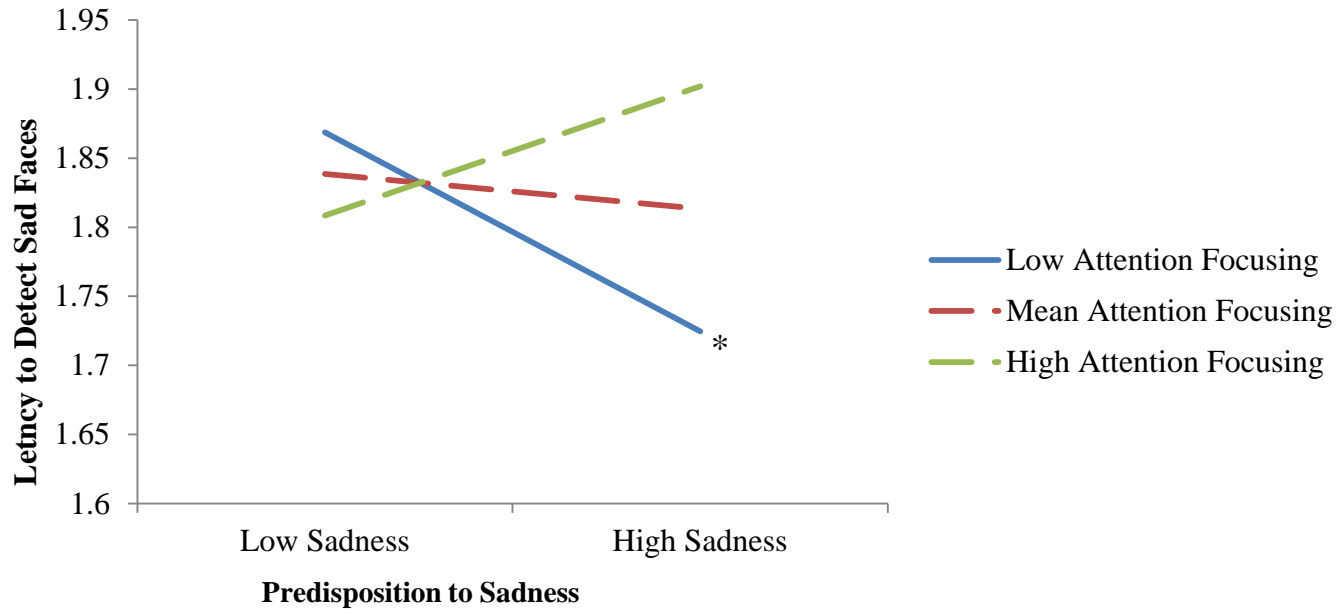


Figure 8. Predisposition to sadness X attentional focusing to latency to detect sad faces

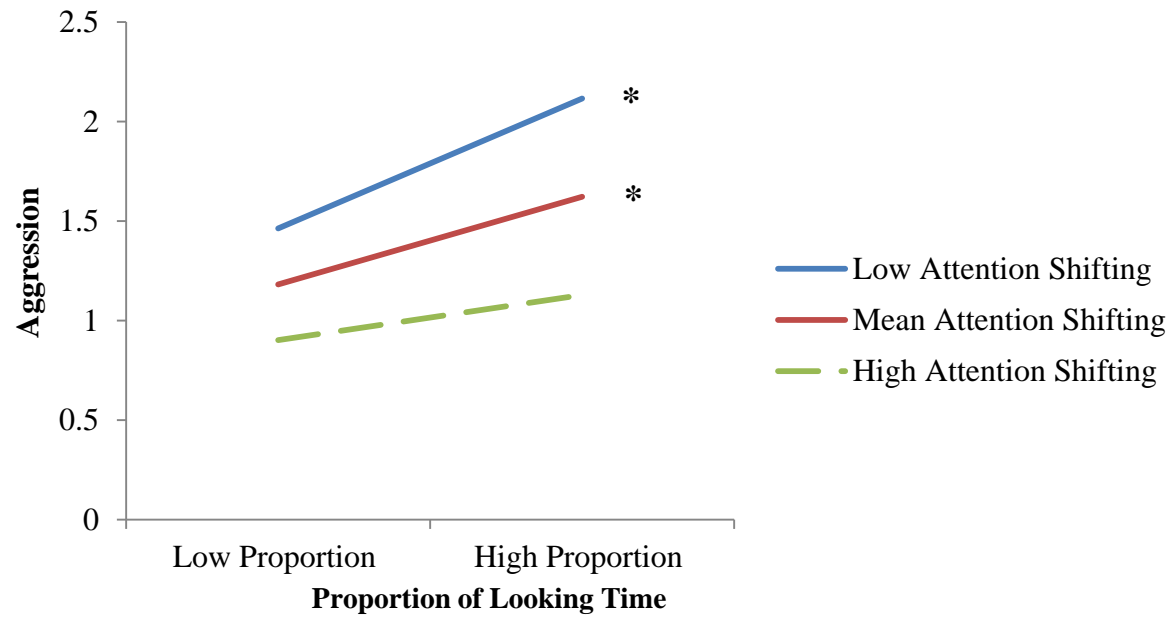


Figure 9. Proportion of looking time X attentional shifting to aggressive behaviors

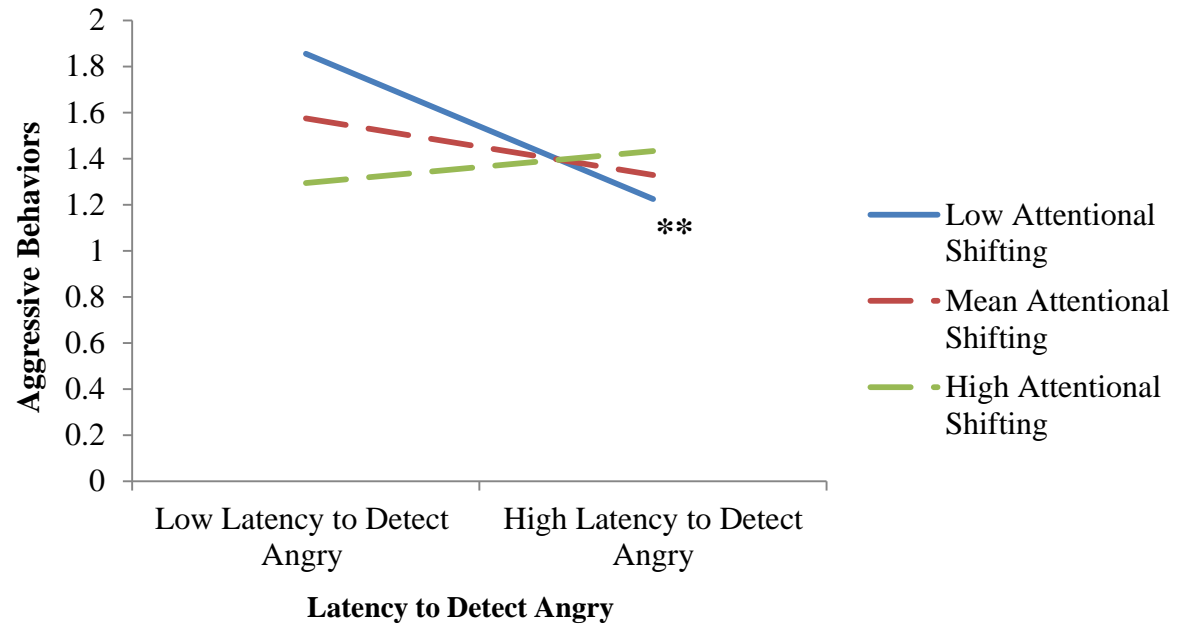


Figure 10. Latency to detect angry X attentional shifting to aggressive behaviors



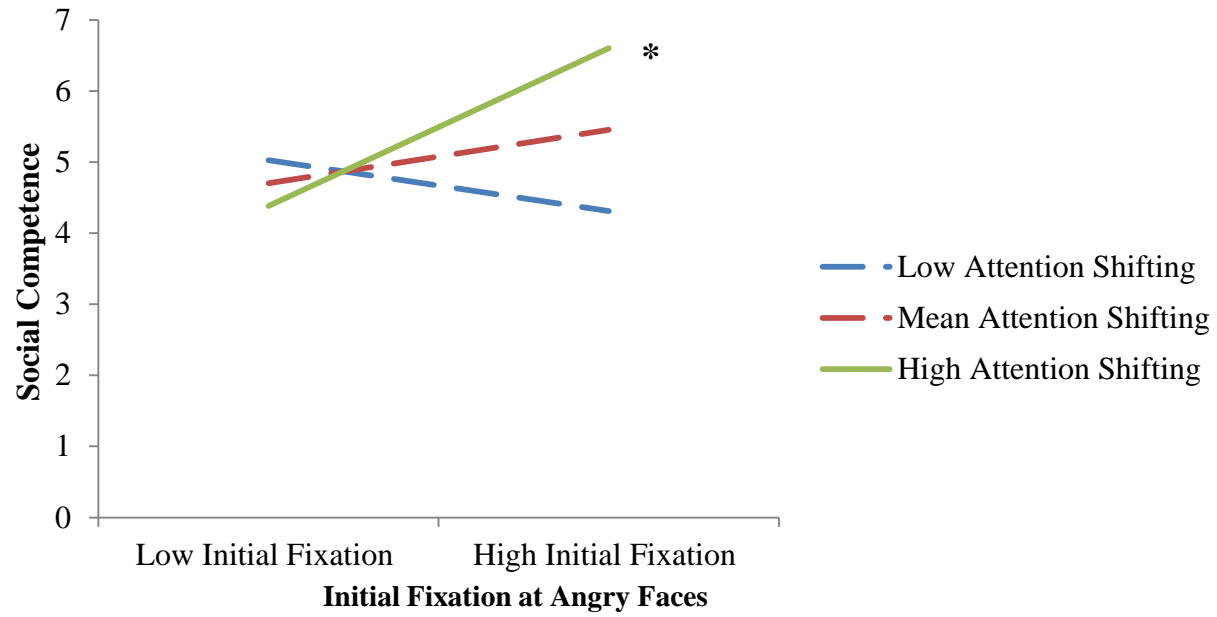


Figure 11. Initial fixation at angry faces X attentional shifting to social competence

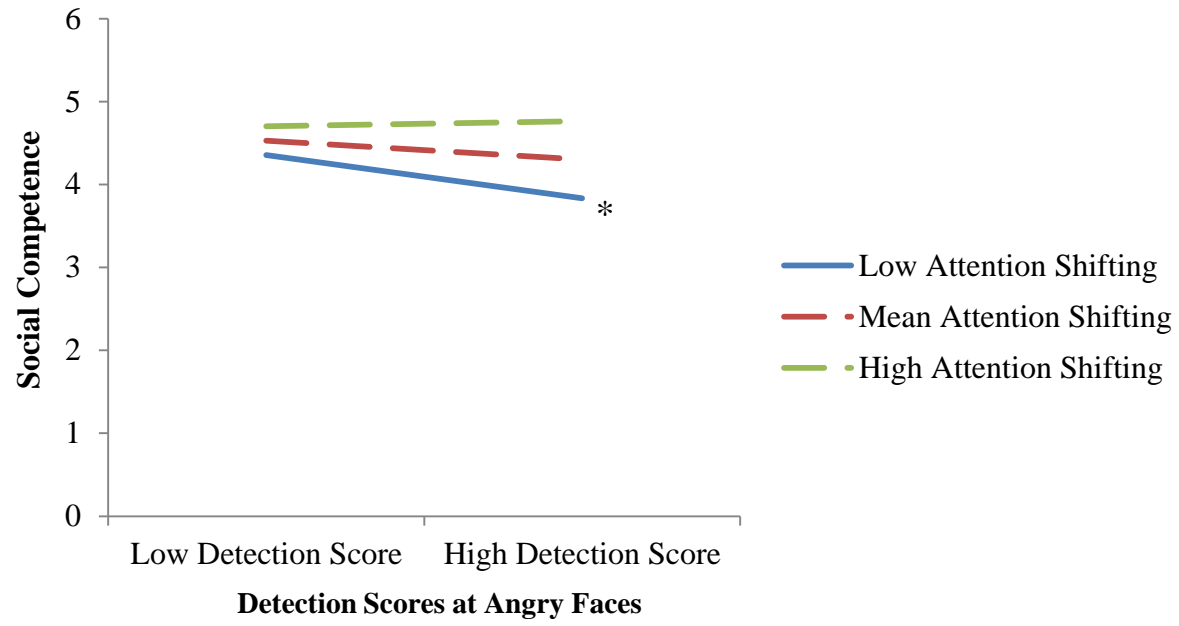


Figure 12. Detection of angry faces X attentional shifting to social competence

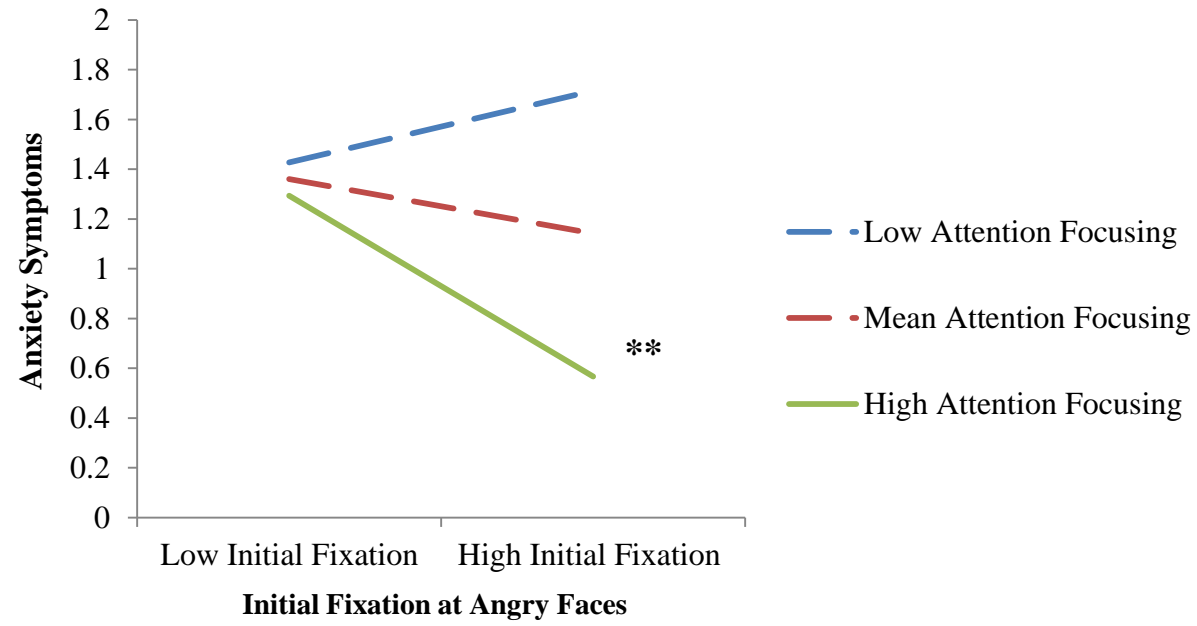


Figure 13. Initial fixation at angry faces X attentional focusing to anxiety symptoms

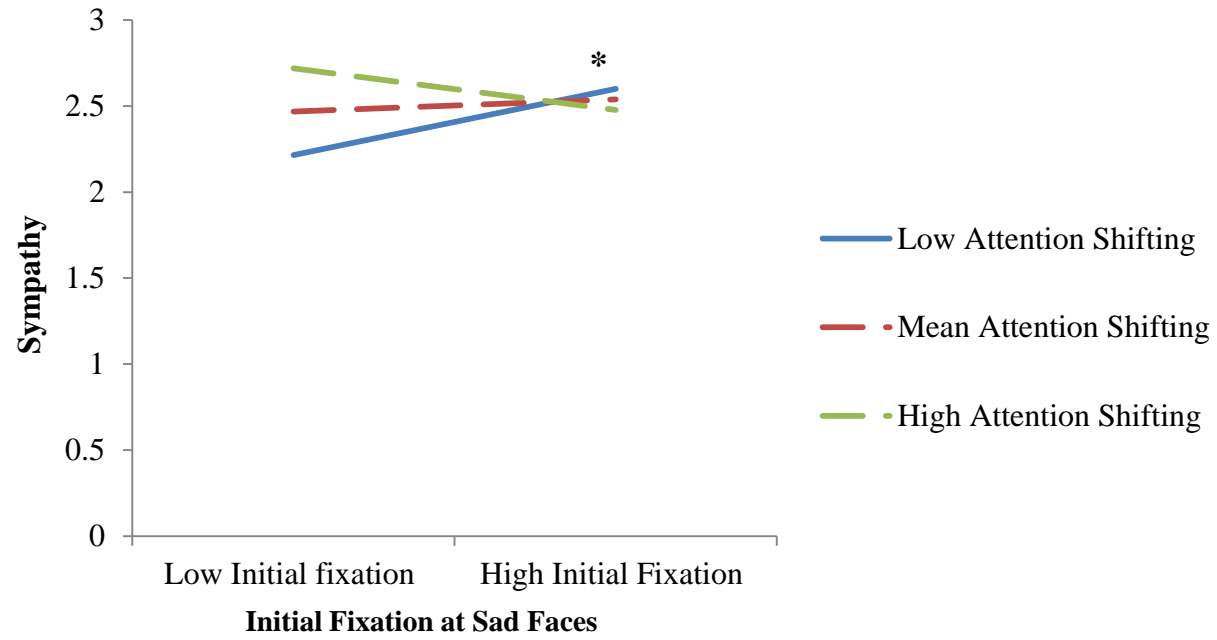


Figure 14. Initial fixation at sad faces X attentional shifting to sympathy