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Recognition of Emotions From Facial Expression and Situational Cues in Children with Autism

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RECOGNITION OF EMOTIONS FROM FACIAL EXPRESSION AND SITUATIONAL CUES IN CHILDREN WITH AUTISM

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ABSTRACT

The present study investigated two areas of emotion recognition in school-aged high-functioning children with autism and typically developing children, matched on chronological age and gender: (1) recognition of facially expressed emotions that were presented in still photographs of adult faces and (2) emotion recognition from situational and facial cues, presented in line drawings of emotionally-laden situations. For the photograph task, children's accuracy in recognizing facial expressions of happy, sad, angry, and fear emotions along with neutral expressions was investigated. All emotional expressions were presented with computer-generated direct and averted eye-gaze at 100% and 50% emotion strength. Of particular interest were whether eye-gaze direction and emotion strength affect children's interpretation of facially expressed emotions and whether these factors influence perception in a different way for typically developing children than children with autism. Children's own ratings of emotional intensity of photographed facial expressions were also explored in relation to emotion strength and eye-gaze direction. In addition to the photograph task, line drawings depicting scenarios of happy, sad, angry, and fear eliciting events were used to investigate the role situational and facial cues play in emotion recognition, particularly when they were incongruent with one another.

Participants were 22 high-functioning children with autism (17 male, 5 female; mean age 10.31) and 22 age and gender matched typically developing children (17 male, 5 female; mean age 9.96). Children with autism had previously been diagnosed with Autism Spectrum Disorder by a certified clinician according to the DSM-IV criteria, they had a verbal mental age of at least 7 years, and had a Performance IQ score above 75.

The present findings are consistent with studies that show autistic children to be less adequate at recognizing basic emotional expressions, particularly fear and sadness. Contrary to the eyes processing deficit hypothesis, children with autism were found to be sensitive to eye-gaze direction while identifying emotional expressions. In addition, direct eye-gaze was shown to heighten the perception of emotional intensity in children with autism but not typically developing children supporting previous findings that direct eye-gaze elicits more arousal. Finally, when children were presented with incongruent facial and situational cues, children with autism tended to rely more on facial cues than situational cues, whereas typically developing children relied more on situational cues. These results are discussed within the context of previous research on emotion recognition in individuals with autism.

CHAPTER ONE

INTRODUCTION

The hallmark of autism is marked social cognitive deficits, as evidenced by inability to communicate effectively using eye-to-eye gaze or facial expressions, failure to develop age-appropriate peer relationships, and a lack of social reciprocity between a parent and a child (e.g., Bakeman & Adamson, 1984; Stone & Hogan, 1993; Wing, 1997; Vig & Jedrysek, 1999). It has been hypothesized that the social problems in childhood result from impaired capacity to process facial emotional cues appropriately during infancy, which significantly disrupts the mother-infant affective relatedness (Hobson, 1986; Osterling & Dawson, 1994; Vig & Jedrysek, 1999). Consistent with this view, numerous studies have reported face processing impairments such as matching of face identities (e.g., Boucher, Lewis, & Collis, 1998; Hobson, Ouston, & Lee, 1988), emotion recognition (e.g., Gross, 2004; Hobson, 1986), and abnormal gaze patterns during social interactions (e.g., Klin, Jones, Schultz, Volkmar, & Cohen, 2002; Trepagnier, 1998).

It has been suggested that the reason individuals with autism have difficulty in recognizing facially expressed emotions is due to atypical face scanning patterns (e.g., Adolphs, Sears, & Piven, 2001; Dawson, Webb, Carver, Panagiotiedes, & McPartland, 2004; Gross, 2004; Hobson, 1986). Specifically, individuals with autism show a preference for the mouth region over the eye region of the face when judging emotion (e.g., Baron-Cohen, Campbell, Karmiloff-Smith, Grant & Walker, 1995). This may be problematic because eyes are believed to carry unique and valuable information about an individual's facial expression (Baron-Cohen, 1995; Ekman, 1972). Indeed, infants as young as two month prefer looking at the eyes over any other region of the face (Langton, Watt, & Bruce, 2000). Furthermore, an ability to establish mutual eye contact and to follow another person's gaze develops rapidly during infancy (e.g., Hood, Willen, & Driver, 1998) and is implicated in several crucial developmental milestones such as joint attention, attachment, and language development (Brooks & Meltzoff, 2005). Recently, eye-gaze direction has been demonstrated to modulate the perception of emotional expressions in normal adults. Specifically, direct eye-gaze was found to enhance recognition of anger and happiness whereas averted eye-gaze was found to enhance recognition of fear and sadness (Adams & Kleck, 2005). In addition, angry expression with direct eye-gaze was perceived as more emotionally intense than angry expression with averted eye-gaze (Sato, Yoshikawa, Kochiyama, & Matsumaura, 2004). Despite the apparent significance of the eyes, there is no research data investigating the effects of the eye-gaze direction on face and emotion recognition in either typically developing or autistic children.

Situational context is another vital factor of interpretation of others emotions, given that most facially expressed emotions do not occur in isolation. The child's ability to understand the context in which a given emotion is appropriate has been linked to positive psychological and behavioral outcomes (Denham, 1998). It has been found that typically developing children's reliance on facial cues decreases with age while the reliance on situation cues increases with age (Gnepp, 1989; Reinchenbach & Masters, 1983), and by 8 or 9 years of age, children utilize both types of cues in their judgments of emotions (Hoffner & Badizinski, 1989). Yet, very few studies have investigated the use of situational cues in recognition of emotions in individuals with autism.

The ability to understand both facial expressions and situational cues are imperative in correctly interpreting the emotional states of others, which is a vital component of social interaction. The current study extends research on emotion recognition in children with autism as revealed through their capacity to process information from people's faces as well as situational cues. There are two primary aims of the present study: (1) to advance understanding of the effects of eye-gaze direction in recognition of facially expressed emotions in a sample of children with and without autism, (2) to advance the understanding of autistic children's use of situational cues in emotion recognition. It is hoped that the findings of this study may eventually play a critical role in the development and implementation of intervention methods that effectively bolster the social-emotional functioning of autistic individuals.

CHAPTER TWO

LITERATURE REVIEW

Perception of Facial Expression in Typically Developing Children

Emotion Recognition in Typically Developing Children

The ability to recognize facial expressions of emotions is a crucial social skill that is necessary for complex interpersonal interactions. Basic understanding of nonverbal cues of emotion seems innate and universal across cultures, at least for some emotions (e.g., Ekman, 1972; Izard, 1978). In fact, infants are able to notice differences in facial expressions as early as three to seven months, and understand that expressions convey information (Kopp & Neufeld, 2003). Additionally, infants can change their expressions and emotional state in response to others' emotional signals (e.g., Dunn, 2003; Meltzoff, Gopnik, & Repacholi, 1999). Some research studies have found that infants as young as 36 hours old are able to imitate sad, happy, and surprised expressions (Field, Woodson, Greenberg, & Cohen, 1982), and to discriminate happy and sad faces from surprised faces (see Nelson & De Haan, 1996). Furthermore, infants use their caregiver's facial cues to bias their own decisions about exploration. For example it has been found that one-year-old infants are less likely to move across a visual cliff when the mother's face expresses fear (Sorce, Emde, Campos, & Klinnert, 1985) or anger (Campos, 1981), as compared to when she poses happy facial expressions.

It has been documented that the vast majority of children master the perception of emotional cues by the end of their preschool years (Denham & Couchard, 1990), with the majority of 3 and 4-year-old children demonstrating the ability to discriminate all five primary emotions: happy, mad, sad, surprised, and scared (e.g., Denham 1986, Fabes, Eisenberg, Nyman, & Michealieu, 1991; Lewis, 2000a; Smiley & Huttenlocher, 1989). Nevertheless, young children are not as accurate in their distinctions between facial emotions as older children (e.g., De Sonneville, Verschoor, Njikiktjien, Ophet, Veld, Toorenaar, & Vranken, 2002). In fact, the ability to interpret emotions from facial expressions increases significantly over the preschool years. Furthermore, children demonstrate disparate performance across emotions with positive emotions recognized first and more accurately than negative emotions (De Sonneville et al., 2002; Michalson & Lewis, 1985; Vicari, Reilly, Pasqualetti, Vizzotto, Caltagirone, 2000; Widen & Russell, 2003).

Additionally, the ability to recognize basic emotions such as happiness, anger, fear, and sadness is better than young children’s ability to recognize more complex, self-conscious types of emotions such as pride, shame, and embarrassment. Basic emotions are thought to be fully developed by 6-years of age, while recognition of more complex emotions continues to mature over time (Markham & Adams, 1992). Davison (in press), for example, found that 6- and 8-year-old children were more likely than older children to explain self-conscious types of emotion (e.g., guilt) using basic labels (e.g., mad), and to recall self-conscious emotions with basic labels. Furthermore, while 6- and 8-year-olds showed a recall advantage for emotion, this was only for basic emotions (Davidson, Luo, & Burden, 2001).

Not only does the accuracy of recognition improve with age, the speed of processing is also shown to increase as the child develops, especially for negative emotions (De Sonneville et al., 2002). Interestingly, the ability to accurately recognize fear is more difficult for children than any other basic emotion, and seems to improve at a slower rate with age (Camras & Alison, 1985; Boyatzis et al., 1993). At 8-years, children correctly identified fear 43.5% of the time and at 16-years, children correctly identify fear 59% of the time, whereas adults performed at rates of 80% (Lenti, Lenti-Boero, & Giacobbe, 1999). In fact, neurobiological studies find that the neural processing involved in perception of emotional faces develops in a step-like fashion throughout childhood while the adult pattern appears only late in adolescence (Batty & Taylor, 2006).

There is some evidence that certain factors such as social environment, verbal ability, and parent-child interaction may have an impact on development of emotional expression recognition. It has been demonstrated that children whose mothers spontaneously explained their emotions to their children was positively related to the children's emotion understanding (Denham, 1994). The impact of parental discourse on emotions was also moderated by the accuracy with which the parent is perceiving the emotions, such that parents who are more accurate in their discussions of emotions have children who have more successful ability to understand emotion than those children whose parents are inaccurate in their perception of emotion (Denham, 1994).

In terms of the current research, the strength of the emotion or intensity of facial expression of emotion has only occasionally been recognized as a contributing factor to more accurate interpretation of facial information in children and adults. Facial emotion intensity refers to the relative degree of displacement, away from a neutral or relaxed facial expression, of the pattern of muscle movements involved in emotional expressions (Hess, Blairy, & Kleck, 1997). In seminal work, Hess, Blairy, and Kleck (1997) demonstrated that adults perceive weak expressions of emotions as reflecting weak emotional states, while strong expressions of emotions were seen to reflect strong emotional states. Moreover, adults were more accurate at recognizing more intense emotions of anger and sadness, and to some degree disgust, but not expression of happiness. It appears that only one published study has investigated the effects of emotion intensity in a sample of 4- to 15-year old children (Herba, Landau, Russell, Ecker, & Phillips, 2006). Photographs of happy, sad, angry and fear expressions of varying intensity levels, ranging from 0% intensity or neutral to 100% intensity, were shown to participants as part of the recognition task. The results indicated that accuracy, as well as response time, improved with increased levels of intensity. Specifically, children were more accurate in identifying emotion when they were presented with pictures of 50% of emotion intensity as compared to 25% of emotion intensity, particularly for fear and happy expressions. However, no significant differences were found between 50% of intensity level, 75% of intensity, and 100% of intensity. Furthermore, findings from a recent investigation into the effects of emotion intensity on event related potential (ERP) suggests that incoming facial information might primarily be coded for its saliency and then for specific emotional content (Sprengelmeyer & Jentzsch, 2006). The facilitative effects of stronger levels of intensity on recognition accuracy were also demonstrated in clinical populations such as children with psychopathic tendencies (Blair, Colledge, Murray, & Mitchell, 2001) and adults with schizophrenia (Kohler, Turner, & Bilker, 2003).

Face Recognition in Typically Developing Children

Research on face recognition in typical children indicates that children improve in accuracy on face recognition tasks between the ages of 5 and 10 years (e.g., Chance & Goldstein, 1984; Diamond & Carey, 1977; Ellis & Flin, 1990; Flin, Markhman, & Davies, 1989). Some studies suggest that there is continual improvement through middle childhood until an adult level of recognition is reached at around age 11 (Chance & Goldstein, 1984; Flin et al., 1989). Faces contain two forms of perceptual information, *featural* and *configural* (see Rakover, 2002 for review), and many researchers argue that adults use configural information while children rely more on featural information to recognize faces (Diamond & Carey, 1977). Specifically, featural information refers to the aspects of the face that can be perceived and identified as individual units (e.g., shape, color of the eyes, nose, and mouth), while configural information refers to the spatial relations among facial features (e.g., the distance between the eyes). In other words, featural processing relies on local, specific details of the face, whereas configural processing integrates the details into a coherent whole.

It has been suggested that adults process faces differently than other non-face objects, relying more on configural strategies, an inference largely based on face-inversion effect. Specifically, healthy adults were shown to exhibit a 20 to 30% decrease in successful face recognition in response to inverted faces (Friere, Lee & Symons, 2000). It is believed that face inversion disturbs the processing of configural information (Mondloch, Le Grand, & Maurer, 2002; Searcy & Bartlett, 1996) thereby leading to the decrease in recognition performance of inverted faces. In addition, it has been demonstrated that individuals have more trouble recognizing facial features in isolation, or out of the context of the face, as compared to parts of non-face objects, suggesting that people pay less attention to individual face parts (i.e., featural information) when they perceive faces (Tanaka and Farah, 1993). The developmental shift in recognition of faces sometimes is attributed to an increased reliance on configural cues of the face and a decreased reliance on featural information as children get older (Diamond & Carey, 1977).

Eye-Gaze and Facial Expression in Typically Developing Children

Eye-gaze direction is an important and crucial feature of facially- communicated emotion. In fact, the ability to perceive eyes develops early in life. Infants as early as eight to 10 weeks of age automatically follow someone else’s eye-gaze (Hood, Willen, & Driver, 1998), by two months of age infants show a preference for looking at the eyes over other regions of the face (see Langton, Watt, & Bruce, 2000), and by four months of age they are able to discriminate between direct and averted gaze (Vacera & Johnson, 1995). In addition the eyes are believed to be the first feature of the face necessary to elicit smiling in the infant (Hainline, 1978). It is unlikely that the visual characteristics of the eyes, such as contrast or shape, are responsible for the increase in looking behavior because similar areas of contrast and contour in the object stimulus did not elicit similar increased looking behavior. Hainline (1978) suggested that infants have become responsive to *faceness* based on past experiences with faces and eye contact. She further postulated that eye contact and a preference for looking at the face are interrelated with social development. Indeed, research indicates that they eyes are crucial in recognition of the human face (Mondloch & Maurer, 2002), development of joint attention between an infant and a caregiver, and subsequent language development.

Additional studies suggest that gaze direction is implicated in a number of perceptual tasks, such as cueing one's attention to peripheral location in the visual field (e.g., Driver, Davis, Ricciardelli, Kidd, Maxwell, E & Baron-Cohen, 1999; Friesen & Kingstone, 1998; Tipples, 2006), person categorization (e.g., Macrae, Hood, Milne, Rowe & Mason, 2002), and identity recognition (e.g., Hood, Macrae, Cole-Davies, & Dias, 2003). For instance, when adults were required to judge whether a face was male or female, gender categorization was speeded when the faces were coupled with direct (i.e., looking straight ahead) eye-gaze, compared to when the faces were coupled with averted (i.e., looking sideways) eye-gaze or closed eyes. Similarly, it was demonstrated that face recognition was enhanced by direct gaze for both children and adults (Hood, Macrae, Cole-Davies, & Dias, 2003). It has been suggested that face recognition is enhanced for faces with direct rather than averted gaze since social targets are mostly ones with whom mutual eye contact has been established.

Electrophysiological studies of humans reveal an event-related potential component that may be sensitive specifically to the eyes (Bentin, Allison, Puce, Perez, &

McCarthy, 1996), suggesting that there may be specialized direction-of-gaze detectors within inferotemporal parts of the brain (Campbell, Heywood, Cowey, Regard, & Landis, 1990). Direct eye contact has also been shown to heighten brain activity related to emotional facial expressions in the anterior parts of the superior temporal gyrus (Wicker, 2003). Additionally, neuropsychological studies have demonstrated that eye-gaze direction modulated the emotional reaction to facial expressions in normal adults. Specifically, stronger amygdala responses were detected in the left amygdala when participants viewed angry faces with direct eye-gaze and fear faces with averted eye-gaze than anger faces coupled with averted eye-gaze and fear faces coupled with direct eye-gaze (Reginald, Gordon, Baird, Ambady, Nalini, & Kleck, 2003). Furthermore, angry faces coupled with direct eye-gaze were perceived as more emotionally intense than angry faces coupled with averted eye-gaze (Sato, Yoshikawa, Kochiyama, and Matsumura, 2004).

An important differentiation has been made between emotions that elicit approach reaction as oppose to avoidance/withdrawal reaction. Adams and Kleck (2005) demonstrated that direct gaze enhanced the perception of anger and joy (approach-oriented) emotions, whereas averted gaze enhanced perception of fear and sadness (avoidance- oriented) emotions in a sample of adults. In fact, Adams and Kleck (2005) demonstrated that neutral faces, coupled with direct gaze, were given more angry and joy dispositional attributes, whereas neutral faces, coupled with averted gaze, were given more fear and sad dispositional attributions. In addition, direct gaze increased the perceived intensity of expressions of anger and joy while averted gaze increased the perceived intensity of expression of fear and sadness. Adams and Kleck (2005) proposed a *shared signal hypothesis* that argues that gaze direction, when matched with the underlying behavioral intent (either approach or avoid) communicated by a specific emotion expression, enhances the perception of that emotion.

In terms of developmental research, Baron-Cohen (1995), hypothesized that aspects of face processing, particularly the ability to detect eye-gaze, are necessary for the development of "theory of mind", or the ability to reason about others mental states and feelings. He further proposed that infants are born with a functional mechanism, the "eye detection device" that detects observers' eye-gaze and enables dyadic communication. This capability coupled with innate representation of intentionality and shared attention allows children to acquire theory of mind, a prerequisite for facile social interaction. In a series of studies, Baron-Cohen and colleagues have demonstrated that when presented with photographs of faces that were looking upwards and sideways in an absence of any object to which their gaze was directed, 4-year-olds were able to infer that the person was simply engaged in a thinking process and not looking at anything specific. Furthermore, when presented with a picture of the eye region of the face, older children and adults were able to reliably select the most appropriate mental-state terms to describe the picture (Baron-Cohen, Wheelright, Hill, Raste, & Plumb, 2001).

Taken together, these findings suggest that eye-gaze is an important emotional cue that facilitates social communication and understanding of others people's intentions. However, no other data exist to indicate whether eye-gaze direction has similar effect in children. The importance of the eyes in facial expression recognition, and the possible implications of the eyes in social development, create questions about the individuals' with autism poor eye contact and the significance of this in terms of emotion recognition and social development. Thus, it is imperative to further investigate the role of eye gaze in emotion recognition in both typically developing and autistic children.

Situational Cues and Facial Expression in Typically Developing Children

An ability to infer others' emotions from situational cues is considered to be an important part of emotional development and has been linked to several indicators of social competence and adaptive behaviors (Denham, McKinley, Couchoud & Holt, 1990; Fine, Izard, Mostow, Trentacosta, & Ackerman, 2003; Izard, Fine, Schultz, Mostow, Ackerman, & Youngstrom, 2001). As children develop, they start relying more on situational and contextual cues to infer emotions of others (Gnepp, 1983; Reichenbach & Masters, 1983). For example, 3- to-5-year-olds were shown to focus exclusively on facial expressions, whereas 8- to- 9-year-old children relied on situational cues in addition to the facial expressions to infer emotion expressions (Hofneer & Badzinski, 1989).

To assess understanding of situational cues, researchers typically present children anywhere between 3 to 10 years of age with verbal vignettes of different emotional situations and then asked about how the protagonist in the story felt (e.g., Davidson, in press; Denham, 1986; Gnepp, 1983) Similar to recognition of facial emotion information, studies have reported that emotional situation knowledge of some basic emotions such as joy, sadness, fear and anger develop earlier before understanding of other complex emotions such as guilt, pride and embarrassment (Davidson et al., 2001;

Davidson, in press; Lewis, 2000a; Fine, Izard, & Trentacosta, 2006; Garner, Jones, & Miner, 1994; Smith & Walden, 1998). In the absence of situational cues, children use information from facial expressions to infer causes and consequences of a given emotion. Russell (1990) found that 4- and 5-year-old children were able to specify plausible reasons for why one might feel happy, angry, sad, or fearful, in addition to plausible consequences for each of the emotions. Children have also been found to use facial expressions of others to infer the sequence of subsequent events in the context of social interactions.

Overall, research indicates that children's accuracy for recognition of emotions from facial expressions increases with age. By the end of preschool years, children are capable of recognizing of most primary emotions (Smiley & Huttenlocher, 1989). However, fear seems to be the hardest to recognize from facial expression (Camras & Alison, 1985; Boyatzis et al., 1993). Intensity of emotional expressions was also found to affect the accuracy of recognition, particularly for fear and happy expressions in both children and adults (Herba et al., 2006; Hess et al., 1997). The direction of the eye-gaze has been found to modulate the emotional reaction to facial expressions in normal adults. Specifically, neutral faces coupled with direct eye-gaze were perceived as angry or happy whereas averted eye-gaze was associated with fear (Adams & Kleck, 2005). In addition, studies on children's reliance on facial and situational cues of emotion have found that reliance on facial expression decreases with age while the reliance on situational cues increases (Gnepp, 1983; Reichenbach & Masters, 1983). There is a developmental shift in children from reliance on facial expression to the simultaneous use of both situation and facial expression to arrive at judgments regarding others' emotions (Hofneer & Badzinski, 1989).

Autism Spectrum Disorder

Definition and Prevalence of Autism Spectrum Disorder

Autism Spectrum Disorder is a pervasive developmental disorder first appearing in early childhood. The estimated prevalence of autism is 2 to 5 cases per 10,000 individuals (DSM-IV-TR, 2000), although more recent data estimates the rate to be as high as 65 cases per 10,000 individuals (Fombonne, 2003; Rutter, 2005). Autism occurs in males at a rate 4 to 5 times higher than females (Volkmar, Szatmari, & Sparrow, 1993). Autism is more prevalent among females with IQ under 35, but is more prevalent among males in the higher IQ ranges. The key features of autism are significant impairments in the development of social relationships and communication skills (DSM-IV-TR, 2000). Common atypical patterns of social development include poor eye contact, delayed onset or complete lack of gaze-following of faces, decreased orienting to faces, absence of the use of social smile, lack of facial expression, lack of responsiveness to parents' voices or attempts to play and interact, and lack of spontaneous imitation (see Volkmar, Chawarska, & Klin, 2005, for review). These patterns are usually observed by parents before child's third year.

In addition to communication problems and social skill deficits, individuals with autism have common patterns of intellectual deficits as well as strengths. Approximately 80% of children diagnosed with autism have mental retardation, characterized by low IQ scores, which are associated with poorer cognitive and behavioral outcome. Twenty-five percent of autistic individuals are reported to have special skills or talents in addition to 5% who are considered to be savants (Freeman, 1993). However, there is a great variability in the clinical expression of autism. Degrees of variation are defined in level of functioning, which is typically assessed by measurements of IQ. Children who score higher on the standardized IQ measure are labeled as “high functioning autistics” (Szatmari, Merette, Bryson, Thivierge, Roy, Cayer, & Maziade, 2002). Due to the classification of higher and lower functioning individuals with autism, it is now recognized that children with autism vary in the number and severity of symptoms (Gillberg, 1991) and biological parameters (Goleberg, Szamari, & Nahmias, 1999).

Perception of Facial Expression and Emotion in Autism Spectrum Disorder

Numerous research investigations have demonstrated that autistic individuals have difficulty in interpreting and understanding facial expressions using facial cues such as lip-movement, specific facial features, and eye-gaze direction (e.g., Deruelle, Rondan, Gepner, and Tardif, 2004; Hobson, Ousten, & Lee, 1988, 1989; Weeks & Hobson, 1987). For instance, Weeks and Hobson (1987) found that autistic individuals were less likely to spontaneously sort pictures according to facial expressions of emotion than non-autistic mentally retarded children. Interestingly, many of the autistic individuals ignored the facial expressions, and gave priority to sorting the pictures according to the type of hat the individual in the pictures was wearing.

In a series of earlier studies, children with autism performed worse than nonverbal mental age-matched children on tasks that involved choosing drawn and photographed facial expressions of emotion to correspond with videotaped emotional vocalizations and facial expressions (Hobson, 1986a). In contrast, autistic children performed at near ceiling levels on tasks that involved choosing drawings of non-emotional things to correspond with movements, sounds, and contexts, showing that they were able to understand the cross-modal nature of such tasks (Hobson, 1986b). Similarly, in a recent investigation of autistic perceptual abilities, in a set of five different face recognition tasks (identity, gaze, gender, emotional expression, and lip reading), autistic children were found to perform worse on all tasks except identity matching tasks than non-autistic children matched on verbal and chronological age (Deruelle, Rondan, Gepner, & Tardif, 2004).

Previous research suggests that children with autism demonstrate impairment in recognition of some basic emotions, particularly negative emotions such as fear, sadness and distress (e.g., Ashwin, Chapman, Colle, Baron-Cohen, 2006; Davis, Bishop, Manstead & Tantam, 1994). Specific deficit in recognition of fear has also been reported by a number of studies (Ashwin et al., 2007; Adolphs, 2001; Pelphery, Sasson, Reznick, Paul, Goldman, & Piven, 2002). However, a great number of studies fail to show any deficits in the perception of simple emotions by children with high functioning autism (Balconi & Carrera, 2007; Capps, Yirmiya, & Sigman, 1992; Castelli, 2005; Grossman, Klin, Carger, & Volkmar, 2000; Oznoff, Pennington, & Rogers, 1990). For instance, Castelli (2005) reported that children with autism did not have any deficit in the ability to recognize six emotions (anger, fear, disgust, happiness, sadness, and surprise). Moreover, autistic children performed as well as the control group at identifying emotion at 70% and 90% of their emotional intensity. Additionally, children with autism (mean age 12.5) were found to be equally proficient at the affect labeling task when compared to the control group when participants were asked to discuss appropriate examples of specific simple and complex emotions as well as label photographs with the appropriate emotions (Capps, Yirmiya, & Sigman, 1992). The comparison group used was a group of children matched on gender, full scale IQ, and chronological age with no disabilities.

Neurobiological data suggests that individuals with autism display abnormalities in the brain regions used during face processing. For instance, individual with autism have been shown to exhibit a weakened activation in the fusiform gyrus, an area associated with face processing, but an increased activation in the inferior temporal gyrus, an area that is associated with processing of objects (Schultz, 2000), as well as show idiosyncratic patterns of activation across brain regions (Pierce, Muller, Ambrose, Allen, & Courchesne, 2001). These results suggest that individuals with autism process faces using regions that are typically involved in object processing.

Several studies have found that children with autism have difficulty recognizing unfamiliar faces relative to controls (Boucher & Lewis, 1992; DeGelder, Vroomen, & Van Der Heide, 1991). Specifically, children with autism who ranged in age from 6 and 16 years performed significantly worse on tests of face identity recognition than their verbal age-matched control group. They did not, however, differ in their performance on non-face recognition tasks, which indicated that the recognition difficulty in autism was specific to faces (DeGelder et al., 1991). Likewise, when children's performance on the identity recognition task (matching faces according to their identity) was compared to their performance on the building recognition task (matching two identical buildings), children with autism showed impaired ability on face recognition, but not building recognition task, relative to the control group (Boucher & Lewis, 1992).

Eye-Gaze and Facial Expression in Autism Spectrum Disorder

One of the key features of autism is the lack of eye-to-eye contact with others. It has been suggested that autistic individuals do not allocate as much attention to the eye region of the face as non-autistic individuals do. Prior research has documented that autistic individuals spend less time looking at the upper part of the face including eyes than at the lower part of the face when making judgments about facial expressions (e.g., Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995; Baron-Cohen, Wheelwright, & Jolliffe, 1997; Bormann-Kischkel, 1995; Gross, 2004; Klin, Jones, Schultz, Volkmar, & Cohen, 2002). For example, when photographs were partially blanked out and only eyes were shown, autistic children's performance drastically declined as compared to non-autistic children (Hobson, Ouston & Lee, 1988).

Several studies utilizing eye-tracking technology have shown that individuals with autism spent proportionally less time and make fewer fixations to internal facial features. Within internal features, they spent less time examining the eyes and nose but spent as much time as typical individuals looking at the mouth (Dalton, Nacewicz, Johnstone, Schaefer, Gernsbacher, Goldsmith, 2005; Pelphrey, Sasson, Reznick, Paul, Goldman, & Piven, 2002). Furthermore, when typically developing children were compared to children with autism on their ability to recognize a face based only on eyes or mouth region of the face, autistic children were most accurate when recognition depended on the mouth region, whereas non-autistic children showed advantage for eye-based face identification (Joseph and Tanaka; 2003).

Nevertheless, research on eyes processing deficits in individuals with autism has lead to equivocal results. For instance, a similar pattern of attention allocation in high-functioning autistic and non-autistic boys was found, with more attention given to the eyes region than to the mouth region when viewing static pictures (Bar-Haim, Shulman, Lamy, & Reuveni, 2006). Similarly, autistic children tended to fixate more often and longer to the eyes and mouth, and tended to make initial fixations to the eye region in a series of experimental tasks (Van der Geest, Kemner, Verbaten, & van Engeland, 2002). It has been suggested that the perceptual bias towards the mouth region during face expression recognition tasks might be due to deficits in the neural mechanisms dedicated to the processing of another person's direct eye gaze (Senju, Yaguchi, Tojo, & Hasegawa, 2003) such that direct gaze elicits great physiological arousal that is too overstimulating for the child (Hutt & Oustead, 1966; Tinbergen, 1974). Consistent with this view, an increased activation of the fear center in the amygdula part of the brain in a sample of adults with autism (Dalton, et al., 2005) and greater skin conductance response (SCR) in a sample of children with autism has been documented in response to direct eye-gaze relative to non-autistic children (Kylliainen & Hietanen, 2006). Furthermore, several studies have demonstrated that non-autistic children and adults detected facial stimuli with direct a gaze more quickly than with an averted gaze, however response time of autistic individuals was not affected by the direction of the gaze (Senju, Hasegawa, & Tojo, 2005). Scarcity of research investigating the direction of eye-gaze in autistic individuals during facial expression recognition tasks limits any further conclusions about the effects of the direct eye contact on emotion recognition.

Face Processing Strategies in Autism Spectrum Disorder

It has been suggested that the non-significant findings of group differences between autistic and non-autistic children observed on recognition tasks does not necessarily indicate normal emotion recognition abilities in autistics, as individuals with autism might rely on *different* perceptual strategies to solve emotion recognition tasks (Hobson, 1991). *Featural processing,* or reliance on local facial features than on configural aspects of face (i.e., the relationship between the different parts), is one such strategy attributed to individuals with autism. Investigations into the perceptual mechanisms that underlie the development of patterns of face processing have determined that, unlike the processing of non-face objects that relies primarily on the recognition of individual features (e.g., nose, eye, mouth), faces are processed by normal adults in a more holistic manner (Diamond & Carey, 1986; Tanaka & Sengco, 1997). Many studies have shown that autistic individuals' performance was not affected on the tasks using inverted faces as compared to their performance on the tasks using upright faces, whereas for non-autistic individuals performance drastically decreased when inverted faces were used (Hobson, Ouston, & Lee, 1988; Tantam, Monaghan, Nicholson, & Sterling, 1989). Additional evidence documenting differences in processing of upright and inverted faces comes from neurological studies. For instance, individuals with autism were shown to exhibit longer latencies to face stimuli and failure to demonstrate differential brain activity to inverted faces as assessed by event related potential (ERP) in adolescents and adults with autism and non-autistic controls of comparable age and nonverabal ability (McPartland et al, 2004). In addition, adults with autism were found to respond slower and show a bias in favor of local information (Behrmann, Avidan, Leonard, Kimchi, Luna, Humphreys, & Minshew, 2006) and children with autism who were better at the emotion recognition task were found to make more global responses on the global-local task (Gross, 2005).

The tendency to rely on featural processing was demonstrated in a sample of adults with autism using an innovative face priming paradigm (Lahaie, Mottron, Berthiaume, Jemel, Arguin, & Saumier, 2006). The newly learned faces was either primed by one, two, three or four face parts, being either natural (i.e., eyes, mouth, nose) or arbitrary parts (i.e., face parts containing partial information on two or more facial features). The results showed similar priming effect with the two types of face segmentation in both autistic and control groups with a greater accelerating priming function when increasing the number of natural than arbitrary parts in the primes. Interestingly, in the natural part priming condition, autistic participants displayed a consistent priming effect for single face parts while participants without autism did not. The findings were interpreted to suggest an enhanced processing for individual face parts in individuals with autism as evidenced by the superior effect of a single natural facial part on recognition speed.

Similarly, an impaired performance on the emotion recognition tasks but not on the neutral expression recognition task was found in children with autism as compared to the children with Down Syndrome and non-autistic children in a study utilizing a delayed-matching task (Celani, Battacchi, & Arcidiacono, 1999). In contrast to the typical matching task, in the delayed-matching task the target picture was made unavailable after a brief exposure. This task was thought to minimize featural processing such that face-stimuli could not be directly compared to one another (e.g., use shape of the mouth to match the picture). Although, there was no direct comparison condition with a typical matching task to indicate whether the differences found were due to featural processing deficit per se.

Taken together, some but not all of past research demonstrates an emotion recognition deficit among individuals with autism. Although, it is suggested that the failure to demonstrate significant differences in performance between autistic and non-autistic individuals should not be taken as a sign of normal abilities for emotion recognition. Rather, these seemingly normal abilities to recognize emotions should be attributed to a use of atypical face processing mechanism such as reliance on featural instead of configural information while viewing a face.

Situational Cues and Facial Expression in Autism Spectrum Disorder

Very few studies have looked at the autistic children's use of situational cues to infer information about emotional states of others. Autistic individuals have been shown to experience difficulties with tasks that require them to match facially expressed emotions with emotions conveyed via situational or other cues of emotion (Hobson, 1986; Fein, Lucci, Braveman, & Waterhouse, 1992; Macdonald, Rutter, Howlin, Rios, Le Coneur, Evered, & Folstein, 1989). For instance, Fein and her colleagues (1992) examined an ability to understand the context in which a given emotion is usually expressed in a sample of children with pervasive developmental disorders (PDD), including children with autism and children with PDD-NOS (not otherwise specified). Children were presented with pictures of various emotion situations such as a girl eating an ice cream cone or a dog jumping on top of a boy, in which the face of the person in the picture was covered. Children were asked to identify an emotion that the person in the picture would be feeling. Results revealed that while as a group children with PDD did not differ from verbally and non-verbally matched controls, children with autism did worse as compared to children with PDD-NOS. These findings suggest that this impairment might be specific to autism disorder. Additionally, when high functioning autistic adults were asked to match photographs of facial expressions with photographs of situations designed to elicit these emotions (e.g., happy expression matched with a picture of a mother playing with a baby) they performed worse as compared to an age matched normal control group (MacDonald et al., 1989).

Nevertheless, children with autism have been shown to understand the context in which they can experience certain emotions. For instance, it has been demonstrated that children with autism have a good understanding of the significance of the presence or absence of the audience in a situation with the potential for embarrassment (Hillier & Allinson, 2002), and empathy (Yirmiaya, Sigman, Kasari, & Mundy, 1992). Furthermore, when asked to recount personal experiences, children with autism had no difficulty recounting experiences of happy, sad, angry emotions and providing contextual details about these events (Capps, Yirmiya, & Sigman, 1992). Although, children were not as detailed and elaborate in their recount of more complex emotional events such as events when they felt proud or embarrassed. Capps et al., (1992) attributed children's success with simple experiences to use of cognitive strategies. Specifically, the children were unable to rely on their own subjective experiences to discuss simple emotional experiences instead they have learned which events may lead to certain emotional experiences and used these prototypical scenarios to describe when they felt happy or sad. In general, these studies provide evidence that autistic children perform less well than would be expected for a given mental age on tasks designed to assess the ability to recognize and coordinate facial expressions with other cues as a means to identify others emotions. However, the pattern of the performance is still unclear. For example, these studies have not established whether children with autism rely more on facial features or situational cues when given multiple sources of information.

Specific Aims of the Study

Research Questions

The difficulty in recognizing and interpreting emotions is one of the salient clinical characteristics of social deficit in individuals with autism. The present study focused on the emotional aspects of social deficit, specifically the effects of eye-gaze direction, emotion intensity, and situational cues in perception of facially communicated emotion in children with autism and typically developing children.

Current research suggests that inability to perceive facially expressed emotions stems from atypical scanning patterns of the face. In particular, it has been demonstrated that individuals with autism spent less time looking at the upper part of the face (e.g., eye area) and spend more time looking at the lower part of the face (mouth area). The eye area of the face conveys a vast amount of information about the expressed emotions and is crucial in the ability to recognize emotion. Recent work by Adams and Kleck (2005) suggests that eye-gaze direction enhances the perception of emotion when the gaze direction matches the underlying behavioral intent communicated by a specific emotion expression. Specifically, anger and joy communicate approach orientation, whereas fear and sadness share an avoidance orientation. Thus, direct gaze enhances the perception of anger and joy expressions, while averted gaze enhances the perception of fear and sadness. The present study adds to the existing body of research by addressing the following questions:

1. Does eye-gaze direction enhance perception of facially communicated emotion, at 50% and 100% intensity, when gaze direction matches the underlying behavioral intent in a sample of children with autism spectrum disorder and typically developing children? Does eye-gaze direction affect interpretation of neutral facial expression?
2. Is there a difference in the perception of intensity of facially communicated emotions as a function of eye-gaze direction?

Despite the importance of situational cues in recognition and interpretation of others' emotional states, relatively little research has been done exploring the way autistic individuals use situational cues and coordinate these cues with facial expressions. There are several reasons to predict that autistic individuals may demonstrate difficulty understanding situational cues in judging of others' emotions. First, some researchers have found that individuals with autism demonstrate specific difficulties on tasks which require them to infer others thought or feelings (e.g., Baron-Cohen et al., 1995), abilities that are integral to the development of understanding of any social interaction. Second, few studies have demonstrated that individuals with autism have difficulty matching facial expressions to appropriate situations that most likely elicit these emotions. Although past studies found that in typically developing children reliance on situational cues increases with age, while reliance on facial expression decreases when situational and facial cues are conflicting, no research has investigated whether that is the case in children with autism. The present study further explored these issues, addressing the following questions:

3. Are there differences between typically-developing children and children with autism in the use of facial and situational cues in recognition of emotions when situational cues are congruent or incongruent with facial cues?
4. Are there differences between typically-developing children and children with autism in recognition of emotions when only situational cues are provided?

Hypotheses

Hypothesis I: Provided with an opportunity to categorize facially expressed emotions with direct or averted eye-gaze, it was hypothesized that non-autistic children will demonstrate a facilitation effect of the *direct* eye-gaze for angry and happy emotions and facilitation effect of *averted* eye-gaze for fear and sad emotions. If individuals with autism have an eyes processing deficit, then it is reasonable to expect that autistic children in the present study will not show these facilitation effects.

Hypothesis II: It was expected that the eye-gaze direction will modulate perception of intensity of facially communicated emotions in typically developing children only. Specifically, the ratings for intensity levels are expected to be higher for angry and happy expressions with direct eye-gaze and fear and sad expressions with averted eye-gaze for the non-autistic group as compared to autistic group.

Hypothesis III: As compared to typically developing children, children with autism were predicted to evidence less accuracy when asked to identify emotions from situational cues alone. In addition, it was anticipated that autistic children will rely on facial cues in identifying emotions when presented with conflicting facial and situational cues whereas typically developing children will show tendency to categorize emotions based on situational cues.

CHAPTER THREE

METHOD

Participants

A sample of 86 typically developing children and a group of 28 high-functioning autistic children were enrolled in this study. The sample of typically developing children was recruited through local elementary schools in greater Chicago area. Only children who were enrolled in normal, age appropriate classrooms were considered. With approval from school principals obtained through principal consent forms (Appendix A), children were sent home with a packet of information including a detailed description of the study and a copy of the parent consent (Appendix B). Parents who wished for their children to participate were asked to review provided information, sign the consent form, and return the signed form to the school.

Children with autism spectrum disorder were identified through specialized schools, clinical centers, and cooperating parent organizations in Chicago, Sterling, Rockford, and central Illinois as well as greater Cleveland area, Ohio. Over 40 organizations were contacted with an initial letter of introduction that included information about child's eligibility profile (Appendix C). The letter specified that children who have a prior clinical diagnosis of autism spectrum disorder, the IQ performance score of greater than 75, the verbal mental age (VMA) at or above 5 years, and whose primary language is English were eligible to part take in the study. In addition, as part of the procedure, schools and centers were notified that in order to participate in the study, the school and the parent would need to consent to a release of clinical diagnosis and testing records for each child. Once the approval of the principal/director was obtained, the investigator provided schools with parent permission letters to distribute to families whose child matched the profile (Appendix D). Parents who agreed to participate were asked to sign the form and send it to their child's school.

Out of the 28 children with autism, data from six participants were not included in the final analyses. Specifically, one child relocated before the investigator could complete the procedure. Two of the children were not able to complete one or more tasks due to inability to sustain attention. A fourth child appeared to guess without paying attention as was evident by the fact that the child looked away during most of the procedure. Finally, two children became frustrated during the procedure and the investigator had to stop the procedure. Upon the researcher's return the following day, both children refused to complete the study. It is important to note that the two children became upset not as a direct result of the task, but other unrelated matters. Consequently, 22 children with autism (17 males, and 5 females) were matched to typically developing children on chronological age and gender.

Assessment. Demographic data for each sample are given in Table 1, including mean chronological age (CA) and verbal mental age (VMA). Verbal mental age was obtained from age equivalent scores from the Peabody Picture Vocabulary Test administered by the investigator (PPVT-III; Dunn & Dunn, 1981). The Peabody Picture Vocabulary Test is a commonly used receptive language abilities assessment that asks children to identify a picture (one of four per page) that describes the target word uttered by the researcher. In addition, Table 1 provides mean Performance IQ and mean Social Responsiveness Scale scores for autistic children only. Standardized Performance IQ scores were taken from clinical/testing records provided by each school. The majority of autistic children (n =16) had been administered WISC-III by a licensed professional within a year of the present study. Two children had been administered Ravens Color Block Design test to assess their non-verbal abilities. Two children had been tested two years prior to the study and did not have current records. Clinical diagnosis of Autism Spectrum Disorder was obtained from children's clinical records provided by each organization.

The Social Responsiveness Scale (SRS; Constantino, 2005) was used as a quantitative measure of autistic traits. The SRS is a 65-item questionnaire designed to assess social awareness, social information processing, capacity for reciprocal social communication, social anxiety/avoidance, and autistic preoccupations and traits. It is appropriate for use with children from 4 to 18 years of age. Total score alpha reliability coefficient was established at .90 and median .85 for subscales. Each parent was asked to complete the scale. On average children were evaluated to have moderate to severe levels of social impairment.

Table 1

Means and Standard Deviations for Chronological Age, Verbal Mental Age, Performance IQ, and Social Responsiveness Scale for Typically Developing and Autistic Children

	M	SD	Range
Chronological Age			
TDC	9.96	1.42	8.08-12.33
AC	10.31	1.69	8.00-12.34
Verbal Mental Age			
TDC	10.64	1.67	8.33-14.50
AC	9.32	1.59	7.16-13.41
Performance IQ			
AC	102.68	10.88	75-121
Total SRS[a]			
AC	154.91	16.40	130-189

Note. TDC = Typically Developing Children. AC = Autistic Children. [a] Social Responsiveness Scale.

Procedure

Each participating child was removed from the class at the time specified by the school and tested individually in a quiet area of the school. A school professional (e.g., teacher, nurse, aid) was present at each session when the researcher was working with autistic children. The experimental procedure took approximately 40 minutes for the non-autistic child to complete. For autistic children, the experimental procedure was divided into two sessions. The first session consisted of the Emotion Recognition Task and the Intensity Rating Task, and the second session consisted of the Emotion Situation Task and administration of the PPVT. The procedure for each experimental task is outlined below.

Emotion Recognition Task

Materials and design. Facial expressions of happy, sad, angry, fear and neutral emotions of six adult Caucasian actors (6 males and 6 females) were selected from the MacBrain Face Stimulus Set[1]. Based on Hess, Blairy, and Kleck procedure (1997), the neutral and the intense emotional expression from the same person were combined using Morph X software. This morphing procedure created intermediate expressions between the neutral (0% emotion strength) and the full emotional display (100% emotion strength). For each emotion, the morphed intermediate expression represented 50% of the pattern of relevant muscle movements away from the neutral toward the full

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[1] Development of the MacBrain Face Stimulus Set was overseen and supported by the John D. and Catherine T. MacArthur Foundation on Network on Early Experience and Brain Development.

emotional expression (see Appendix E). In addition to the neutral expression, two levels, 50% and 100% emotion strength, were used in this task.

Utilizing Adobe Photoshop software, the face stimuli with direct eye-gaze were manipulated to display averted eye-gaze. Direction of lateral gaze shift (right or left) was randomly assigned for each averted gaze face (Appendix E). Each participant was presented with a set of 60 black-and-white photographs of facial expressions. Forty eight photographs included happy, sad, angry and fearful expressions at 50% and 100% emotion strength, each with directed and averted eye-gaze, and 12 neutral faces with direct and averted eye-gaze. There were a total of 12 facial expressions per each emotion. The direction of the eye-gaze and emotion strength were counterbalanced such that photographs with direct and averted eye-gaze and 50% and 100% emotion strength did not appear back to back. Four different sets were created to control for possible order effects.

A categorization procedure in which children identified how the person in each picture felt was used. The task started with two practice items in order to assure that children understood the nature of the task. After the successful practice trials, each child was presented with the rest of the set one card at a time. After presenting participants with a photograph, the researcher asked: "*How do you think this person feels?*" Following by presentation of a Response Panel of schematic faces with verbal labels and pointing to each face and uttering: "*Does she/he feel happy, sad, angry, scared or just ok?*" The display of the schematic faces was counterbalanced in order to control for biases due to a preference of a particular position (e.g., central position versus lateral). The child was allowed to either point to a schematic face or verbally state the answer.

Intensity Rating Task

Materials and design. A subset of 18 pictures was selected from the original previously used set in the emotion recognition task. Two expressions were used as practice items. Sixteen experimental stimuli included four emotional expressions (happy, sad, angry, and fear) at 50% and 100% of their emotion strength, with direct and averted eye-gaze.

Each participant was asked to judge the level of intensity of the presented facial stimuli on a 4-point scale. Similar to the Hoffner and Badzinski (1989) rating scale, four circles, increasing in size were labeled, a *little bit [happy, angry, sad, scared*], *pretty [happy, angry, sad, scared*], *very [happy, angry, sad, scared*], and *very very [happy, angry, sad, scared*]. Each picture was presented one at a time. Participants were given as much time as they needed to accomplish this task.

Situation Cue Task

Materials and design. Twelve pictures of affect-laden situations were drawn by a professional artist. The situations corresponded to 4 emotions: happy, sad, angry, and scared. Six pictures featured a female character and 6 pictures a male character (see Appendix F). Three sets of 4 pictures corresponding to each of the four emotions were created (based on Fein, Lucci, Braverman, and Waterhouse, 1992). The first set consisted of congruent clues in which the character's expression was consistent with the depicted situation (e.g., child is smiling opening a present). The second set included incongruent clues in which the character's expression was inconsistent with the depicted situation (e.g., child is frowning eating ice cream). The third set included situation cues only, in which a child was shown with no facial features. The stimuli set of 12 pictures was in color, printed on an 8 x 11- inch paper, and laminated.

Each participant was tested under three conditions: (1) the facial expression of the character was visible, and is congruent with the situation, (2) the facial expression of the character was visible but incongruent with the situation depicted in the picture, and (3) the facial expression the character was not visible to the participants. The conditions were counterbalanced to avoid any order effects. All pictures were accompanied by a brief narrative describing the situation. Upon presentation of the picture, the researcher described the situation and then asked the child to identify the emotion. For each condition, the instructions were as follows: "*Look, the boy/girl is doing X (e.g., eating ice cream). How does she feel?*" For the no face condition, the instructions were: "*Look, the boy/girl is doing X. His/her face is covered so you can not see it. If you could see it, how would she/he feel? Would she be feeling happy, sad, angry, or scared?*" The same Response Panel used in the Emotion Recognition Task was used to facilitate non verbal responses. Children were allowed to either give verbal or nonverbal responses.

CHAPTER FOUR

RESULTS

Preliminary Analyses

Data Screening

In order to ensure subsequent adequacy of inferential procedures, data were checked for missing values, outliers and normality of distribution of values. Standardized scores for each variable were examined and no univariate outliers were detected (*zs* < 3.29, *p* > .001; Tabachnik & Fidell, 2007). Frequency analysis, used to examine the distribution of values, indicated that *Happy 100% Averted Eye-Gaze* (skewness = -2.39, *SD* = .49) and *Angry 100% Averted Eye-Gaze* (skewness = -2.9, *SD* = .49) variables were modestly negatively skewed. Any subsequent transformations made the variables moderately positively skewed, offering no advantages to the transformations. Subsequently, raw scores for both variables were used in the analysis.

Prior research has suggested that recognition of emotions might be related to the overall development of verbal ability (e.g., Loveland et al., 1997). Verbal mental age was obtained from age equivalent scores from the Peabody Picture Vocabulary Test (PPVT-III; Dunn & Dunn, 1997). Results of the independent- samples t-test revealed significant differences in verbal mental age between typically developing and children with autism, $t(42) = 2.69$, $p < .05$. In order to account for the effects of verbal ability, secondary to the analysis of variance (ANOVA), analysis of covariance (ANCOVA) was used with verbal mental age (VMA) as a covariate. The appropriateness of the analysis of covariance was established by examination of the homogeneity of regression assumption, achieved by looking at the Diagnostic Group x VMA interaction (SPSS Inc, 1999). The homogeneity of regression assumption requires that both non-autistic and autistic groups have the same relationship between the covariate and the performance or dependent variables (Tabachnik & Fidell, 2007). The results showed no violation of the assumption as evidenced by the non-significant Diagnostic Group (Typically Developing, Autism) x VMA interactions (Fs $(1, 40) = .08 – 1.25$, $p \geq .41$). Controlling for verbal mental age did not modulate findings that were obtained from the analysis of variance, indicating that verbal mental age may not affect performance on recognition of facially expressed emotions. Consequently, results of ANOVA and unadjusted group means are reported in the following analyses.

Main Analyses

Children's Ability to Recognize Facially Expressed Emotions: The Effects of Emotion Strength and Eye-Gaze Direction

In order to investigate whether eye-gaze direction influenced recognition of facially expressed emotions in children with and without autism, four different emotional states (happy, sad, angry, and fear) were investigated. Each emotional expression was examined in combination with two levels of emotion strength (50% and 100%) and two eye-gaze orientations (direct and averted). The total number of correct responses (or accuracy) across emotion type, emotion strength, and eye-gaze orientation served as the dependent variable. Additionally, to establish that children selected emotion labels to each facial expression at above the chance rate, goodness of fit χ^2 tests were utilized. Results indicated that children were not choosing emotions based on chance alone (χ^2 (4, N = 44) = 13.50 – 113.27, $p < .001$). Based on previous research (e.g., Adams & Kleck, 2005) it was expected that for typically developing children, averted eye-gaze would facilitate recognition of sad and fear emotions, whereas direct eye-gaze would facilitate recognition of happy and angry emotions especially in the case of ambiguous emotional expressions (at 50% emotion strength). The effect of eye-gaze orientation was not anticipated for children with autism.

Children's mean total accuracy scores for each emotion type, across emotion strengths and eye-gaze directions are shown in Table 2. A mixed 4 (Emotion Type: Happy, Sad, Angry, Fear) x 2 (Emotion Strength: 100%, 50%) x 2 (Eye-Gaze Direction: Direct, Averted) x 2 (Diagnostic Group: Typically Developing, Autism) analysis of variance (ANOVA), with diagnostic group as a between-subject factor, and emotion type, emotion strength and eye-gaze direction as within-subject factors, was conducted. However, when there are more than two levels of the within-subject factor, analysis of variance requires that variance and covariances across all levels of the repeated factor are homogenous, also known as the sphericity assumption (Tabachnik & Fidel, 2007). In order to bypass the assumption of sphericity, a multivariate criterion of Wilks' lambda (Λ) was used to test the main effects and the interactions. All post hoc pairwise comparisons used Bonferroni approach to control for familywise error rate.

The analysis revealed a significant Diagnostic Group x Emotion Type x Emotion Strength x Eye-Gaze Direction four-way interaction, $\Lambda = .80$, F (3, 40) = 3.15, $p < .04$, partial $\eta^2 = .21$. First, pairwise post hoc comparisons were conducted to investigate between-group differences. Typically developing and autistic children did not differ in their ability to correctly identify happy and angry emotional expression at 100% strength with direct and averted eye-gaze, *F*s(1, 42) = .55 – 1.21, *p* > .05. In contrast, the ability to identify fear at 100% strength with direct and averted eye-gaze, and sadness at 100% with direct eye-gaze, was significantly worse in autistic children than their typically developing peers, *Fs* (1, 42) = 4.16-4.68, *p* < .05. In addition, there were no differences between the performance of typically developing and autistic children in the case of 50% strength facial expressions of all four emotions with direct and averted eye-gaze, *F*s(1, 42) = .78 – 3.84, *p* > .05.

Second, pairwise post hoc comparisons examined how eye-gaze direction affected accuracy of recognition across four emotions within each group. The effect of eye-gaze orientation on emotion recognition of facial expressions for typically developing and autistic children at 100% emotion strength is illustrated in Figure 1and at 50% emotion strength in Figure 2. As demonstrated in Figure 1 and 2, a different pattern of findings emerged within each group. Specifically, at 100% of emotion strength, eye-gaze orientation did not influence recognition of happy, sad, and fear emotions, *F*s (1, 42) = .01-1.14, *p* > .05, among both typically developing and autistic children. Expressions of anger, were recognized significantly better when presented with averted versus direct eye-gaze, in typically developing children, *F* (1, 42) = 13.88, *p* < .01. A similar trend was observed for autistic children, although, the mean difference did not reach statistical significance, *p* < .07. When emotional expressions were presented at 50% of their strength, typically developing children were better at recognizing expressions with averted as compared to direct eye-gaze in case of happy (F (1, 42) = 10.86, $p < .001$), sad (F (1, 42) = 13.40, $p < .001$), and fear (F (1, 42) = 6.32, $p < .02$) emotions, and no effect of averted eye-gaze was found for angry expressions, F (1, 42) = .44, $p > .05$. Children with autism benefited from averted eye-gaze in the case of happy expressions, F (1, 42) = 32.57, $p < .001$, as they were more likely to identify averted than direct eye-gaze expressions correctly. It appears that eye-gaze orientation did not facilitate recognition of angry, sad and fear emotional expressions in children with autism.

A main effect of Emotion Strength was also observed, $\Lambda = .85$, F (1, 42) = 21.56, $p < .001$, partial $\eta^2 = .81$. As expected, children across groups identified emotions at 100% of their strength with greater accuracy ($M = 2.38$, $SD = .08$) than emotions at 50% of their strength ($M = 1.53$, $SD =.05$). A significant Emotion Type x Emotion Strength x Eye-Gaze Direction, $\Lambda = .69$, F (3, 40) = 6.12, $p < .002$, partial $\eta^2 = .32$, further revealed that for facial expressions with direct eye-gaze, children across both groups identified all four emotions at 100% strength with greater accuracy than these emotional expressions at 50% strength, Fs (1, 42) = 11.23-54.79, $p < .001$. When facial expressions with averted eye-gaze were presented, both autistic and non-autistic children recognized sadness and anger at 100% strength significantly better than 50% strength, Fs (1, 42) = 19.23-23.79, $p < .01$. However, children's performance did not significantly differ for 100% versus 50% emotion strength expressions of happiness and fear with averted eye-gaze, Fs (1, 42) = .33-6.2, $p > .05$.

Table 2

Mean Total Accuracy Scores for Happy, Sad, Angry, and Fear Emotional Expressions as Function of Emotion Strength and Eye-Gaze Direction

	Typically Developing Children					
	100% Emotion Strength			50% Emotion Strength		
	Direct	Averted		Direct	Averted	
Happy	2.68(.10)[d]	2.78(.13)	*2.73(.11)*	1.70(.15)[c,d]	2.37(.18)[c]	*2.04(.17)*
Sad	2.36(.19)[a,d]	2.31(.22)[e]	*2.14(.21)*	.68(.15)[c,d]	1.46(.24)[c,e]	*1.07(.20)*
Angry	2.36(.14)[c,d]	2.83(.13)[c,e]	*2.60(.14)*	1.27(.17)[d]	1.38(.17)[e]	*1.33(.17)*
Fear	2.50(.20)[a,d]	2.27(.18)[a]	*2.39(.19)*	1.64(.21)[c,d]	2.18(.21)[c]	*1.91(.21)*
Total	*2.48(.16)*	*2.55(.17)*	*2.47(.16)*	*1.32(.17)*	*1.85(.20)*	*1.58(.19)*
	Autistic Children					
Happy	2.90(.11)[d]	2.72(.13)	*2.81(.12)*	1.54(.15)[c,d]	2.64(.18)[c]	*2.09(.17)*
Sad	1.78(.17)[b,d]	2.00(.21)[e]	*1.89(.19)*	.91(.15)[d]	1.05(.15)[e]	*.98(.15)*
Angry	2.40(.14)[d]	2.68(.13)[e]	*2.54(.14)*	1.23(.14)[d]	1.50(.14)[e]	*1.37(.14)*
Fear	1.86(.19)[b,d]	1.68(.18)[b]	*1.77(.19)*	1.36(.20)[d]	1.55(.24)	*1.46(.22)*
Total	*2.24(.15)*	*2.27(.16)*	*2.25(.16)*	*1.26(.16)*	*1.69(.18)*	*1.47(.17)*

Note. Total accuracy scores can range from 0-3. [a, b] Superscripts indicate significant between-group differences, $p \leq .05$; [c-c] Superscripts indicate significant within-group differences (direct vs. averted eye-gaze), $p \leq .05$. [d-d, e-e] Superscripts indicate significant within-group differences (50% vs. 100% emotion strength). Standard deviations are in parentheses.

Figure 1

Effects of Eye-Gaze Direction on Recognition of Facial Expressions at 100% Emotion Strength for Typically Developing and Autistic Children

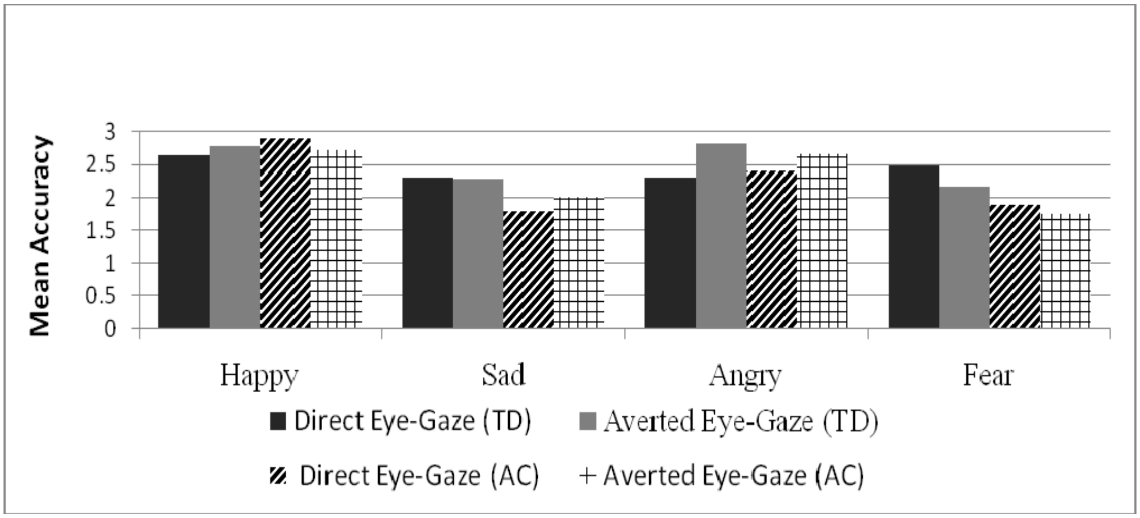
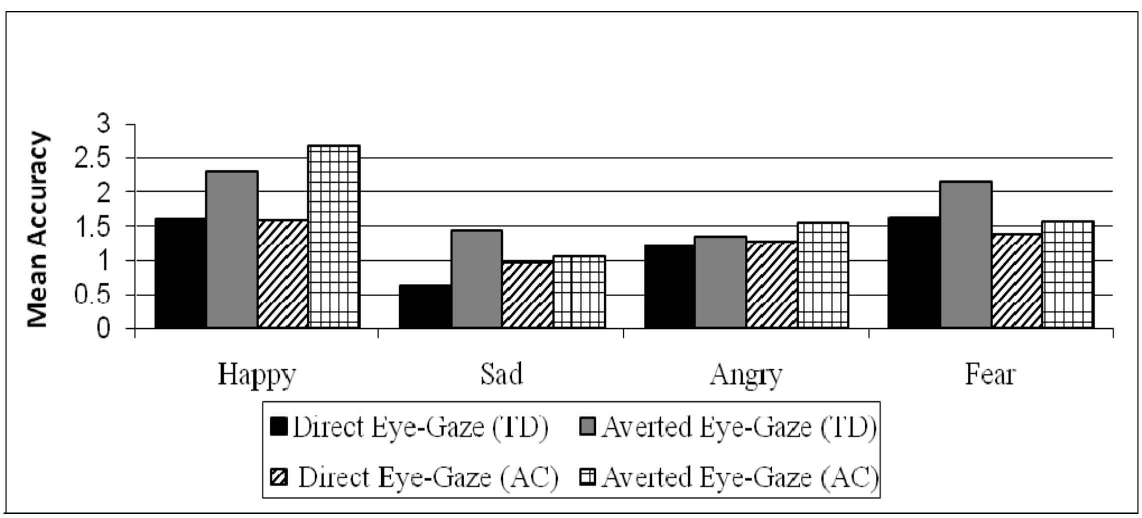


Figure 2

Effects of Eye-Gaze Direction on Recognition of Facial Expressions at 50% Emotion Strength for Typically Developing and Autistic Children



Interactive effects of Diagnostic Group x Emotion Type, $\Lambda = .79$, $F\ (3, 40) = 3.01$, $p < .04$, partial $\eta^2 = .18$ were also found. The ability of children with autism to recognize emotion of sadness and fear was significantly worse than their typically developing peers ($Fs\ (1, 42) = 4.9 - 5.18$, $p < .05$), see Table 3. No group differences were observed for happy or angry emotions ($Fs\ (1, 42) = .04 - .18$, $p > .05$). In addition, within-group pairwise comparisons revealed that typically developing children identified happy emotional expression with significantly greater accuracy than emotions of sadness and anger, but not fear, $F\ (3, 40) = 15.89$, $p < .001$. Autistic children were better at recognition of happy expressions than emotions of sadness, anger and fear $F\ (3, 40) = 27.68$, $p < .001$.

Table 3

Mean Total Accuracy Scores for Happy, Sad, Angry, and Fear Emotional Expressions Averaged Across 100% and 50% Emotion Strengths for Typically Developing and Autistic Children

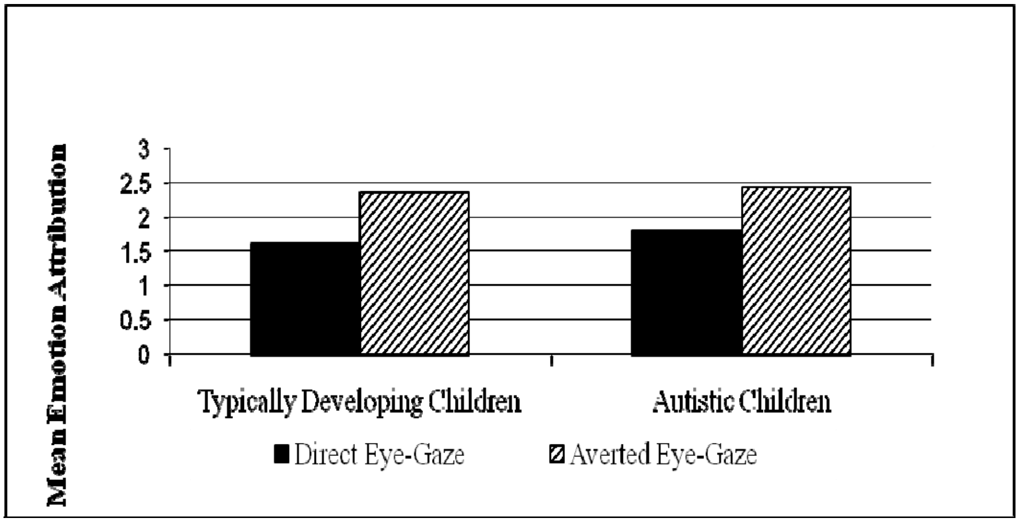
	Happy	Sad	Angry	Fear
Typically Developing Children	2.38(.10)	1.70(.11)[a]	1.97(.09)	2.15(.17)[a]
Autistic Children	2.43(.10)	1.43(.12)[b]	1.96(.09)	1.61(.17)[b]

Note. Accuracy scores ranged from 0-3. Standard errors are in parentheses. Different letter superscripts indicate significant between-group differences (typically developing vs. autistic children), $p \leq .05$.

Attribution of Emotional State to Facial Expressions at 50% Emotion Strength. In the previous analysis, accuracy responses were used to investigate whether eye-gaze direction facilitated recognition of emotional expressions. In order to further examine the effect of eye-gaze orientation on identification of ambiguous (50% strength) facial expressions in typically developing and autistic children, the dependent variable was recoded. Children's responses were recoded from *accuracy scores* to the *number of emotion labels* assigned across each emotion type. Specifically, responses were coded as 0- *no emotion (neutral)* and 1- *other emotion labels* for each facial expression. A total score was derived by totaling responses. Significance was tested with a mixed 4 (Emotion Type: Happy, Sad, Angry, Fear) x 2 (Eye-Gaze Direction: Direct, Averted) x 2 (Diagnostic Group: Typically Developing, Autism) analysis of variance (ANOVA), with diagnostic group as a between-subject factor, emotion type and eye-gaze direction as within-subject factors. No differences were found between autistic and non-autistic children, F (1, 42) = 1.06, $p \geq .30$. A main effect of Eye-Gaze Direction, $\Lambda = .66$, F (1, 42) = 80.13, $p < .003$, partial $\eta^2 = .21$, was significant, indicating that typically developing and autistic children alike labeled ambiguous (50% strength) emotional expressions with direct eye-gaze as expressing emotion less often than these expressions with averted eye-gaze (see Figure 3).

Figure 3

Attribution of Emotion Label vs. No Emotion Label to Facial Expressions with Direct or Averted Eye-Gaze for Typically Developing and Autistic Children



Autistic children were affected by the averted eye-gaze orientation, as they were more likely to assign an emotion label to facial expressions with averted eye-gaze than direct eye-gaze, at least at 50% emotion strength. Children in both groups benefited from averted eye-gaze in identifying happy emotional expression, as they identified averted eye-gaze expressions with greater accuracy than direct eye-gaze stimuli.

Children's Attribution of an Emotional State to Neutral Facial Expressions

Of interest was whether children would be more likely to attribute an emotional state to neutral facial expressions with averted eye-gaze than with direct eye-gaze orientation, as well as the potential group differences of this effect between children with and without autism. Six neutral expressions with direct and six neutral expressions with averted eye-gaze were first coded for accuracy with 1- *neutral* and 0- *other emotion* *labels*, then combined to result in the total composite scores with a range of 0-6. A mixed 2 (Diagnostic Group: Typically Developing, Autism) x 2 (Eye-Gaze Direction: Direct, Averted) analysis of variance (ANOVA), with diagnostic group as a between-subject factor and eye-gaze direction as a within-subject factor, was performed. A main effect of Diagnostic Group was significant $F(1, 42) = 4.21$, $p < .05$, showing that, regardless of the eye-gaze orientation, typically developing children were more accurate in identifying neutral expressions ($M = 5.21$, $SD = 1.31$) than children with autism ($M = 4.14$, $SD = 1.31$). No interactive effects of eye-gaze direction and diagnostic group were found, $F(1, 42) = 1.70$, $p > .05$, indicating that autistic children were as likely to attribute emotional state to a neutral expression with direct and averted eye-gaze as their typically developing peers.

Error Analysis in Recognition of Facially Expressed Emotions. To examine the type of errors children made when identifying facial expressions of happy, sad, angry, fear, and neutral faces, error analyses were conducted. Emotional expressions were analyzed in terms of the frequency with which the target emotion was identified incorrectly. Separate analyses of variance were conducted for errors made when identifying happy expressions (i.e., error: sad, angry, fear, neutral), sad expressions (i.e., error: happy, angry, fear, neutral), angry expressions (i.e., error: happy, sad, fear, neutral), fear expressions (i.e., error: happy, sad, angry, neutral), and neutral expressions (i.e., error: happy, sad, angry, fear). Error data were analyzed using 4 (Error Type) x 2 (Emotion Strength: 100%, 50%) x 2 (Eye-Gaze Direction: Direct, Averted) x 2 (Diagnostic Group: Typically Developing, Autism) with diagnostic group as a between-subject factor and emotion strength, eye-gaze direction and error type as the within-subject factors. All post hoc pairwise comparisons used Bonferroni adjustment to control for familywise error rate.

The analysis of errors made when identifying happy expressions revealed a significant Error Type x Emotion Strength x Eye-Gaze Direction interaction, ($\Lambda = .70$, *F* (3, 40) = 5.10, $p < .01$, partial $\eta^2 = .28$), while no differences in the type of errors children made were found between autistic and typically developing groups, *F* (1, 42) = .63, $p > .05$. Specifically, both typically developing and autistic children were more likely to label happy expressions as neutral when faces were presented at 50% emotion strength with direct eye-gaze (*M* = 1.16, *SD* = .11) rather than averted eye-gaze (*M* = .43, *SD* = .09). A Similar error pattern was observed for angry expressions as indicated by a significant Error Type x Emotion Strength x Eye-Gaze Direction interaction, $\Lambda = .76$, *F* (3, 40) = 4.27, $p < .01$, partial $\eta^2 = .24$. Children in both groups selected the neutral label more often while viewing angry expressions at 50% strength with direct eye-gaze (*M* = 1.34, *SD* = .09) compared to averted eye-gaze (*M* = .81, *SD* = .11).

Differences between typically developing and autistic children were found in the analyses of errors made when identifying sad expressions. A significant interaction between Error Type, Emotion Strength, Eye-Gaze Direction and Diagnostic Group, ($\Lambda = .76$, *F* (3, 40) = 4.19, $p < .01$, partial $\eta^2 = .28$), revealed that autistic children more often confused sad expressions at 50% emotion strength with averted eye-gaze as anger (*M* = 1.18, *SD* = .14) than typically developing children (*M* = .05, *SD* = .41). However, when sad expressions at 50% strength were presented with direct eye-gaze, both typically developing children (M = 1.91, SD = .64) and autistic children (M = 1.55, SD = .45) tended to mislabel them as neutral.

In the case of fear expressions, a significant Error Type x Emotion Strength x Eye-Gaze Direction interaction was found, Λ = .71, F (3, 40) = 5.41, p < .01, partial η^2 = .29. Typically developing children as well as children with autism were more likely to mistake fear expressions for sadness when presented at 100% strength with averted eye-gaze (M = .64, SD = .10) than direct eye-gaze (M = .37, SD = .09) and were more likely to mistake fear expressions at 50% strength with direct eye-gaze as neutral (M = .95, SD =.14) compared to averted eye-gaze (M = .63, SD = .12).

Finally, a significant main effect of Error Type, Λ = .69, F (3, 40) = 5.96, p < .01, partial η^2 = .20, was found when children were viewing neutral expressions. Children across both groups were found to confuse neutral expressions with fear more so than any other emotion.

In sum, compared to typically developing children, children with autism made specific errors when identifying expressions with averted eye-gaze. Autistic children confused anger for sadness when viewing an ambiguous (50%) face; and sadness for fear when viewing full strength (100%) expressions. Across most emotions, children in both groups were more likely to label ambiguous (50%) faces with direct eye-gaze as neutral than the same expressions with averted eye-gaze.

Children's Ratings of the Intensity of Facial Expressions: The Effect of Emotion Strength and Eye-Gaze Direction

Children's ratings of how intense the emotional expressions appeared to them were analyzed. Of issue was whether children's ratings of emotional intensity would vary as a function of emotion type, emotion strength and eye-gaze direction. It was predicted that averted eye-gaze would increase intensity ratings for expressions of sadness and fear, whereas direct eye-gaze would increase intensity ratings for happy and angry expressions in the typically developing sample. Children were asked to rate the intensity of the each emotional expression on a scale of 1-*not at all intense* to 4-*extremely intense*. A mixed 4 (Emotion Type: Happy, Sad, Angry, Fear) x 2 (Emotion Strength: 100%, 50%) x 2 (Eye-Gaze Direction: Direct, Averted) x 2 (Diagnostic Group: Typically Developing, Autism) analysis of variance (ANOVA) was used with children's ratings of intensity as the dependent variable. Multivariate criterion Wilks lambda (Λ) was used because one of the repeated factors (Emotion Type) had more than 2 levels. Bonferroni approach was used to adjust for Type I error in the follow-up post hoc comparisons.

A significant Emotion Type x Emotion Strength x Eye-Gaze Direction interaction was found, $\Lambda = .76$, $F(3, 40) = 4.21$, $p < .05$, partial $\eta^2 = .24$, indicating that both autistic and non-autistic children tended to rate angry expressions at 100% with direct eye-gaze as more emotionally intense than these expressions with averted eye-gaze, $F(1, 42) = 24.71$, $p < .001$, see Table 5. A similar pattern was found for expressions of sadness presented at 50%, as both groups rated these expressions with direct eye-gaze as more emotionally intense than with averted eye-gaze, *F* (1, 42) = 14.21, $p < .001$. There were no differences in children's ratings of intensity for happy or fear emotions.

Table 4

Mean Intensity Ratings for Happy, Sad, Angry, and Fear Emotional Expressions as a Function of Emotion Strength and Eye-Gaze Direction Averaged Across Typically Developing and Autistic Children

	100% Emotion Strength		50% Emotion Strength	
	Direct	Averted	Direct	Averted
Happy	2.84(.16)	2.77(.12)	1.50(.10)	1.75(.14)
Sad	2.52(.13)	2.09(.15)	2.93(.14)[b]	2.16(.14)[b]
Angry	3.21(.10)[a]	2.30(.15)[a]	2.16(.16)	2.46(.16)
Fear	3.18(.13)	2.96(.14)	2.00(.16)	1.86(.13)

Note. [a-a, b-b] Superscripts indicate significant differences, $p \leq .05$. Standard deviations are in parenthesis.

Interactive effects of Diagnostic Group x Emotion Strength, $\Lambda = .76$, *F* (1, 42) = 17.24, $p < .001$, partial $\eta^2 = .31$, and Diagnostic Group x Eye-Gaze Direction, $\Lambda = .88$, *F* (1, 42) = 6.88, $p < .02$, partial$\eta^2 = .14$, were also found. Children with autism tended to rate facial expressions presented at 50% as more intense than their typically developing peers, *F* (1, 41) = 12.7, $p < .001$. Intensity ratings of facial expressions at 100% emotion strength were similar for typically developing and autistic children, see Table 6. Further, both typically developing and autistic children rated 100% strength expressions as more emotionally intense than 50% emotion strength expressions F (1, 41) = 83.45, $p < .001$, F (1, 41) = 12.11, $p < .01$, respectively.

Table 5

Mean Intensity Ratings for Facial Expressions by Emotion Strength for Typically Developing and Autistic Children

	100% Emotion Strength	50% Emotion Strength
Typically Developing Children	2.73(.88)[*]	1.82(.90)[a*]
Autistic Children	2.73(.89)[*]	2.38(.80)[b*]

Note. Standard deviations are in parentheses. Different letter superscripts indicate significant between-group differences (typically developing vs. autistic children), $p \leq .05$; asterisks indicate significant within-group differences, $p \leq .05$

In addition, children with autism gave higher intensity ratings to emotional expressions with direct eye-gaze than children without autism, F (1, 41) = 10.68, $p < .01$, see Table 7. These group differences were not found for expressions with averted eye-gaze, F (1, 41) = .35, $p > .50$, as both groups rated averted eye-gaze expressions the same. Interestingly, within-group comparisons revealed that autistic children perceived facial expressions with direct eye-gaze as more intense than averted eye-gaze, F (1, 41) =

22.39, $p < .001$, whereas no differences in intensity ratings between direct and averted eye-gaze expressions were observed for typically developing children.

Table 6

Mean Intensity Ratings of Facial Expressions by Eye-Gaze Direction for Typically Developing and Autistic Children

	Direct Eye-Gaze	Averted Eye-Gaze
Typically Developing Children	2.36(.08)[a]	2.25(.09)
Autistic Children	2.72(.08)[b*]	2.33(.09)[*]

Note. Intensity ratings ranges from 1 (*Least Intense*) to 4 (*Most Intense*). Different letter superscripts indicate significant between-group differences (typically developing vs. autistic children), $p \leq .05$; asterisks indicate significant within-group differences, $p \leq .05$. Standard deviations are in parentheses.

Group intensity ratings also varied across different emotional expressions, $\Lambda = .69$, F (3, 40) = 5.73, $p < .01$ partial $\eta^2 = .14$. Specifically, children with autism tended to rate expressions of happy and fear emotions as more intense than their typically developing peers, F (1, 42) = 10.32, $p < .01$, F (1, 42) = 10.29, $p < .01$, see Table 8. Examination of simple effects of emotion within each group indicated that typically developing children rated happy facial expression as significantly less intense than emotional expression of sadness and anger, F (3, 40) = 7.93, $p < .001$. There were no differences in intensity ratings between emotions for autistic participants, $F(3, 40) = 2.44$, $p > .05$.

Table 7

Mean Intensity Ratings for Happy, Sad, Angry, and Fear Emotions by Eye-Gaze Direction for Typically Developing and Autistic Children

	Emotion Type			
	Happy	Sad	Angry	Fear
Typically Developing	1.92(.12)[a*]	2.40(.12)[*]	2.50(.13)[*]	2.29(.08)[a]
Autistic Children	2.50(.12)[b]	2.45(.12)	2.56(.13)	2.71(.08)[b]

Note. Intensity ratings can range from 1 (*Least Intense*) to 4 (*Most Intense*). Different letter superscripts indicate significant between-group differences (typically developing vs. autistic children), $p \leq .05$; asterisks indicate significant within-group differences, $p \leq .05$. Standard deviations are in parentheses.

Children's Ability to Recognize Emotion: Effects of Situational and Facial Cues

Of interest was whether typically developing and autistic children would identify emotion from line drawings accurately when presented with situational cues that were congruent with facial cues, incongruent with facial cues, or in the absence of facial cues. Four emotion stimuli (happy, sad, angry, fear) were presented across these conditions. Children's responses to each emotion picture were first coded as 1-*correct* and 0-

incorrect. For the incongruent condition, correct responses were assigned when a child labeled the emotions according to the situational cues and not the accompanied facial expression. As can be seen in Table 9, the majority of typically developing and autistic children were able to correctly identify emotions when situational cues were congruent with facial expression and when situational cues were presented alone.

Table 8

Percentage of Correct Responses for Each Emotion Stimulus across Autistic and Typically Developing Children

	Typically Developing Children	Autistic Children
Congruent Condition		
Happy	91	100
Sad	96	100
Angry	100	87
Fear	96	82
Incongruent Condition		
Happy	91	23
Sad	77	41
Angry	50	9
Fear	82	64
No Face Condition		
Happy	86	96
Sad	82	86
Angry	73	91
Fear	86	100

In order to investigate differences between typically developing and autistic children, responses were combined across four emotion stimuli within each condition to result in a total number of correct responses with a range of 0-4. The mean values and standard deviations are shown in the Table 10. A mixed 2 (Diagnostic Group: Typically Developing, Autism) x 3 (Condition: Congruent, Incongruent, No Face) analysis of variance (ANOVA) with group as a between-subject factor, condition as a within-subject factor was conducted. Results revealed a significant Diagnostic Group x Condition interaction, F (2, 84) = 13.74, $p < .001$, partial $\eta^2 = .30$ and a main effect of Diagnostic Group, F (1, 42) = 21.32, $p < .001$, partial $\eta^2 = .34$. Between-group differences were observed in the Incongruent Condition, F (1, 42) = 22.49, $p < .001$, indicating that children with autism were significantly less likely to use situational cues and relied mostly on the facial cues, whereas typically developing children were more likely to rely on the situational cues in their responses, see Table 10. However, when children were given only situational cues without facial expression, no group differences were found, ($p > .05$). In addition, no group differences were observed in the congruent condition suggesting that for autistic children, these findings are not due to an inability to interpret emotional content given situational cues but due to their preference for facial cues over situational cues when a discrepancy between the two is presented.

Table 9

Mean Total Accuracy Scores for Congruent, Incongruent, and No Face Conditions for Typically Developing and Autistic Children

	Congruent	Incongruent	No Face
Typically Developing	3.82(.09)	3.00(.24)[a]	3.73(.19)
Autistic Children	3.68(.09)	1.36(.25)[b]	3.27(.19)

Note. Total accuracy scores can range from 0-4. [a, b] Superscripts indicate significant between-group differences, $p \leq .05$. Standard deviations are in parenthesis.

Differences in children's responses for the incongruent stimuli were further investigated for each emotion-laden drawing separately (see Table 11). Chi-square analyses revealed significant between-group differences for happy, sad, and angry drawings, χ^{2} (3, $N = 44$) = 9.00 – 20.94, $p < .03$. However, no differences between typically developing and autistic children were observed for the drawing that exhibited fear, χ^2 (4, $N = 44$) = 5.83, $p > .05$.

Table 10

Percentage of Children's Responses for Each Incongruent Emotion Drawing

	Children's Responses				
	Happy	Sad	Angry	Fear	Neutral
Girl Holding a Birthday Gift with a Frown					
Typically Developing Children	91	9	0	0	0
Autistic Children	23	69	4	4	0
Boy Holding Hurt Knee with a Smile					
Typically Developing Children	9	78	0	4	9
Autistic Children	50	41	0	0	14
Girl Holding a Broken Toy with a Smile					
Typically Developing Children	5	45	50	0	0
Autistic Children	45	36	9	0	9
Boy Getting Attacked by Bees with a Smile					
Typically Developing Children	9	9	0	82	0
Autistic Children	13	4	0	72	9

CHAPTER FIVE

DISCUSSION

Autism Spectrum Disorder is a pervasive developmental disorder first appearing in early childhood and characterized by the impairment of social behavior and social relationships (Klin et al., 2005). Individuals with autism exhibit a wide variety of social abnormalities including impairment of eye-gaze following, failure of joint attention interactions, and unresponsiveness to social stimulation (see Volkmar, Chawarska, & Klin, 2005 for a review). Impairment in the recognition of facially expressed emotion is believed to partially account for the social deficit (Hobson, 1986), as facial expressions convey important information about the emotional state, intentions, and motivations of others (Izard, 1991). To date, research on the recognition of facially expressed emotions in individuals with autism has led to equivocal results with a number of studies demonstrating impairment in recognition of several basic emotions (e.g., Ashwin et al., 2006; Davis et al., 1994; Hobson, 1986a), with other studies reporting a specific deficit in recognition of fear (Ashwin et al., 2007; Howard et al., 2000; Pelphery et al., 2002), or no impairment in these abilities (e.g., Balconi & Carrera, 2007; Castelli, 2005; Grossman et al., 2000; Oznoff et al., 1990). It is possible that autistic individuals are worse at recognition of some emotions than others. However, methodological limitations such as investigation of a composite of different emotions (Bolte & Poustka, 2003; Celani, Battacchi, & Arcidiacono, 1999; Da Fonesca et al., 2009) or two opposite valence emotions (e.g., happy vs. angry; Clark, Winkielman, & McIntosh, 2008), renders it difficult to make inferences regarding any one specific emotion.

An emotion recognition problem may be due to the propensity for individuals with autism to ignore the eye region when examining faces (e.g., Dalton et al., 2005; Gross, 2004; Joseph & Tanaka, 2003; Klin et al., 2002; Pelphrey et al., 2002), although not all agree with this assertion (Back, Ropar & Mitchell, 2007; Bar-Haim et al., 2006; Van der Geest et al., 2002). The eye region of the face, and eye-gaze direction in particular, have been found to communicate important information about a person's emotional state, at least in healthy adults (Adams & Kleck, 2005). Yet no empirical studies have investigated how eye-gaze direction is implicated in perception of emotions in children with autism, or for that matter, typically developing children.

The present study investigated two areas of emotion recognition in school-aged high-functioning children with autism and typically developing children, matched on chronological age and gender: (1) recognition of facially expressed emotions that were presented in still photographs of adult faces and (2) emotion recognition from situational and facial cues, presented in line drawings of emotionally-laden situations. For the photograph task, children's accuracy in recognizing facial expressions of happy, sad, angry, and fear emotions along with neutral expressions was investigated. All emotional expressions were presented with computer-generated direct and averted eye-gaze at 100% and 50% emotion strength. Of particular interest were whether eye-gaze direction and emotion strength affect children's interpretation of facially expressed emotions and whether these factors influence perception in a different way for typically developing children than children with autism. Children's own ratings of emotional intensity of photographed facial expressions were also explored in relation to emotion strength and eye-gaze direction. In addition to the photograph task, line drawings depicting scenarios of happy, sad, angry, and fear eliciting events were used to investigate the role situational and facial cues play in emotion recognition, particularly when they were incongruent with one another.

The Effects of Eye-Gaze Direction and Emotion Strength

Recognition of Facially Expressed Emotions

There have been no empirical studies investigating the effect of eye-gaze direction on perception of facially expressed emotions in typically developing or autistic children. The expectations for the present study were guided by the *shared signal hypothesis* (Adams & Kleck, 2005) and the *eyes processing deficit hypothesis* in autism (Baron-Cohen, 1995, Baron-Cohen et al., 2001). The shared signal hypothesis suggests that the way eye-gaze direction influences emotion perception depends on the specific combination of the type of emotion and eye-gaze direction. Specifically, both emotion and eye-gaze orientation are believed to communicate approach or avoidance characteristics of the situation, with averted eye-gaze indicating avoidance and direct eye-gaze indicating approach behaviors. According to this hypothesis, averted eye-gaze should enhance recognition of emotions that match its behavioral intent to avoid such as sadness and fear, whereas direct eye-gaze should enhance recognition of emotions that match the behavioral intent to approach, such as happiness and anger (Adams & Kleck, 2005). The eyes processing deficit hypothesis suggests that individuals with autism do not process information communicated by the eye region of the face when engaged in social interactions, as they have a visual preference for the mouth region of the face (e.g., Dalton et al., 2005; Pelphery et al., 2002). In contrast, typically developing individuals have been demonstrated to focus primarily on the eye region of the face, and more importantly, rely on the information communicated by the eyes for their successful recognition of emotions (e.g., Spezio, Adolphs, Hurley, & Piven, 2007). Derived from these hypotheses, it was expected that for children with autism, recognition and interpretation of facially expressed emotions would not be affected by eye-gaze direction, whereas among typically developing children, eye-gaze direction was anticipated to have an effect as predicted by the shared signal hypothesis.

The results of the present study were mixed. As expected, eye-gaze orientation modulated recognition of emotions and had a less pronounced effect on accuracy of recognition in children with autism. However, the effects of eye-gaze direction were not always in accordance with the shared signal hypothesis and children with autism were found to be sensitive to some extent to the eye-gaze direction. In line with previous research looking at healthy adults, averted eye-gaze was found to enhance recognition of sadness and fear in typically developing children when photographs were presented at 50% emotion strength. Normal adults have been demonstrated to have shorter response latencies and enhanced recognition of sadness and fear with averted eye-gaze in comparison to the same faces with direct eye-gaze (Adams & Kleck, 2003, 2005; Reginald et al., 2003; Sato et al., 2004). The present study is the first to provide support for the facilitative properties of averted eye-gaze in perception of fear and sadness in school-aged typically developing children, at least when perceptual cues of these emotions were ambiguous. Hence, the perceptual characteristics of the behavioral intent to avoid, communicated by the averted eye-gaze in combination with fear and sadness, may start to be observed prior to the middle childhood years.

In contrast, among children with autism, averted eye-gaze was not found to enhance the salience of emotion-related characteristics of sadness or fear. In fact, children with autism had the most difficulty identifying sadness and fear. These findings are consistent with past studies that suggest a deficit in emotion recognition in children with autism (e.g., Hobson et al., 1986a; Mazefsky & Oswald, 2006), particularly in terms of impairment in recognition of negative basic emotions such as distress, fear, sadness and discomfort (e.g., Ashwin et al., 2006; Sigman, Kasari, Kwon, & Yirimiya, 1992). Present findings support the idea that individuals with autism may have a fear recognition impairment; even at a 100% emotion strength, autistic children were found to be significantly less accurate than their typically developing peers in identifying fear, regardless of the eye-gaze direction. It has been suggested that children with autism acquire perceptual expertise when recognizing facial expressions that vary in mouth features but not eye features, as a result of the increased fixation to the mouth region of the face (Klin et al., 2002). Even very young children with autism were demonstrated to be relatively less able than the typically developing cohort to match emotions of humans, dogs, and apes based on the upper face alone, and their error pattern suggested that their primary attention was focused on the lower portion of the face (Gross, 2004). State of fear in particular is believed to be communicated primarily by the eye-region of the face.

Indeed, eye-tracking studies looking at patients with bilateral amygdala damage, suggest that deficit in fear recognition from facial expression stems from a failure to look at the eyes (Adolphs et al., 2005). The fact that autistic children were not better at recognizing expressions of fear with averted eye-gaze as compared to direct eye-gaze, while typically developing children's performance improved significantly, is in support of the presence of different viewing patterns between children with and without autism.

An impaired ability to develop adequate joint attention skills (Kasari, Sigman, Mundy, & Yirmiya, 1990; Mundy, Sigman, Ungerer, & Sherman, 1986), or the capacity to coordinate or share attention with a social partner regarding an object or event (see Mundy & Burnette, 2005), can provide a second explanation for the fear recognition deficit found in children with autism. Expression of fear communicates an indirect threat that is present in the environment that is different from a more immediate threat, such as an angry face (Springer, Rosas, McGetrick, & Bowers, 2007). Learning through joint attention with an adult may be required in order to develop an understanding that an expression of fear is a response to another potentially threatening object in the environment. To some extent, recognition of fear may require the ability to put oneself into someone else's shoes and imagine their thoughts and feelings, also known as a *theory of mind*. In fact, one of the developmental stepping stones to the emergence of an adequate theory of mind is the capacity to engage in joint attention (Mundy et al., 1986; Mundy & Burnette, 2005). Often, children with autism are found to have failure of joint attention skills (e.g., Baron-Cohen, Spitz, & Cross, 1993; Baron-Cohen et al., 2001; Baron-Cohen, 2008) and show impaired abilities on various tasks design to assess theory of mind, such as "false-belief" tasks and deception tasks (e.g., Baron-Cohen, 1992; Baron-Cohen, Wheelwright, Hill, & Plumb, 2001).

In the present study, children with autism were also found to be less accurate than typically developing children in identifying expression of sadness at 100% emotion strength with direct eye-gaze. To date, only one published study has documented a specific deficit in recognition of sadness from both animations and photographs of faces in adults with autism (Boraston, Blakemore, Chilvers, & Skuse, 2007). In this study, autistic adults were compared to typically developing peers matched on chronological age. Both groups were presented with computerized animations featuring an emotional triangle interacting with a circle and an emotion recognition task using conventional facial expressions. Participants were asked to attribute an emotion to the triangle from its pattern of movement in the first experiment, and identify emotions from photographs of facial expressions during the second experiment. Adults with autism were poor at recognizing sadness, but not other emotions, on both tasks. Interestingly, a recent study investigating emotion recognition abilities in mothers and fathers of children with severe autism found that their accuracy performance was significantly worse for emotions of sadness and disgust (Palermo, Pasqualetti, Barbati, Intelligente, & Rossini, 2006). This may suggest a genetic link (Palermo et al., 2006), but may also be indicative of parental socialization of emotion perception skills. It is likely that parents engage in less discourse about emotions with young children with autism than with children without autism due to the presence of more social isolation and language delays (Chamberlain, Kasari, & Rotheram-Fuller, 2006; Klin, 1991; Kjelgaard & Tager-Flusberg, 2001). It is important to note that the autistic children in the present study were not significantly worse than their typically developing peers at identifying sad expressions with averted eye-gaze when presented at 100% emotion strength. This may indicate that averted eye-gaze enhanced autistic children's ability to recognize sadness, although not significantly, but enough to eliminate group differences. It may also suggest that the deficit in recognition of fear found in children with autism was more profound than recognition of sadness.

It is possible that the poor performance on recognition of sadness and fear among children with autism might be due to the general developmental delays that are characteristic of the disorder. Past research with typically developing children has provided evidence that the ability to recognize fear is more difficult, and improves at a slower rate, than children's ability to recognize other basic emotions (Barth & Bastiani, 1997; Boyatzis et al., 1993 Camras & Alison, 1985; De Sonneville et al., 2002; Durand, Gallay, Seigneuric, Tobichon, & Baudouin, 2007; Lenti et al., 1999). For instance, when 4-year-old preschoolers were asked to identify emotions from facial expressions posed by their peers, they recognized fear correctly only 12% of the time, as compared to 40% and 20% for happy and angry emotions respectively (Barth & Bstiani, 1997). In fact, researchers eliminated expressions of fear from the final analysis due to such a low response rate (Barth & Bastiani, 1997). This difficulty has been linked to a limited exposure to, and experience with, threatening external events among children in modern western cultures. In addition, there is evidence to suggest that sadness may also be a challenging emotion for children to identify due to its lack of distinctive facial features

(De Sonneville et al., 2002). Facial expression of sadness is often found to be confused with neutral expressions, as was the case with the ambiguous stimuli with direct eye-gaze in the present study. Unlike fear, the accuracy of processing sad emotions has been found in past studies to improve fairly rapidly with age, with children as young as 10 years old demonstrating adult-like abilities (De Sonneville et al., 2002).

In contrast to studies that have shown direct eye-gaze to enhance recognition of anger and happiness in adults (e.g., Adams & Kleck, 2003, 2005), beneficial effects of direct eye-gaze were not observed in the present research. In fact, the findings suggest that averted, and not direct, eye-gaze amplifies the perceptual salience of emotion-related cues in the happy and angry faces as averted eye-gaze improved recognition of these emotions. Specifically, both typically developing and autistic children were better at identifying happy expressions (at 50% strength) with averted than direct eye-gaze. Typically developing children were also more accurate in their recognition of angry expressions (at 100% strength) with averted than direct eye-gaze, and a similar trend was observed but did not reach statistical significance ($p < .07$) for children with autism. Hence, the function of direct eye-gaze to communicate behavioral intent to approach appears not to be perceived by school-aged typically developing and autistic children. More importantly, despite the tendency to ignore the eye region of a face, the present findings revealed that children with autism are sensitive to the eye-gaze direction. Similar findings were reported in a recent study that examined whether children with autism use information from the eye region while identifying mental states in faces (Back, Ropar, & Mitchell, 2007). Children were presented with dynamic faces displaying various mental states (e.g., worried, surprised, relieved) with some stimuli having eyes, mouth or nose static while the rest of the face moved to form the facial expression. Children with autism were found to be better at recognizing mental states when eyes conveyed information than when this region remained static and neutral.

The results of the present study showed that children with autism were able to recognize expression of anger as well as their typically developing peers. Several models of emotion processing suggest that there are specialized mechanisms responsible for the enhanced processing of threat-related information such as angry faces (e.g., Davis & Whalen, 2001; LeDoux, 1996; Mogg & Bradley, 1998; Ohman, 1996; Pessoa, 2005). Evidence from various paradigms, such as visual search and visual cueing tasks, indicate that angry faces are processed preferentially over neutral and positive emotions (e.g., Calvo, Avero, & Lundqvist, 2006; Ohman et al., 2001; Maratos, Hogg, & Bradley, 2008). Moreover, anger superiority effect was recently demonstrated in high functioning autistic adults in a study using angry and happy schematic faces. In a series of multiple experiments, autistic adults were reported to detect angry faces quicker and more accurately than friendly faces, similar to the control participants (Ashwin, Wheelwright, Baron-Cohen, 2006). These results were interpreted to suggest that the rapid and automatic processing of social threat may be intact in people with autism. This may explain why children with autism were able to recognize expression of anger (both at 100% and 50% strength), but not fear or sadness, as well as their typically developing peers in the present research.

Additionally, in the present research, children's own ratings of emotional intensity indicated that both typically developing and autistic children perceived angry expressions with direct eye-gaze as more intense than these expressions with averted eye-gaze. This is consistent with research showing that anger is associated with higher arousal (see Izard & Ackerman, 2000), and greater duration than are happiness and sadness (Effron, Neidenthal, Gil, & Droit-Volet, 2006; Gil, Neidenthal, & Droit-Volet, 2007). Furthermore, previous work demonstrated greater ratings of intensity for angry faces that were coupled with direct eye-gaze versus averted eye-gaze in healthy adults (Sato et al., 2005). Similarly, children may be more sensitive to the unique and salient quality of angry expression to communicate threat-related information when coupled with direct eye-gaze as oppose to averted eye-gaze. However, in terms of the recognition abilities of anger, the effect of direct eye-gaze was associated with reduced, not enhanced performance, which is opposite of what was seen in adults (Adams & Kleck, 2005).

It was unexpected to find facilitative effects of averted eye-gaze direction in recognition of happy expressions presented at 50% emotion strength, as the shared signal hypothesis would predict direct eye-gaze to enhance recognition of joy. Moreover, similar results were observed for children with autism and typically developing children where averted eye-gaze increased perceptual salience of emotion cues in happy faces. To date, there are no empirical studies that have examined the influence of eye-gaze direction on recognition of happy facial expressions, particularly when the expressions convey subtle or more ambiguous emotion-related information. Adams and Kleck (2005) have demonstrated that adults were more likely to attribute joy dispositions to neutral expressions with direct eye-gaze as compared to averted eye-gaze. However, their study did not include happy expressions. The present findings indicate that given subtle cues of a happy emotion, as is the case with 50% emotion strength stimuli, children are better at recognizing these expressions with averted, rather than direct, eye-gaze. Future research is needed to determine whether this finding is an artifact of the present study.

Not surprisingly, children with autism were similar to the typically developing children in their ability to identify happy emotions, and they recognized happy emotions with greater accuracy than other emotions, in line with previous research (e.g., Ashwin et al., 2006; Boraston, Blakemore, Chilvers, Skuse, 2007; Gross, 2004). Past research showed that even in photographs of non-human faces, such as canine and orangutan, children with autism were shown to perform on par with typically developing children in identifying happy emotions but not sad, angry and surprise emotions (Gross, 2004). Similarly, typically developing children demonstrate the highest accuracy levels and fastest reaction times for the identification of happy emotions (e.g., Bullock & Russell, 1984; Denham & Couchard, 1990; De Sonneville et al., 2002; Fabes, Eisenberg, Nyman & Michealieu, 1991; Grossman et al., 2000). Happy expressions are characterized by a unique mouth pattern (Ekman, 1971; Herba & Phillips, 2004) that alone could be sufficient to discriminate them from other emotions (Loveland et al., 2005; Kestenbaum, 1992). It is possible that the autistic children’s visual preference for the lower part of the face accounts for the superior performance found in their recognition of happy emotions (Gross, 2004). In addition to its perceptual simplicity, happy expressions were also more conceptually distinct as they were the only positive emotional expressions presented to children in the current study.

Interestingly, children's performance on the recognition task was similar for all four emotions when they were presented at 50% strength, suggesting that typically developing children had as much difficulty as the autistic children in identifying emotional expressions when only subtle cues of emotions were present. The fact that typically developing children were significantly worse at identifying emotions presented at 50% strength than 100% strength is in contrast to the first published study investigating children's sensitivity to emotions presented at various levels of strength (Herba et al., 2006). Herba and colleagues found that compared to 50% emotion strength level, typically developing 4-to-15-year-olds' accuracy did not improve significantly when emotion strength was increased to 75% or 100%, although children were quicker to match more expressive faces. Since then, evidence has emerged to suggest that the development of sensitivity to at least some facial expressions continues well into adolescence. For instance, a recent study investigating sensitivity to five facial expressions (happy, sad, angry, fear, and disgust) in familiar and unfamiliar faces among 4- to-15-year-olds, demonstrated that sensitivity improved with increasing ages for happy and fear expressions but not for disgust, sad, and angry expressions (Herba, Benson, Landau, Russell, 2008). A different pattern emerged in a study that used morphing to create six intermediate emotion strength levels between neutral and expressions of fear and anger; children and adolescence were less sensitive than adults for both anger and fear (Thomas, De Bellis, Graham, & LaBar, 2007). Another study investigating age differences in sensitivity and ability to distinguish between different intensity levels of happy sad and fearful expressions in 5- 7-, and 10-year-olds and adults found that children's threshold to indicate that happy and sad faces are expressive (not neutral) reaches an adult-like level by 5 years of age. However, a different developmental pattern was found for fear than for happy or sad expressions. Specifically, even at the peak intensity (100%), 5-year-olds were significantly less accurate than adults in recognizing fearful faces (Gao & Maurer, 2009). Results of the present research indicate that children's ability to identify all four emotions including happiness, decreased significantly when the level of emotion strength was reduced to 50%.

Although the strength of the emotion cue has not received as much attention in the autism literature, the current results provide evidence to suggest that children with autism are similar to typically developing children in having less sensitivity to varying degree of subtle cues of emotional expressions. Across typically developing and autistic children, it should be noted that this was only the case when facial expressions were coupled with direct eye-gaze. For facial expressions coupled with averted eye-gaze, accuracy of recognition between 100% and 50% strength of fear and happy emotions was not significantly different in typically developing and autistic children in the present research. These findings suggest that averted eye-gaze may have enhanced recognition of 50% strength expressions of happiness and fear to the level of the performance observed in case of 100% strength expressions of these emotions, especially for typically developing children. This may not be the case for children with autism, as they experienced more difficulty recognizing fear regardless of the eye-gaze direction and emotion strength, although their pattern of performance for happy expressions was similar to the typically developing children.

These results indicated that averted eye-gaze did not enhance recognition of any of the negative emotions presented at 50% strength in children with autism. The question of whether typically developing and autistic children were interpreting ambiguous expressions with direct and averted eye-gaze as neutral or ascribing some other emotional state remained. In order to investigate how eye-gaze affected children's interpretation of these ambiguous facial expressions, children's responses were recoded from accuracy ratings to attribution of an emotional state versus non-emotional or neutral state. A similar pattern was found for typically developing children and autistic children, as children across both groups were more likely to attribute emotional states to expressions with averted eye-gaze than direct eye-gaze. That is, when asked to identify ambiguous (50% strength) emotional expressions with averted eye-gaze, children were less likely to classify them as neutral, but instead assigned a specific emotion to such expressions. Ambiguous expressions with direct eye-gaze, on the other hand, were more likely to be labeled as neutral. Past research has shown that adults also use a neutral label for less obvious emotional expressions (Durand, Gallay, Seigneuric, Robichon, & Baudouin, 2007).

In the present study, children with autism, in contrast to typically developing children, were often incorrect about the emotion label that they assigned to sadness and fear. In fact, they were significantly more likely to misinterpret sadness as anger and fear as sadness. For instance, 86% of children with autism labeled at least one ambiguous expression of sadness with averted eye-gaze as anger whereas only 22% of typically developing children did so. Similar systematic misjudgments of sadness and anger have also been found in previous research with younger typically developing children and are believed to relate to the resemblance in the position of facial features of these expressions such as furrowed eye-brows and pursed lips (Carlson, Felleman & Masters, 1983; Reichenbach & Masters, 1983). Typically developing children's ability to discriminate facial expressions of emotion improves with age, suggesting that the observed results can be due to general developmental delays among children with autism in their abilities to recognize emotions. In addition to maturational factors, social experiences have been shown to contribute to children's ability to recognize facial expressions of emotion (see Gross & Ballif, 1991). Previous research suggests that children with poor peer relationships have hostile perceptions of their social environment, especially when the social stimuli are ambiguous (Dodge, 1980). Additionally, it has been found that the tendency to misread facial expressions as angry is associated with the inability to discriminate hostile from innocuous intensions (Dodge, Murphy, & Buchsbaum, 1984). Hence, lacking close peer relationships could render autistic children disadvantaged when engaging in emotional interactions.

In sum, among typically developing children eye-gaze direction appears to modulate perception of emotion, but not entirely in accordance with the shared signal hypothesis. In fact, no evidence of the beneficial effects of direct eye-gaze on recognition of happiness or anger were found. Instead, presence of averted eye-gaze enhanced recognition of fear, sadness and happiness at 50% emotion strength and anger at 100% emotion strength. There are three possibilities for these findings. The first explanation is that the shared signal hypothesis is valid, but typically developing children are only sensitive to the behavioral intent to avoid communicated by the averted eye-gaze in combination with sadness and fear. It is also plausible that the enhancing effects of direct eye-gaze on recognition of anger and happiness may appear later in life. The second explanation is that averted eye-gaze simply increases the perceptual salience of the emotion-related cues, especially for the ambiguous expressions. The reason for this is unclear, as previous research has shown that direct eye-gaze heightens perceptual processing and enhances recognition efficiency of identity information conveyed by the face (e.g., Macrae et al., 2002). Finally, it is possible that the effects of eye-gaze direction are different for each emotion, regardless of the behavioral intent it is believed to communicate. For example, fear and happiness are enhanced by averted eye-gaze because it indicates the source of threat or feelings of joy. Indeed, it has been demonstrated that children tend to ascribe the cause of happiness to external and uncontrollable events, similar to fear. Sadness is influenced by averted eye-gaze because it is associated with social withdrawal (Izard, 1991), while anger is facilitated by averted eye-gaze because it attenuates the intensity of the immediate threat.

The reason why autistic children were not better at identifying fear and sadness with averted eye-gaze, as was the case among typically developing children, could be due to their propensity to ignore the eye region of the face. However, closer investigation of the data revealed that children with autism were sensitive to eye-gaze direction as they were more likely to assign an emotion state to the ambiguous (50%) expression with averted eye-gaze than direct eye-gaze, and did so in a nonrandom manner. Thus, it is possible that children with autism used configural information (i.e., the relationship between different parts) to some extent and did not just rely on local facial features while viewing these emotional expressions. Future research is needed as specific face processing strategies were not directly tested.

The present study also indicates that children with autism experience difficulty recognizing sadness and fear. However, it should be noted that children's performance was above chance levels and they made specific errors when identifying these emotions. For instance, children with autism were likely to label sad expressions as anger and fear expressions as sadness. Thus, children did not randomly assign the labels to these emotional expressions but rather used them in an inaccurate way. Because children with autism seemed to understand the behavioral consequences and recognize appropriate situational context for these emotional states (demonstrated in this study and discussed later in the chapter), it is the ability to accurately discriminate facial expressions and to associate them with the corresponding emotional state that appears to be either impaired or delayed in children with autism.

Children's Attribution of an Emotional State to Neutral Facial Expressions

Unlike the interpretation of ambiguous emotional expressions, no main or interactive effects of eye-gaze direction were found when children were presented with neutral expressions. Typically developing and children with autism were equally likely to attribute an emotional state to a neutral expression with direct eye-gaze as they were to a neutral expression with averted eye-gaze. Moreover, averted eye-gaze orientation did not lead to the greater frequency of attribution of sadness and fear and direct eye-gaze did not lead to more anger and happy dispositional attributions in neither typically developing children nor in children with autism. This is in contrast to Adams and Kleck's (2005) study showing in healthy adults, eye-gaze direction systematically influenced interpretation of these emotion characteristics conveyed by the neutral expressions. Taken together, these findings suggest that averted eye-gaze direction influences interpretation of these expressions when subtle cues of emotion are present, but not when facial expressions are completely neutral.

Methodological differences between the present study and previous research (Adams & Kleck, 2005) may account for this discrepancy. Unlike Adams and Kleck's (2005) procedure, where participants were asked to rate each neutral expression on a scale indicating "how likely the person depicted in the photograph is to experience anger, fear, sadness, and joy", the present study utilized a forced-choice paradigm, where children were asked to indicate how the person in the photograph feels. More importantly, children in the present study were given neutral emotion as one of the choices, whereas the previous study limited participants to the four emotions. Thus, it appears that given the opportunity to identify expressions as neutral, the effect of eye-gaze direction dissipates.

Unfortunately, to date there are no behavioral studies examining the development of recognition of neutral expression among typically developing and autistic children. Neuroimaging studies suggest that while viewing a neutral expression, children's and adults' amygdale function is different. For example, Thomas et al., (2001) compared amygdale activations to fear and neutral faces among children and adults. In adults, the amygdale responded more to fear faces than to neutral faces, whereas in children the amygdale responded more to neutral faces. These results were interpreted to reflect the ambiguity of neutral faces for children. In the present study, typically developing children were more accurate in identifying neutral expressions than children with autism, thereby suggesting that children with autism may find neutral expressions more confusing and consequently ascribe more emotional states. In addition, to an autistic child who is lacking exposure to typical social interactions, a neutral face posed by an adult (as was the case in the present study) may indicate disappointment in the child's behavior more so than neutral emotional disposition.

Children's Ratings of the Intensity of Facial Expressions

In addition to examining the effects of eye-gaze direction on children's ability to identify happy, sad, angry and fearful expressions, children were asked to rate the emotional intensity of these expressions at 50% and 100% emotion strength. Based on the shared signal hypothesis and the eyes processing deficit hypothesis, it was predicted that averted eye-gaze would intensify perception of sadness and fear, whereas direct eye-gaze would intensify perception of happiness and anger for typically developing children only. Eye-gaze direction was not expected to modulate intensity ratings for autistic children.

In line with previous research examining emotion perception in healthy adults (e.g., Adams & Kleck, 2005; Sato et al., 2004), typically developing children in the present study were found to rate angry faces at 100% strength with direct eye-gaze as more emotionally intense than these faces with averted eye-gaze. However, expressions of fear and sadness with averted eye-gaze were not associated with greater levels of perceived intensity than direct eye-gaze, as was previously demonstrated in adults (Adams & Kleck, 2005; Sato et al., 2004). In fact, typically developing and autistic children found sad expressions with direct eye-gaze to be more intense than with averted eye-gaze when these photographs were presented at 50% emotion strength. In addition, no differences between direct and averted eye-gaze were observed for happy faces. Furthermore, children with autism had a similar response pattern, indicating that intensity ratings of autistic children were influenced by the direction of the eye-gaze.

Overall, children with autism tended to rate facial expressions with direct eye-gaze as more intense than averted eye-gaze. In addition, children with autism found emotional expressions with direct eye-gaze more intense than their typically developing peers. It has been previously suggested that autistic individuals' propensity to avoid the eye region of the face is due to the arousing effects elicited by direct eye contact (Dalton et al., 2005; Kylliainen & Hietanen, 2006; Hutt & Ounsted, 1966). To date, no empirical studies have investigated the effects of eye-gaze direction on intensity judgments of facially expressed emotions in children with autism and only one study has directly examined these effects on the level of physiological arousal (Kylliainen & Hietanen, 2006). In their study, Kyllianinen and Hietanen (2006) utilized neutral expressions to differentiate between the effects of direct and averted eye-gaze on the skin conductance response (SRC). Children with autism were found to have higher arousal to stimuli with direct eye-gaze than the control group. Thus, the present study provides behavioral support to these findings, as well as additional evidence for the intensifying effect of direct eye-gaze on the perception of happy, sad, angry, and fearful expressions in children with autism. If the enhanced ratings of intensity reflect the fact that eye contact is experienced as more arousing and uncomfortable by children with autism, it is possible that they may be more likely to avoid the eye region when it is coupled with direct rather than averted eye-gaze. Hence, it is possible that viewing an emotional expression with averted eye-gaze may enable children with autism to explore the eye region and lead to more accurate inferences about the emotion being expressed.

Several differences between typically developing and autistic groups were observed with regard to emotion strength and emotion type. Specifically, children with autism rated ambiguous expressions as more intense than typically developing children. As Hutt and Oustead (1966) suggested, children with autism may experience heightened autonomic response to faces, resulting in more sensitivity to and higher ratings of even the subtle cues of emotional expressions. With respect to differences between emotions, children with autism rated expressions of happiness and fear as more intense than typically developing children, while intensity ratings of anger and sadness were the same for both groups. It is interesting that autistic children, as compared to typically developing children, had a deficit in recognition of expression of fear, yet when asked to rate "*how scared the person feels*", their perception of intensity was greater than typically developing children. This may indicate that labeling facially expressed fear and evaluating the intensity of emotional reaction to threat involve two different processes. To date, only one published study has examined intensity judgments of emotional events in children with autism (Rieffe, Terwogt, & Kotronopoulou, 2007). A sample of children with autism was compared to typically developing children in their ability to produce, from their own experiences, concrete examples of emotion evoking situations and to rate the intensity of these occurrences. Children with autism rated sad and angry events with less intensity than fear, and described less number of social occasions in which anger and sadness were experienced. The results were taken to suggest that with negative emotions, autistic children may experience fear more intensely. This may explain why autistic children, as compared to typically developing children, reported higher ratings of intensity for expressions of fear in the present research. Children with autism, however, did not find fear to be significantly more intense than expressions of sadness or anger. The paucity of research examining perception of emotion intensity in children with autism limits discussion of the present findings. Future research is needed to understand what factors influence typically developing and autistic children's perception of emotional intensity in facial expressions, particularly negative expressions.

The Effects of Situational and Facial Cues

Children's Ability to Recognize Emotion

Situational context is vital in interpretation of others' emotions, given that most facially expressed emotions do not occur in isolation. The present study examined typically developing and autistic children's ability to identify emotions when presented with line drawings of emotionally-laden situations that were congruent with facial cues, incongruent with facial cues, or were in the absence of facial cues. Past research has found that typically developing children's accuracy of recognition of congruent situational and facial cues reaches near perfect performance by the third grade (Kurdek & Rodgon, 1975). Their reliance on situational cues increases with age, while reliance on facial expression decreases (Gnepp, 1983; Reichenbach & Masters, 1983). Autistic children, in general, perform less well than their typically developing peers on tasks that assess the ability to coordinate multiple cues to identify others' emotions (e.g., Hobson, 1986; Fein et al., 1992; Macdonald et al., 1989). For instance, children with autism have been found to have difficulty matching facial expressions to appropriate situations that most likely elicit these emotions (Fein et al., 1992). However, to date no studies have investigated whether children with autism rely more on facial features or situational cues especially when faced with conflicting sources of information.

Developmental differences may also affect these results. In the past, typically developing 3-to-5-year-olds were shown to focus exclusively on the facial expression when dealing with incongruent facial and contextual cues, whereas 8-to-9-year-olds were shown to rely more on situational cues (Genpp 1983; Reichengach & Masters, 1983). In the present study, autistic children were expected to rely primarily on facial and not situational cues when asked to identify emotions from drawings with conflicting facial and situational cues, similar to the pattern found in younger children. Autistic children were also anticipated to be less accurate than typically developing children when asked to identify emotions from situational cues alone. When situational and facial cues were congruent, their performance was expected to be similar to typically developing children.

The present results revealed that children with autism interpreted drawings differently than typically developing children when presented with incongruent situational and facial cues. As anticipated, children with autism tended to rely on facial cues whereas typically developing children relied predominantly on situational cues. For example, when a picture of a girl who is eating ice-cream yet frowning was presented, typically developing children were more likely to ignore the frowning face (indication of sadness) and reply that the girl felt happy. In contrast, children with autism tended to base their answers on the facial cue (i.e., frown) and indicated that the girl felt sad.

In most situations there are certain contextual details that provide clues to the possible emotional reactions of the participating individuals. It appears that autistic children in the present study were not as sensitive to some contextual clues as their typically developing peers. In the case of the drawing with a smiling girl whose doll was broken by her brother, several contextual details in the script were purposefully included to highlight the fact that anger could be an appropriate response for the girl. For instance, “favorite” was used as an adjective to describe the girl’s toy and the vindictive, not accidental, nature of the brother’s act was emphasized. While viewing this drawing, only 9% of autistic children said the girl felt angry and 36% indicated that the girl felt sad. The rest of children with autism (45%) relied on the facial expression and indicated that the girl felt happy. In contrast, 50% of typically developing children indicated that the girl felt angry and 45% thought she felt sad. Although approximately half of the children in both groups realized that the girl could feel sad about the toy being broken, only two children with autism characterized the girl’s feelings as anger. These findings suggest that children with autism were less likely to understand the contextual cues than typically developing peers.

It is important to note that recognition accuracy was not the focus in this task. Due to the complex nature of emotional display rules and a limited amount of information about the character, it is hard to say with certainty which emotion is more appropriate in this situation, happiness or sadness. With increasing age, typically developing children start to appreciate the psychological intricacy of emotional experiences (Gross & Ballif, 1991). Generally, by age 11, typically developing children understand how emotional display rules function (e.g., Harris & Olthof, 1982) and that emotional states can be internally redirected such as thinking sad thoughts in a happy situation (Harris, Olthof, & Terwogt, 1981). The present findings highlight the saliency of the facial cues over situational cues among children with autism when making inferences about others' emotional states in a confusing situation. Future research should specifically focus on developing a better understanding of emotional display rules in children with autism.

The impairments in theory of mind in autistic individuals, specifically their understanding of desires, thoughts and beliefs, may also explain group differences. For example, in order to interpret the girl's reaction as anger, one has to understand that the girl *believes* that her brother deliberately broke the toy. Children with autism clearly were less insightful about the premeditated nature of the brother's actions. It has also been suggested that autistic children are less perceptive of their own emotional experiences (e.g., Hill, Berthoz, & Frith, 2004). A recent study has shown that 10-year-old children with autism were less aware of their own emotions than their non-autistic peers. They more often claimed not to feel an emotion and were less able to generate emotionally charged situations from their own experiences. Interestingly, anger was one emotion that was reported to be experienced less by the autistic children (Reiffe et al., 2007). Thus, it is plausible that in the present study children with autism, when presented with a more problematic task (i.e., incongruent facial and situational cues), failed to evaluate the situation according to their own self-experiences and relied predominantly on the facial cues, whereas typically developing children responded in the way they would feel in a similar situation.

Other sources of variation in how typically developing and autistic children interpret emotional events are the differences in the quality of social-life experiences (Bandura, 1986) and interpersonal experiences associated with different social-life phases (Wells & Higgins, 1989). Typically developing children for example, are exposed to socially complex, peer-driven situations in which they become increasingly aware of their social status, social acceptance or rejection, and potentially duplicitous nature of any social interaction. These experiences provide a good base for learning how to integrate conflicting social cues. For children with autism, however, quality and frequency of social interactions are qualitatively distinct, leaving them at a disadvantage for learning social rules (Hobson, 1986).

Overall, when situational and facial cues were conflicting, children with autism relied more often on facial cues to infer the emotional states of others. However, fear was the exception. When children were presented with a picture of a smiling boy being attacked by a swarm of bees, the majority of typically developing children (82%) and children with autism (71%) indicated that the boy felt scared. Compared to other emotional scripts, contextual cues describing a frightening situation seem to have more salience over the accompanied incongruent facial expression. The fact that the fear was an exception was surprising in light of the earlier findings from the photograph task in which children with autism were significantly worse than typically developing children in recognizing fear from facial expression. This may indicate that children with autism understand typical situations that elicit fear but may not recognize fear from facial expression alone.

When situational cues were congruent or without facial expression, children with autism performed similarly to the typically developing children, accurately labeling the characters' affective states most of the time. The present findings suggest that children with autism show a similar understanding of simple emotions in prototypical situations (e.g., birthdays, injuring yourself), at least in the case of the four emotions examined. This is consistent with several laboratory findings demonstrating that high functioning individuals with autism seem to be able to discuss experiences when they felt happy, sad, scared, or angry (Kassari et al., 2001; Loveland et al., 1997), and identify these emotions from scripts (Balconi & Carrera, 2007). Although children with autism have been shown to evince some understanding of emotional experiences, they have also been shown to apply more cognitive effort and provide more superficial and scripted accounts of emotional events (e.g., Adams, Green, Gilchrist, & Cox, 2002; Capps et al., 1992; Hale & Tager-Flusberg, 2005). It has been suggested that individuals with autism utilize more computational approaches to interpret and understand social-emotional interactions as compared to typically developing individuals who are guided by more intuitive processes

(Frith, Morton, & Leslier, 1991; Losh & Capps, 2006). In the present study, when incongruent stimuli were shown, the majority of typically developing children hesitated in their response. The majority of the children commented on the disparity between the facial expression and the contextual cues by providing copious reasons for the character's emotional reactions. Most of the children with autism, on the other hand, did not contemplate about the conflicting cues, possibly suggesting that autistic children are less aware of how characters' personal information affects the relationship between the situations and their emotions.

Limitations of Present Research

It is important to consider several methodological limitations when interpreting the present findings. First, children in the sample were high functioning on the autism spectrum, as indicated by their verbal mental age and performance IQ scores. Results may be characteristic of their greater cognitive capacity, limiting the generalizability of the data. Nevertheless, in the present study, average total scores on the Social Responsiveness Scale indicated that autistic children were rated as suffering moderate to severe levels of social impairment.

Another possible objection to the findings in this study concerns the fact that no explicit nonverbal IQ indices were given, and only verbal measures were administered. Limited nonverbal ability could have negatively affected the outcomes of the study. However, as part of the recruitment procedure, schools and centers for autism were instructed to only select children with a verbal mental age at or above 5 years and IQ performance scores of greater than 75. In fact, after reviewing children's clinical records, the average nonverbal ability for the autistic children was 102.66, indicating average performance. This provides reasonable validity to the results and prevented the children from additional, perhaps unnecessary, testing.

An important procedural limitation was identified during the data collection phase of the study. The researcher became aware that the majority of autistic children were enrolled in emotion recognition training classes. These classes are offered to higher functioning children and require presenting children with photographs, schematic faces, or cartoon drawings while teaching them about emotions. Generally these classes are available to autistic children as young as 4 years. It is estimated that the majority of autistic children in the present study were enrolled in such classes as all of the children were high functioning. Specific information regarding these training classes was not collected and presents a threat to internal validity of the present study. Despite the training, the present findings indicate that the children were struggling in identifying emotional expressions, particularly of sadness and fear. However, similarities in the performance between groups when they judged line drawings with congruent facial and situational cues or situational cues alone may be a direct result of the emotion-training programs.

In addition, when children were presented with incongruent facial and situational cues, the majority of typically developing children spontaneously provided explanations to rationalize their answers. Although most autistic children did not elaborate about their responses, two children with autism did so. For example, in order to explain a frown on a girl’s face who was eating an ice cream cone, one child suggested that the ice cream was the wrong flavor, while another child suggested that the girl did not like it. Thus, some children with autism were able to integrate both facial and situational cues when making their inferences. However, to fully understand the process of how children with autism make inferences about other's emotions given incongruent information, an opportunity to provide a solution should be given to the children. In fact, when typically developing children were given such opportunity in a study conducted by Wells and Higgins (1989), even 4-to-5-year-old children were able to integrate facial and situational cues.

Implications of Present Research

The present study extends research on emotion recognition in children with autism as revealed through their capacity to process information from people's faces as well as situational cues. The ability to interpret others' emotional states is an imperative component of any social interaction. The present findings are consistent with studies that show autistic children to be less adequate at recognizing basic emotional expressions, particularly fear and sadness. Impairments in recognizing these emotions could have significant effects on social-emotional development, for example, the development of empathetic concern for others. This is consistent with the findings of several studies that have shown that autistic children may not respond with empathy to distress and discomfort in others (e.g., Charman, 1997; Sigman, Kasari, Kwon, & Yirmiya, 1992).

The inability to recognize expressions of fear can have potentially dangerous consequences. For instance, a sign of a threat may be ignored leading a child into an unfavorable situation. Children with autism may also not recognize that the person who appears to be scared may require assistance in avoiding the threat. Some suggest that an ability to recognize fear can be a marker for better social outcomes later in life, although in the present study no significant relationship was found between performance on the recognition of fear and severity of social symptoms or verbal abilities.

One of the common features of autism spectrum disorder is the lack of eye-to-eye contact, gaze following, and a lack of joint attention. Children with autism are believed to have preference for the mouth region of the face and ignore the eye region, resulting in an impaired ability to understand information communicated by the facial expression including emotions and deficits in developing interpersonal connections. The present study demonstrated that children with autism were sensitive to eye-gaze direction while identifying emotional expressions. This suggests that even if autistic children do not directly focus on the eyes, their perception of the emotional content of the face is still affected by the eye-gaze direction. Furthermore, direct eye-gaze was shown to heighten the perception of emotional intensity in children with autism but not typically developing children supporting previous findings that direct eye-gaze elicits more arousal. The present study also adds to an emerging database suggesting that eye-gaze direction modulates perception of facially expressed emotions in healthy adults (Adams & Kleck, 2005, 2003). Expression of fear and sadness were found to be influenced by the eye-gaze direction suggesting that eye-gaze is an important feature of emotion processing. Further investigation of how eye-gaze direction is implicated in emotion recognition and the normative developmental pattern of these effects is necessary in order to understand pathology in this area (Cicchetti, 2007).

One unexpected finding was that children with autism were more likely to label sadness as anger when the facial expression was ambiguous. Continuous misinterpretation of facial expressions as angry may lead to deleterious outcomes for the socialization of anger in the child. For instance, Crockenberg (1985) has demonstrated that adult behavior perceived as anger by the typically developing child was associated with irritated, noncompliant behavior and less empathic responding on the part of the child. For autistic children, such interchanges may interfere with the acquisition of more prosocial behavior as well as with more optimal patterns of communication with others. Finally, knowing that children with autism rely on facial cues more in situations with conflicting contextual cues can benefit care givers and educators. It allows adults to be more sensitive to the children's needs in such situations by explaining what one truly feels. Additionally, in an ambiguous situation, autistic children may benefit from knowing specific details about the incident, as present findings demonstrated that they had a better understanding of emotions when contextual cues were provided.

In conclusion, the present project served to expand upon previous investigations regarding the implication of eye-gaze direction in emotion recognition from facial expression as well as situational cues in typically developing and autistic children. It appears that perception of emotion is modulated by the eye-gaze direction among both children with and without autism. In addition, direct eye-gaze seems to intensify the perception of emotional intensity in autistic children but not typically developing children. The study also supported previous research suggesting that children with autism have an impaired capacity to identify emotions from facial expressions. Further, the study demonstrated that children with autism rely primarily on facial cues over situational cues, when making inferences about others' emotional states in a conflicting situation. Lastly, the present findings provide support for past research that has shown that children with autism show good understanding of simple emotions in typical situations. Future research can is needed to further elucidate our understanding of autistic children's recognition and understanding of emotion.

APPENDIX A:

LETTER TO PRINCIPAL

TYPICAL SCHOOLS

Dear Principal____________,

I am a doctoral student in the developmental psychology program at Loyola University Chicago. Under the supervision of Dr. Denise Davidson, I am conducting my dissertation study on emotion recognition by school-aged children with autism spectrum disorder (ASD) and without ASD. With your permission, we would like to invite students at the_____School to participate in the project.

The purpose of the present study is to examine if children with Autism Spectrum Disorder (ASD) and children without ASD use the same or different facial features and contextual cues to recognize emotional expressions. In order to assess children's recognition of emotional information, children will be presented with photographs of adult facial expressions (neutral, happy, sad, angry, and scared) and cartoon-like pictures of emotional situations. To help you make an informed decision regarding participation in the study, I have included a more detailed proposal along with samples of photographs to be used during the study. Also included is a sample parent permission letter. Should your school agree to participate I will provide copies of the parent permission letters.

Please feel free to call me, (773) 508-8343, or e-mail me, dtell@luc.edu, if you have any questions or would like additional information about the project or our research program. Thank you very much for taking the time to read the materials and consider participating in the study. I hope that your school will be able to participate and I look forward to the possibility of working with you.

Sincerely,

Dina Tell, M. A.
Doctoral Candidate
Department of Psychology
Loyola University Chicago
6525 N. Sheridan Road
Chicago, IL 60625

APPENDIX B:

PARENT CONSENT FORM

TYPICAL SCHOOLS

Project Title: Recognition of Emotions from Facial Expression and Situational Cues in Children with Autism

Researcher: Dina Tell, M. A., Doctoral Candidate
Faculty Sponsor: Denise Davidson, Ph.D., Associate Professor, Program Director

Dear Parent,

I am a doctoral student, currently pursuing my degree in child development at Loyola University Chicago. For my dissertation, I am conducting a study, under the direct supervision of Denise Davidson, Ph.D., that examines the role facial features and situational cues play in children's recognition of emotion.

I am writing to invite you and your child to participate in this project, which has been approved by the principal of your child's school. Please read this letter carefully and ask any questions you may have before deciding whether to allow your child to participate in the study.

The purpose of this research study is to examine how typical children and children with autism make judgments about other's emotional states. Specifically, the role of eye-gaze direction and situational cues in recognition of emotional expression is examined.

Along with investigating how these features affect emotion recognition in normal development, I would like to compare these abilities to a sample of children diagnosed with Autism Spectrum Disorder. If you agree to allow your child to be in the study, he/she will be asked to complete the following tasks:

Task 1 Your child will be administered the *Peabody Picture Vocabulary Test*, to assess his/her verbal abilities.

Task 2 Your child will be asked to look at photographs of *neutral*, *happy*, *sad*, *angry*, and *scared* expressions of adults and sort them according to each emotion.

Task 3 Your child will be asked to rate the intensity of several emotional expressions depicted in the photographs. A subset of pictures that were presented in the second task will be used.

Task 4 Your child will be asked to look at cartoon-like pictures of various situations (*e.g., girl eating ice cream*) in which your child will be asked to identify the emotion.

All children will receive either a sticker or a decorated, unsharpened pencil at the end of the experiment as a thank you for their participation.

The study will require approximately 45 minutes of your child's time. Please note that the study will be conducted at your child's school during regular school hours. Your child will be taken out of the normally scheduled activities for the duration of the study and may have to make up any of these activities.

All individual results will be kept completely confidential. Your child's name will not be associated with his or her score, nor will scores be kept in the child's school records. Your child's responses will be recorded on paper, with only a code name on the top. No participants will be identified in any report or publication of this study or its results. All data collected will be used for research purposes only.

Your child is free not to answer any question or to withdraw from participation at any time without penalty. Your child will be told ahead of time that he/she may quit at any time and nothing will happen. Your participation is greatly appreciated, although it is *completely voluntary*, and will have no impact on your child's grades or education. If you do not want your child to be in this study, he/she does not have to participate.

There are no foreseeable risks involved in participating in this research beyond those experienced in everyday life. There are no direct benefits to your child from participation in this study. I am hoping that this study may lead to further understanding of the emotion recognition process in typical development and in autism spectrum disorder.

I hope that you and your child will consider helping me in this effort to better understand the roles that facial features and situational cues play in the emotion process. If you are interested, please sign below, and ***have your child return the form to his or her school office*** in the enclosed envelope. At the end of the study I will provide the school principal with a copy of our findings, which you are free to look at too.

If you have any questions, please feel free to call me at (773) 508-8343 or the faculty sponsor Dr. Denise Davidson at (773)508-3008. Please call Loyola's Compliance Manager at (773) 508-2689 if you have any questions about your child's rights as a research participant. Thank you very much for your time and consideration of this matter.

****

Statement of Consent:

Your signature below indicates that you have read and understood the information provided above, have had an opportunity to ask questions, and agree to allow your child to participate in this research study**.** You will be given a copy of this form to keep for your records.

___________Yes, my child may participate.

___________No, my child may not participate.

Child's Name	**Child's Date of Birth**
Signature of Parent or Guardian	**Date**

APPENDIX C:

LETTER TO PRINCIPAL/DIRECTOR

AUTISM SCHOOLS/CENTERS

Dear Principal/Director____________:

I am a doctoral student in the developmental psychology program at Loyola University Chicago. Under the direct supervision of Dr. Denise Davidson, I am conducting my dissertation study on emotion recognition by children with autism spectrum disorder. With your permission, we would like to invite students in the_____Program/Center to participate in the project.

Briefly, this study will examine the role facial features and situational cues play in recognition of emotional expressions in children with autism spectrum disorder. Children who could potentially participate in the study need to match the following profile:

- Diagnosis of Autism Spectrum Disorder
- English is the Child's first and primary language
- Age may range from 8 to12 years
- IQ or other standardized achievement test performance should not fall below 70
- Verbal mental age as assessed by standardized verbal ability test should be at or above 5 years

For the participating children only, we would like to obtain, with your permission, the diagnostic information and testing information. This information includes scores on any standardized IQ measure, any standardized verbal abilities measure, and diagnostic measure(s). In addition, teachers will be asked to complete the *Social Responsiveness Scale*, a 65-item paper-and-pencil questionnaire designed to assess severity of the symptoms. To help you and the teachers to make an informed decision regarding participation in the study, I have included a more detailed description along with samples of photographs to be used during the study and a copy of the questionnaire.

I hope that you will look over the more detailed description of the project provided in order to help you make an informed decision regarding participation in our study. Thank you very much for taking the time to read our materials and consider participating in our study. Also included in this packet are a sample of consent form to be signed by participating teachers and a sample parent permission letter. Should your school agree to participate I will provide copies of the parent permission letters.

Please feel free to call me, (773) 508-8343, or e-mail me, dtell@luc.edu, if you have any questions or would like additional information about the project or our research program. Once again, thank you for your time and consideration of my project. I hope that your school will be able to participate in our study and we look forward to the possibility of working with you.

Sincerely,

Dina Tell, M. A
Doctoral Candidate
Department of Psychology
Loyola University Chicago

APPENDIX D:

PARENT CONSENT FORM

AUTISM CHILDREN

Project Title: Recognition of Emotions from Facial Expression and Situational Cues in Children with Autism

Researcher: Dina Tell, M. A., Doctoral Candidate
Faculty Sponsor: Denise Davidson, Ph.D., Associate Professor, Program Director

I am a doctoral student, currently pursuing my degree in child development at Loyola University Chicago. For my dissertation, I am conducting a study, under the direct supervision of Denise Davidson, Ph.D., that examines the role facial features and situational cues play in children's recognition of emotion. I am writing to invite you and your child to participate in this project, which has been approved by the principal of your child's school. Please read this letter carefully and ask any questions you may have before deciding whether to allow your child to participate in the study.

Your child is asked to participate because this study investigates emotion recognition from facial expressions and situational cues in children diagnosed with autism spectrum disorder (ASD) and your child was identified by the ____________ Center to fit into the following profile:

- Your child is diagnosed with Autism Spectrum Disorder
- Your child has an IQ or other standardized achievement test performance above 75
- Your child's verbal mental age as assessed by standardized verbal ability test is at or above 5 years
- English is the Child's first and primary language
- Your child is between 8 and 12 years of age

The purpose of this research study is to examine how children with autism and without autism make judgments about other's emotional states. Specifically, I am interested in the role of eye-gaze direction and situational cues in interpretation of emotional expressions. If you agree to allow your child to be in the study, he/she will be asked to complete the following tasks:

- First, your child will be administered the *Peabody Picture Vocabulary Test*, to assess his/her verbal abilities.
- Then, your child will be administered the *Block Design* subtest of *Wechsler Intelligence Scale for Children,* to assess spatial abilities.
- Third, your child will be asked to look at photographs of neutral, happy, sad, angry, and scared facial expressions of adults and sort them according to the emotions expressed. The photographs will have faces with eye-gaze looking straight ahead and eye-gaze looking away to the side.

- Fourth, your child will be asked to rate the intensity of several emotional expressions depicted in the photographs. A subset of pictures that were presented in the second task will be used.
- The last task will include the presentation of cartoon-like pictures of various situations (e.g., girl eating ice cream) in which your child will be asked to identify the emotion. Some of these drawing will have a person expressing appropriate emotion (e.g., girl eating ice cream and smiling), some drawings will have a person expressing conflicting emotions (e.g., girl eating ice cream and frowning), and some of the drawings will have the person's face covered.
- In addition, the parent/caregiver will be asked to complete the *Social Responsiveness Scale*, a 65-item paper-and-pencil questionnaire rating your child's social and behavioral skills.

The study will require approximately two hours of your child's time, and will be conducted at your child's school during normal school hours. Please note that participation is greatly appreciated, although it is *completely voluntary*, and will have no impact on your child's grades or education. All children will receive either a sticker or a fancy, unsharpened pencil at the end of the experiment as a thank you for their participation.

There are no foreseeable risks involved in participating in this research beyond those experienced in everyday life. There are no direct benefits to your child from participation in this study. I am hoping that this study may lead to further understanding of the cognitive components that contribute to face and emotion recognition in autistic and typical children. The results may also elucidate the role of eye-region of the face play in emotion perception.

All individual results will be kept completely confidential. Your child's name will not be associated with his or her score, nor will scores be kept in the child's school records. Your child' responses will be recorded on paper, with only a code number on the top. The child's principal or director will be asked to provide information about your child's diagnosis and previous testing records (performance IQ, mental verbal age). This information will be recorded on a sheet *without* the child's name, only with the given code number. No participants will be identified in any future report or publication of this study or its results. All data collected will be used for research purposes only.

Participation in this study is voluntary. If you do not want your child to be in this study, he/she does not have to participate. Even if you decide to allow your child to participate, he/she is free not to answer any question or to withdraw from participation at any time without penalty. Your child will be told ahead of time that he/she may quit at any time and nothing will happen.

I hope that you and your child will consider helping me in this effort to better understand the roles that facial features and situational cues play in the emotion process. If you are interested, please sign below, and ***have your child return it to his or her school office*** in the enclosed envelope. I have included the Social Responsiveness Scale for you to complete. Please return the questionnaire in the enclosed envelope along with the consent slip. At the end of the study I will provide the school principal with a copy of our findings, which you are free to look at too.

If you have any questions, please feel free to call me at (773) 508-8343 or the faculty sponsor Dr. Denise Davidson at (773)508-3008. Please call Loyola's Compliance Manager at
(773) 508-2689 if you have any questions about your child's rights as a research participant. Thank you very much for your time and consideration of this matter.

****

Statement of Consent:

Your signature below indicates that you have read and understood the information provided above, have had an opportunity to ask questions, and agree to allow your child to participate in this research study**.** You will be given a copy of this form to keep for your records.

___________Yes, my child may participate.

___________No, my child may not participate.

______________________________	______________________________
Child's Name	**Child's Date of Birth**
______________________________	______________________________
Signature of Parent or Guardian	**Date**

APPENDIX E:

EXAMPLES OF EMOTIONAL EXPRESSIONS

APPENDIX F:

LIST OF EMOTION SITUATIONS AND

EXAMPLES OF PICTURES

List of Emotion Situations

Pictures
1. Girl eating ice cream
2. Two children are fighting over a cookie
3. Big dog is approaching a boy
4. Boy is holding a hurt knee
5. Boy is getting a cake
6. Boy is looking at broken toy
7. Dog is jumping on girl
8. Boy is holding a balloon
9. Girl felt down
10. Girl is holding a broken teddy bear
11. Girls fighting
12. Girl dropped ice cream
13. Boy is sliding
14. Boy is on the roof
15. Girl is fighting with a boy
16. Boy is about to get a shot
17. Girl is petting a dog
18. Girls are fighting over a toy

REFERENCES

Adolphs, R., Damasio, H., Tranel, D., Cooper, G., & Damasio, A. R. (2000). A role for somatosensory corticies in the visual recognition of emotion as revealed by three-dimensional lesion mapping. *Journal of Neuroscience*, *20*, 2683-2690.

Adams, R.B., Jr., & Kleck, R.E. (2003). Perceived gaze direction and the processing of Facial displays of emotion. *Psychological Science, 14*, 644-647

Adams, C., Green, J., Gilchrist, A., & Cox, A. (2002). Conversational behavior of children with Asperger syndrome and conduct disorder. *Journal of Child Psychology and Psychiatry, 43,* 679-690.

Ashwin, C., Chapman, E., Colle, L., & Baron-Cohen, S. (2006). Impaired recognition of negative basic emotions in autism: A test of the amygdala theory. *Social Neuroscience, 1,* 349-363.

Ashwin, C., Wheelwright, S., & Baron-Cohen, S. (2006). Finding a face in the crowd: Testing the anger superiority effect in Asperger Syndrome. *Brain and Cognition, 61*, 78-95.

Astington, D.R. Olson (Eds.), *Developing theories of intention: Social understanding and self-control* (pp. 17-41), Mahwah, NJ: Lawrence Erlbaum

Back, E., Ropar, D., & Mitchell, P. (2007). Do the eyes have it? Inferring mental states form animated eyes in autism. *Child Development, 78*, 397-411.

Bakeman, R., & Adamson, L. (1984). Coordinating attention to people and objects in mother-infant and peer-infant interaction. *Child Development, 55*, 467-478.

Balconi, M., & Carrera, A. (2007). Emotional representation in facial expression and script: Acomparison between normal and autistic children. *Research in Developmental Disabilities, 28,* 409-422.

Bar-Haim, Y., Shulman, C., Lamy, D., & Reuveni, A. (2006). Attention to eyes and mouth in high-functioning children with autism. *Journal of Autism and Developmental Disorders, 36*, 131-137.

Baron-Cohen, S. (1995). The eye direction detector (EDD) and the shared attention mechanism (SAM): Two cases for evolutionary psychology. In C. Moore & P.J. Dunham (Eds.), *Joint attention: Its origins and role in development.* (pp. 41-59), Hillsdale, NJ: Lawrence Erlbaum Associates.

Baron-Cohen, S., Baldwin, D.A., & Crowson, M. (1997). Do children with autism use the speaker's direction of gaze strategy to crack the code of language? *Child Development, 68*, 48-57.

Baron-Cohen, S., Campbell, R., Karmiloff-Smith, A., Grant, A., & Walker J. (1995). Are children with autism blind to the mentalistic significance of the eyes? *British Journal of Developmental Psychology, 13,* 379-398.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the mind in the eyes" Test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry, 42,* 241-251.

Baron-Cohen, S., Wheelwright, S., & Jolliffe, T. (1997). Is there "language of the eyes?" Evidence from normal adults, and adults with autism or Asperger syndrome. *Visual Cognition, 4,* 311-331.

Baron-Cohen, S., Spitz, A., & Cross, P. (1993). Can children with autism recognize surprise? *Cognition and Emotion, 7,* 507-516.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the mind in the eyes" test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry, 42*, 241-251.

Barth, J.M., & Bastiani, A. (1997). A longitudinal study of emotion recognition and preschool children's social behavior. *Merrill-Palmer Quarterly, 43,* 107-128.

Batty, M., & Taylor, M.J. (2006). The development of emotional face processing during childhood. *Developmental Science, 9,* 207-220.

Behrmann, M., Avidan, G., Leonard, G.L., Kimchi, R., Luna, B., Humphreys, K., & Minshew, N. (2006). Configural processing in autism and its relationship to face processing. *Neuropsychologia, 44,* 110-129.

Bentin, S., Allison, T., Puce, A., Perez, E., & McCarthy, G. (1996). Electrophysiological studies of face perception in humans. *Journal of Cognitive Neuroscience, 8,* 551-565.

Blair, R.J., Colledge, E., Murray, L., & Mitchell, D.G. (2001). A selective impairment in the processing of sd and fearful expressions in children with psychopathic tendencies. *Journal of Abnormal Child Psychology, 29*, 491-498.

Bolte, S., & Poustka. (2003). The recognition of facial affect in autistic and schizophrenic subjects and their first-degree relatives. *Psychological Medicine, 33*, 907-915.

Boraston, Z., Blakemore, S.J., Chilvers, R., & Skuse, D. (2007). Impaired sadness recognition is lined to social interaction deficit in autism. *Neuropsychologia*, *45,* 1501-1510.

Boucher, J., & Lewis, V. (1992). Unfamiliar face recognition in relatively able autistic children. *Journal of Child Psychology and Psychiatry*, *33*, 843-859.

Boyatzis, C. J., Chazan, E., & Ting, C.Z. (1993). Preschool children's decoding of facial emotions. *The Journal of Genetic Psychology, 154*, 375-382.

Brooks, R., & Meltzoff, A. (2005). The development of gaze following and its relation to language. *Developmental Science, 8*, 535-543.

Bruce, V., Campbell, R. N., DohertySneddon, G., Import, A., Langton, S., & McAuley, S.,et al. (2000). Testing face processing skills in children. *British Journal of Developmental Psychology*, *18*, 319-333.

Buitelaar, J. K., Van der Wees, M., Swabb-Barneveld, H., & Van der Gaag, R.J. (1999). Theory of mind and emotion-recognition functioning in autistic spectrum disorders and in psychiatric control and normal children. *Development and Psychopathology, 11*, 39-58.

Bullock & Russell. (1984). Preschool children's interpretation of facial expressions of emotion. *International Journal of Behavioral Development*, *7,* 193-214.

Campbell, R., Heywood, C., Cowey, A., Regard, M., & Landis, T. (1990). Sensitivity to eye gaze in prosopagnosia patients and monkeys with superior temporal sulcus ablation. *Neuropsychologia, 28*, 1123-1142.

Campos, J.J. (1981). Human emotions: Their new importance and their role in social referencing. *Research and Clinical Center for Child Development, Annual Rpt.,* 1-7.

Camras, L.A., & Allison, K. (1985). Children's understanding of emotional facial expressions and verbal labels. *Journal of Nonverbal Behavior, 9,* 84-94.

Capps, L., Yirmiya, N., & Sigman, M. (1992). Understanding of simple and complex emotions in non-retarded children with autism. *Journal of Child Psychology and Psychiatry, 33*, 1169-1182.

Carey, S., & Diamond, R. (1977). From piecemeal to configurational representation of faces. *Science, 195*, 312-314.

Carey, S., & Diamond, R. (1994). Are faces perceived as configurations more by adults than by children? *Visual Cognition, 1*, 253-274.

Carlson, C., Felleman, E., & Masters, J. (1983). Influence of children's emotional states on the recognition of emotion in peers and social motives to change another's emotional state. *Motivation and Emotion, 7*, 61-79.

Castelli, F. (2005). Understanding emotions from standardized facial expressions in autism and normal development. *Autism*, *9*, 428-449.

Celani, G., Battacchi, M. W., & Arcidiacono, L. (1999). The understanding of the emotional meaning of facial expressions in people with autism. *Journal of Autism and Developmental Disorders*, *29*, 57-66.

Chamberlain, B., Kasari, C., & Rotheram-Fuller, E. (2006). Involvement or Isolation? The social networks of children with autism in regular classrooms. *Journal of Autism and Developmental Disorders, 37*, 230-242.

Chance, J.E., & Goldstein, A.G. (1984). Face recognition memory: implications for children's eyewitness testimony. *Journal of Social Issues, 40*, 69-85.

Clark, T.F., Winkielman, P., & McIntosh, D.N. (2008). Autism and the extraction of emotion from briefly presented facial expressions: Stumbling at the first step of empathy. *Emotions, 8*, 803-809.

Da Fonseca, D., Santos. A., Bastard-Rosset, C.R., Poinso, F., & Deruelle, C. (2009). Can children with autistic spectrum disorder extract emotions out of contextual cues? *Research in Autism Spectrum Disorders, 3*, 50-56.

Dalton, K.M., Nacewicz, B.M., Johnstone, T., Schaefer, H.S., Gernsbacher, M.A., & Goldsmith, H.H. (2005). Gaze fixation and the neural circuitry of face processing in autism. *Nature Neuroscience, 8*, 519-526.

Denham, S.A. (1994). Mother-child emotional communication and preschoolers' security of attachment and dependency. *Journal of Genetic Psychology, 155*,119-121.

Davidson, D. (2006). The role of basic, self-conscious and self-conscious evaluative emotions in children's memory and understanding of emotion. *Motivation and Emotion., 30,* 237-247.

Davidson, D., Luo, Z., & Burden, M.J. (2001). Children's recall of emotional behaviors, emotional labels, and nonemotional behaviors: Does emotion enhance memory? *Cognition and Emotion, 15*, 1-26.

Davis, M., & Whalen, P.J. (2001). The amygdala: Vigilance and emotion. *Molecular Psychiatry, 6*, 3-34.

Davies, S., Biship, D., Manstead, A.S., & Tantam, D. (1994). Face perception in children with autism and Asperger's syndrome. *Journal of Child Psychology and Psychiatry, 35*, 1033-1057.

Dawson, G., Carver, L., Meltzoff, A. N., Panagiotides, H., McPartland, J., & Webb, S. J. (2002). Neural correlates of face and object recognition in young children with autism spectrum disorder, developmental delay and typical development. *Child Development, 73*, 700-717.

Dawson, G., Meltzoff, A. N., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders, 28*, 479-485.

Dawson, G., Webb, S. J., Carver, L., Panagiotides, H., & McPartland, J. (2004). Young children with autism show atypical brain responses to fearful versus neutral facial expressions of emotion. *Developmental Science, 7*, 340-359.

de Gelder, B., Vroomen, J., & Van der Heide, L. (1991). Face recognition and lip-reading in autism. *European Journal of Cognitive Psychology, 3,* 69-86.

De Sonneville L.M.J., Verschoor C.A, Njikiktjien C., Op het VeldV., Toorenaar N., & Vranken M. (2002). Facial identity and facial emotions: speed, accuracy, and processing strategies in children and adults. *Journal of Child and Experimental Neuropsychology, 24,* 200-213.

Deruelle, C., & Fagot, J. (2005). Categorizing facial identities, emotions, and genders: Attention to high- and low-spatial frequencies by children and adults. *Journal of experimental child psychology, 90*, 172-184.

Driver, J., Davis, G., Ricciardelli, P., Kidd, P., Mazwell, E., & Baron-Cohen, S. (1999). Gaze perception triggers reflexive visuospatial orienting. *Visual Cognition, 6,* 509-540.

Denham, S.A., & Couchard, E.A. (1990). Young preschoolers understanding of emotion. *Child Study Journal, 20*, 171-191.

Denham, S. A., McKinley, M., Couchoud, E.A., & Holt, R. (1990). Emotional and behavioral predictors of preschool peer ratings. *Child Development*, *61*, 1145-1152.

Deruelle, C., Rondan, C., Gepner, B., & Tardif, C. (2004). Spatial Frequency and Face Processing in Children with Autism and Asperger Syndrome. *Journal of Autism and Developmental Disorders*, *34*, 199-210.

Diamond, R. & Carey. S. (1977). Developmental changes in the presentation of faces. *Journal of Experimental Child Psychology, 23*, 1-22.

Dodge, K.A. (1980). Social cognition and children's aggressive behavior. *Child Development,51*, 162-170.

Dodge, K.A., Murphy, R.M., & Buchsbaum, K. (1984). The assessment of intention-cue detection skills in children: Implications for developmental psychopathology. *Child Development, 55*, 163-173.

Dunn, J. ((2002). Mindreading, emotion understanding, and relationships. In Hartup, W. Willard, R.K. Silbereisen (Eds.), US: Psychology Press.

Durand, K., Gallay, M., Seigneuric, A., Robichon, F., & Baudouin, J.Y. (2007). The development of facial emotion recognition: The role of configural information. *Journal of Experimental Child Psychology, 97*, 14-27.

Dyck, M.J., Ferguson, K., & Schochet, I.M (2001). Do autism spectrum disorders different from each other and from non-spectrum disorders on emotion recognition tests? *European Child and Adolescent Psychiatry, 10,* 105-116.

Ekman, P. (1971). Constant across cultures in the face and emotion. *Journal of Personality and Social Psychology*, *17*, 124-129.

Ekman, P., Freisen, W.V., O'Sullivan, M., Chan, A., Diacoyanni-Tarlatzis, I., & Heider, K., et al. (1987). Universal and cultural differences in the judgments of facial expressions of emotion. *Journal of Personality and Social Psychology, 53*, 712-717.

Ellis, H.D., & Flin, R.H. (1990). Encoding and storage effects in 7-year-olds and 10-year-olds memory for faces. *British Journal of Developmental Psychology*, *8*, 77-92.

Fabes, R., Eisenberg, N., Nyman, M., & Michealieu, Q. (1991). Young children's appraisals of others' spntaneous emotional reactions. *Developmental Psychology, 27*, 858-866.

Friesen, C.K., & Kingstone, A. (1998). The eyes have it: Reflexive orienting is triggered by reflexive attentional effects. *Cognition, 87*, B1-B10.

Fein, D., Lucci, D., Braverman, M., & Waterhouse, L. (1992). Comprehension of affect in context in children with pervasive developmental disorders. *Journal of Child Psychology and Psychiatry, 33*, 1157-1167.

Field, T.M, & Walden, T.A. (1982). Production and discrimination of facial expressions by preschool children. *Child Development, 53*, 1299-1300.

Field, T.M., Woodson, R., Greenburg, R., & Cohen, D. (1982). Discrimination and imitation of facial expression by neonates. *Science, 212*, 179-181.

Fine, S.E., Izard, C.A., & Trantacosta, C.J. (2006). Emotion situation knowledge in elementary school: models of longitudinal growth and preschool correlates. *Social Development, 15*, 730-751.

Fine, S.E., Izard, C.E., Mostow, A.J., Trentacosta, C.J., & Ackerman, B.P. (2003). First grade emotion knowlegde predictor of fifth grade self-reported intenalizing behaviors in children from econmically-disadvantaged families. *Development and Psychopathology, 15*, 331-342.

Flin, R., Markham, R., & Davies, G. (1989). Making faces: developmental trends in the construction and recognition of photofit face composites. *Journal of Applied Developmental Psychology, 10*, 131-145.

Fombonne E. (2003). Epidemiologic surveys of autism and other pervasive developmental disorders: An update. *Journal of Autism and Developmental Disorders, 33*, 365-82.

Freire, A., Lee, K., & Symons, L. (2000). The face-inversion effect as a deficit in the encoding of configural information: Direct evidence. *Perception, 29*, 159-170.

Gao, X., & Maurer, D. (2009). Influence of intensity on children's sensitivity to happy, sad, and fearful facial expressions. *Journal of Experimental Child Psychology, 102*, 503-521.

Garner, P.W., Jones, D.C., & Miner, J.L. (1994). Social competence among low-income preschoolers: Emotion socialization practices and social cognitive correlates. *Child Development, 65*, 622-637.

Gillberg, C. (1991). Debate and argument: Is autism a pervasive developmental disorder? *Journal of Child Psychology and Psychiatry, 32*, 1169-1170.

Greenspan, S., Barenboim, C., & Chandler, M.J (1976). Empathy and pseudoempathy: the affective judgments of first- and third-graders. *Journal of Genetic Psychology, 129*, 77-88.

Gross, T.F. (2004). The perception of four basic emotions in human and nonhuman faces by children with autism and other developmental disabilities. *Journal of Abnormal Child Psychology, 32*, 469-480.

Gross, A.L., & Ballif, B. (1991). Children's understanding of emotion from facial expressions and situations: A review. *Developmental Review, 11*, 368-398.

Grossman, J.B., Klin, A., Carter, A.S., & Volkmar, F. (2000). Verbal bias in recognition of facial emotions in children with Asperger's syndrome. *Journal of Psychology and Psychiatry, 41*, 369-379.

Gnepp, J. (1983). Children's social sensitivity: Inferring emotions from conflicting cues. *Developmental Psychology, 19*, 805-814.

Goldberg, J., Szatmari, P., & Nahmias, C. (1999). Imaging of autism: Lessons from the past to guide studies in the future. *Canadian Journal of Psychiatry, 44*, 793-801.

Herba, H.B., Landau S., Russell T., Ecker C., & Phillips, M.L. (2006). The development of emotion-processing in children: effects of age, emotion, and intensity. *Journal of Child Psychology and Psychiatry, 47*, 1098-1106.

Hainline, L. (1978). Developmental changes in visual scanning of face and nonface patterns by infants. *Journal of Child Psychology, 25*, 90-115.

Howard, M. A., Cowell, P.E., Boucher, J., Broks, P., Mayes, A., Farrant, A., et al. (2000). Convergent neuroanatomical and behavioral evidence of an amygdala hypothesis of autism. *Neuroreport, 11*, 2931-2935.

Kjelgaard, M.M., & Tager-Flusberg, G. (2001). An investigation of language impairment in autism: Implications for genetic subgroups. *Language and Cognitive Processes, 16*, 287-308.

Klin, A., Jones, W., Schultz, R., Volkmar, F., & Cohen D. (2002). Visual fixation patterns during viewing of naturalistic social situations as predictors of social competence in individuals with autism. *Archives of General Psychiatry, 59*, 809-816.

LeDoux, J.E. (1996). *The emotional brain: The mysterious underpinnings of emotional life*. New York: Simon and Schuster.

Izard, C.E., (1978). Emotions and emotion-cognition relationships. In M. Lewis & J. M Haviland-Jones (Eds.), *Handbook of emotions* (2nd Edition, pp. 458-475), New York, NY: The Guildford Press.

Hale, C.M., & Tager-Flusberg, H. (2005). Brief report: The relationship between discourse deficits and autism symptom logy. *Journal of Autism and Developmental Disorders, 35*, 519-524.

Hess, U., Blairy, S., & Kleck, R.E. (1997). The intensity of emotional facial expressions and decoding accuracy. Journal of Nonverbal Behavior, 21, 241-257.

Herba, C.M., Benson, P., Landau, S., Russell, T., Goodwin, C., Lemche, E., Santosh, P., & Phillips, M. (2008). Impact of familiarity upon children's developing facial expression recognition. *Journal of Child Psychology and Psychiatry, 49*, 201-210.

Herba, C.M., Landau, S., Russell, T., Ecker, C., & Phillips, M. L. (2006). The development of emotion-processing in children: effects of age, emotion, and intensity. *Journal of Child Psychology and Psychiatry, 47,* 1098-1106.

Hillier, A. & Allinson, L. (2002). Understanding embarrassment among those with autism: Breaking down the complex emotion of embarrassment among those with autism. *Journal of Autism and Developmental Disorders, 32*, 583-592.

Hill, E., Berthoz, S., Frith, U. (2004). Brief Report: Cognitive processing of won emotions in individuals with autistic spectrum disorder and in their relatives. *Journal of Autism and Developmental Disorders, 34*, 229-235.

Hoffner, C., & Badzinski, D. M. (1989). Children's integration of facial and situational cues to emotion. *Child Development*, *60*, 411-422.

Hobson, R. P., Ouston, J., & Lee, A. (1989). Naming emotion in faces and voices: Abilities and disabilities in autism and mental retardation. *British Journal of Developmental Psychology, 7*, 237-250.

Hobson, R. P., Ouston, J., & Lee, A. (1988). What is in the face? The case of autism. *British Journal of Developmental Psychology, 79*, 441-453.

Hobson, R. P. (1986). The autistic child's appraisal of expressions of emotion. *Journal of Child Psychology and Psychiatry, 27*, 321-342.

Hobson, R. P. (1986). The autistic child's appraisal of expressions of emotion: A further study. *Journal of Child Psychology and Psychiatry, 27*, 671-680.

Hood, B.M., Macrae, N.C., Cole-Davies, V., & Davies, M. (2003). Eye remember you: The effects of gaze direction on face recognition in children and adults. *Developmental Science, 6*, 67-71.

Hood, B. M., Willen, J.D., & Driver, J. (1998). Adults' eyes trigger shifts of visual attention in human infants. *Psychological Science*, *12*, 360-365.

Joseph, R. M., & Tanaka, J. (2003). Holistic and part-based face recognition in children with autism. *Journal of Child Psychology and Psychiatry, 44*, 529-542.

Kasari, C., Freeman, S., Mundy, P., & Sigman, M.D. (1995). Attention regulation by children with Down-syndrome- coordinated joint attention and social referencing looks. *American Journal on Mental Retardation, 100*, 128-136.

Kohler, C.G., Turner, T.H., Bilker, W.B., Brensinger, C.M., Siegel, S.J Kanes, S.J., et al. (2003). Facial emotion recognition in schizophrenia: Intensity effects and error pattern. *American Journal of Psychiatry, 160*, 1768-1774.

Kylliainen, A., & Hietanen, J. K. (2004). Attention orienting by another's gaze direction in children with autism. *Journal of Child Psychology and Psychiatry, 45*, 435-444.

Lahaie, A., Mottron, L., Arguin, M., Berthiaume, C., Jemel, B., & Saumier, D. (2006). Face perception in high-functioning autistic adults: Evidence for superior processing of face parts, not for a configural face-processing deficit. *Neuropsychology, 20*, 30-41.

Langton, S. R. H., Watt, R. J., & Bruce, V. (2000). Do the eyes have it? cues to the direction of social attention. *Trends in cognitive sciences, 4*, 50-59.

Lenti, C., Lenti-Boero, D., & Glacobbe, A. (1999). Decoding of emotional expressions in children and adolescents. *Perceptual and Motor Skills, 89*, 808-814.

Lewis, M. (2000a). The emergence of human emotions, In M. Lewis & J.M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd Edition, pp.265-280). New York, NY: The Guilford Press.

Lewis, M. (2000b). Self-conscious emotions: embarrassment, pride, and guilt, In M. Lewis & J,M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd Edition, pp.623-636). New York, NY: The Guilford Press.

Losh, M., & Capps, L. (2006). Understanding of emotional experience in autism: Insights form the personal accounts of high-functioning children with autism. *Developmental Psychology, 42*, 809-818.

Macrae, C.N., Hood, B.M., Milne, A.B., Rowe, A.C., & Mason, M.F. (2002). Are you looking at me? Eye gaze and person perception. *Psychological Science, 13,* 460-464.

Macdonald, H., Rutter, M., Howlin, P., Rios, P., LeCouteur, A., Evered, C. & Folstein, S. (1989). Recognition and expression of emotional cues by autistic and normal adults. *Journal of Child Psychology and Psychiatry, 30,* 865-877.

Markham, R., & Adams, K. (1992). The effect of type of task on child identification of facial expressions. *Journal of Nonverbal Behavior, 16*, 21-39.

Mazefsky, C.A., & Oswald, D.P. (2007). Emotion perception in Asperger's syndrome and high-functioning autism: The importance of diagnostic criteria and cue intensity. *Journal of Autism and Developmental Disorders, 37,* 1086-1095.

Maratos, F.A., Mogg, K,., & Bradley, B.P. (2008). Identification of angry faces in the attentional blink. *Cognition & Emotion, 22,* 1340-1352.

McPartland, J., Dawson, G., Webb, S.J., Panagiotides, H., & Carver, L.J. (2004). Event-related brain potentials reveal anomalies in temporal processing of faces in autism spectrum disorder. *Journal of Child Psychology and Psychiatry, 45*, 1235-1245.

Meltzoff, A.N., Gopnik, A., & Repacholi, B.M. (1999). *Toddlers' understanding of intentions, desires and emotions: Explorations of the dark ages.* In P. D. Zelazo, J. W. Astington, & D. R. Olson (Eds.), Developing theories of intention: Social understanding and self-control (pp. 17-41). Mahwah, NJ: Erlbaum. W.

Mogg, K., & Bradley, B.P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research and Therapy, 36*, 809-848.

Mondloch, C.J., Geldart, S., Maurer, D., & LeGrand, R. (2003). Developmental changes in face processing skills. *Journal of Experimental Child Psychology, 86*, 67-84 Associates Publishers.

Mondloch, C.J., LeGrand, R., & Maurer, D. (2002). Configural face processing develops more slowly than featural face processing. *Perception, 31(5),* 553-566.

Mondloch, C.J., Maurer, D., & Ahola, S. (2006). Becoming a Face Expert. *Psychological Science, 17*, 930-934.

Mundy, P. & Burnette, C. (2005). *Joint attention and neurodevelopment*. In F. Volkmar, A.Klin, & R. Paul (Eds.), Handbook of Autism and Pervasive Developmental Disorders, (pp. 650-681). Hoboken, NJ: John Wiley.

Mundy, P., Sigman, M., Ungerer, J., & Sherman, T. (1986). Defining the social deficits of autism: the contribution of non-verbal communication measures. *Journal of Child Psychology and Psychiatry, 27*, 657-659.

Nelson, C.A. (1987). The recognition of facial expressions in the first two years of life: mechanism of development. *Child Development, 58,* 889-909.

Nelson, C.A., & DeHaan, M. (1996). Neural correlated of infants visual responsiveness to facial expression of emotion. *Developmental Psychology, 29*, 577-595.

Ohman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology, 80*, 381-396

Osterling, J., & Dawson, G. (1994). Early recognition of children with autism: A study of first birthday home videotapes. *Journal of Autism and Developmental Disorders, 24*, 247-257.

Oznoff, S., Pennington, B., & Rogers, S.J. (1990). Are there emotion perception deficits in young autistic children? *Journal of Child Psychology and Psychiatry, 31*, 343-363.

Palermo, M.T., Pasqualetti, P., Barbati, G., Intelligente, F., & Rossini, P.M. (2006). Recognition of schematic facial displays of emotion in parents of children with autism. *Autism*, *10*, 353-364.

Pelphrey, K.A., Sasson, N.J., Reznick, J.S., Paul, G., Goldman, B.D., & Piven, J. (2002). Visual scanning of faces in autism. *Journal of Autism and Developmental Disorders, 32*, 249-261.

Pierce, K., Muller, R.A., Ambrose, J., Allen, G., & Courchesne, E. (2001). Face processing occurs outside the fusiform “face area” in autism: Evidence form functional MRI. *Brain, 124*, 2059-2073.

Puce, A., Allison, T., Bentin, S., Core, J.C., & McCarthy, G. (1998). Temporal cortex activation in humans viewing eye and mouth movements. *Journal of Neuroscience*, *18*, 2188-2199.

Rakover, S. S. (2002). Featural vs. Configural information in faces: A conceptual and empirical analysis. *British Journal of Psychology*, *93*, 1-30.

Reginald, A.B., & Kleck, R.E. (2003). Perceived gaze direction and the processing of facial displays of emotion. *Psychological Science*, *14*, 644-647.

Reginald, A.B., Gordon, H., Baird, A.A., Ambday, N., & Kleck, R.E. (2003). Effects of gaze on amygdale sensitivity to anger and fear faces. *Science, 300*, 1536-1538.

Reichenbach, L., & Masters, J. (1983). Children's use of expressive and contextual cues in judgments of emotion. *Child Development, 54*, 993-1004.

Rieffe, C., Terwogt, M.M., & Kotronopoulou, K. (2007). Awareness of single and multiple emotions in high-functioning children with autism. *Journal of Developmental Disorders*, *37*, 455-465.

Russell, J.A. (1990). The preschooler's understanding of the causes and consequences of emotion. *Child Development, 61*, 1872-1881.

Rutter, M. (2005). Incidence of autism spectrum disorders: Changes over time and their meaning. *Acta Paediatrica*, *94*, 2-15.

Sato, W., Kochiyama, T., Yoshikawa, S.,& Matsumura, M. (2004). The amygdale process the emotional significance of facial expressions: An fMRI investigation using the interaction between expression and face direction. *NeuroImage, 22*, 1106-1013.

Sato, W., Kochiyama, T., Yoshikawa, S., Naito, E., & Matsumura, M. (2004). The amygdula processes the emotional significance of facial expressions: An fMRI study. *Cognitive Brain Research, 20*, 81-91.

Schnull, S., & Laird, J.D. (2003). Keep smiling: Enduring effects of facial expressions and postures on emotinal experience and memory. *Cognition and Emotion, 17*, 787-797.

Schultz, R. T (2000). Abnormal ventral temporal cortical activity during face discrimination among individuals with autism and Asperger syndrome. *Achieves in General Psychiatry, 57*, 331-340.

Senju, A., Tojo, Y., Yaguchi, K., & Hasegawa, T. (2005). Deviant gaze processing in children with autism: An ERP study. *Neuropsychologia, 43*, 1297-1306.

Senju, A., Yaguchi, K., Tojo, Y., & Hasegawa, T. (2003). Eye contact does not facilitate detection in children with autism. *Cognition, 89*, B43-B51.

Sigman, M.D., Kasari, C., Kwon, J.H., & Yirmiya, N. (1992). Responses to the negative emotions of others by autistic, mentally retarded, and normal children. *Child Development, 63*, 796-807.

Smith, M., & Walden, T. (1998). Developmental trends in emotion understanding among a diverse sample of African- American preschool children. *Journal of Applied Developmental Psychology, 19*, 177-198.

Smiley, P., & Huttenlocher, J. (1989). Young children's acquisition of emotion concepts, In C. Saarni (Ed.), *Children's understanding of emotions (pp.27-49)*. Cambridge: United Press

Sorce, J.F., Emde, R.N., Campos, J.J., & Klinnert, M.D. (1985). Maternal emotional signaling: Its effects on the visual cliff behavior of 1-year-olds. *Developmental Psychology, 21*, 195-200.

Spezio, M.L., Adolphs, R., Hurely, R.S., & Piven, J. (2007). Abnormal use of facial information in high-functioning autism. *Journal of Autism and Developmental Disorders, 37*, 929-939.

Sprengelmeyer, R., & Jentzsch, I. (2006). Event related potentials and the perception of intensity in facial expressions. *Neuropsychologia, 44*, 2899-2906.

Szatmari, P., Merette, C., Bryson, S.E., Thivierge, J., Roy, M., Cayer.M., & Maziade, M. (2002). Quantifying dimensions in autism: A factor-analytic study. *Journal of the American Academy of Child & Adolescent Psychiatry, 41*, 467-474.

Tanaka, J.W., & Farah, M.J. (1993). Parts and wholes in face recognition. *Journal of Experimental Psychology, 46a*, 225-245.

Tanaka, J & Sengco, J. (1997). Features and their configuration in face recognition. *Memory and Cognition, 25*, 583-592.

Tantam, D., Monaghan, L., Nicholson, J. & Stirling, J (1989). Autistic children's ability to interpret faces: A research note. *Journal of Child Psychology and Psychiatry, 30*, 623-630.

Thomas, L.A., De Bellis, M.D., Graham, R., & LaBar, K.S. (2007). Development of emotional facial recognition in late childhood and adolescence. *Developmental Science, 10*, 547-558.

Thomas, K.M., Drevets, W.C., Whalen, P.J., Eccard, C.H., Dahl, R.E., Ryan, N.D., & Casey, B.J. (2001). Amygdala response to facial expressions in children and adults. *Biological Psychiatry, 49*, 309-316.

Tipples, J. (2006). Fear and fearfulness potentiate automatic orienting to eye gaze. *Cognition and Emotion, 20*, 309-320.

Trepagnier, C. G. (1998). Virtual environments for the investigation and rehabilitation of cognitive and perceptual impairments. *NeuroRehabilitation, 12*, 63-72.

Trepagnier, C., Sebrechts, M.M., & Peterson, R. (2002). Atypical face glaze in autism. *CyberPsychology & Behavior, 5,* 213-217.

Vacera, S.P., & Johnson, M.H. (1995). Gaze detection and the cortical processing of faces: Evidence from infants and adults. Visual Cognition, 2, 59-87.

Van der Geest, J. N., Kemner, C., Camfferman, G., Verbaten, M. N., & van Engeland, H. (2002). Looking at images with human figures: Comparison between autistic and normal children. *Journal of Autism and Developmental Disorders, 32*, 69-75.

Vicari, S., Reilly, J.S., Pasqualetti, P., Vizzotto, A., & Caltagirone, C. (2000). Recognition of facial expressions of emotions in school-age children: The intersection of perceptual and semantic categories. *Acta Paediatrica, 89*, 836-845.

Vig, S., & Jedrysek, E. (1999). Autistic features in young children with significant cognitive impairment: Autism or mental retardation? *Journal of Autism and Developmental Disorders, 29*, 235-248.

Volkmar, F., Chawarska, K., & Klin, A. (2005). Autism in Infancy and Early Childhood. *Annual Review of Psychology, 56*, 315-336.

Volkmar, F.R., & Mayers, L.C. (1990). Gaze behavior in autism. Development and *Psychopathology, 2,* 61-69.

Volkmar, F.R., Szatmari, P., & Sparrow, S.S. (1993). Sex differences in pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 23*, 579-591.

Wallace, S., Coleman, M., & Bailey, A. (2008). An investigation of basic facial expression recognition in autism spectrum disorders. *Cognition and Emotion, 22*, 1353-1380.

Weeks, S.J. & Hobson, R.P. (1987). The salience of facial expression for autistic children. *Journal of Child Psychology and Psychiatry, 28*, 137-152

Widen, S. C., & Russell, J.A. (2003). A closer look at preschoolers' freely produced labels for facial expressions. *Developmental Psychology, 39*, 114-128.

Wing, L. (1997). The history of ideas on autism. *Autism, 1*, 13-23.

Yirmiya, N., Sigman, M.D., Kasari, C., & Mundy, P. (1992). Empathy and cognition in high-functioning children with autism. *Child Development, 63,* 150-160.

Yirmiya, N., Kasari, C., Sigman, M., & Mundy, P. (1989). Facial expressions of affect in autistic, mentally retarded and normal children. *Journal of Child Psychology and Psychiatry, 30*, 725-735.

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