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Emotion Perception in Asperger's Syndrome and High-functioning Autism: The Importance of Diagnostic Criteria and Cue Intensity

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Emotion Perception in Asperger's Syndrome and High-functioning Autism: The Importance of Diagnostic Criteria and Cue Intensity

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by
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ABSTRACT

EMOTION PERCEPTION IN ASPERGER'S SYNDROME AND HIGH-FUNCTIONING AUTISM: THE IMPORTANCE OF DIAGNOSTIC CRITERIA AND CUE INTENSITY

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Asperger's syndrome (AS) is a pervasive developmental disorder that is associated with marked social dysfunction. Deficits in the perception of nonverbal cues of emotion may be related to this social impairment. Research has indicated that children with autism are limited in their emotion perception abilities, but studies that have addressed this issue with individuals with AS or high-functioning autism (HFA) have yielded inconsistent findings. These inconsistencies may be related to methodological differences across studies including diagnostic criteria and failure to consider the intensity of the emotion cues. It was hypothesized that children with AS and HFA would both have deficits in emotion perception compared to typically-developing children. However, children with HFA were expected to have an even greater emotion perception deficit than children with AS and this difference was hypothesized to be most pronounced for low intensity cues of emotion. It is important to clarify whether individuals with AS and HFA differ in emotion perception because most studies of this skill combine them into one group or use poorly defined diagnostic criteria. This study examined the ability of 30 8- to 15-year-old

children with either AS or HFA to perceive emotion from high and low intensity cues. In order to address limitations with the differential validity of the DSM-IV criteria for AS, diagnoses were based on diagnostic criteria proposed by Klin et al. (in press). A researcher who was blind to diagnosis administered a test that presented low and high intensity cues of emotion in photographs of facial expression and audiotapes of tone of voice. Comparison of the emotion perception accuracy of children with AS to the normative means of this instrument for typically-developing children did not reveal any significant differences. In contrast, the children with HFA were significantly less accurate in their perception of facial expressions and tone of voice than the normative sample and the participants with AS. Contrary to expectations, IQ was significantly related to emotion perception accuracy. After controlling for IQ, the difference in perception of facial expressions between children with AS and HFA was not significant. On the other hand, cue intensity moderated the relation between diagnosis and emotion perception accuracy for tone of voice even after IQ was taken into account. Children with AS perceived high and low intensity tone of voice cues with similar accuracy, but children with HFA had significantly poorer performance on the low intensity tone of voice cues. Although emotion perception accuracy was related to better adjustment, it was not correlated with the most sensitive measure of current social functioning. This suggests that even when children with AS or HFA perceive cues correctly, they may not know how or be able to properly integrate them for adaptive responses in social interaction. The findings have important implications for understanding inconsistencies in past research and identifying future directions.

LITERATURE REVIEW

Both Asperger's syndrome and autism are pervasive developmental disorders that involve impairment in social functioning and communication and the presence of repetitive behaviors, but individuals with classic forms of autism are considered lower functioning. Higher-functioning individuals with autism have not been clearly differentiated from individuals with Asperger's syndrome using current diagnostic criteria, but new diagnostic criteria with more specificity regarding the early development of children with Asperger's syndrome have demonstrated better differential ability for Asperger's syndrome. Social dysfunction is considered the most debilitating feature of Asperger's syndrome.

The perception of nonverbal cues of emotion is critical for successful social interaction. Research has uniformly found that individuals with classic autism are impaired in their ability to perceive nonverbal cues of emotion, but the findings of studies of higher functioning individuals with pervasive developmental disorders such as those with Asperger's syndrome and high-functioning individuals with autism have been inconsistent. These inconsistencies may be related to methodological differences across studies including use of different diagnostic criteria and failure to consider the intensity of the emotion cues. Studies have varied the diagnostic criteria used to screen participants and have often failed to differentiate between individuals with Asperger's syndrome and those with other diagnoses, such as high-functioning autism. The intensity of emotional cues is also likely to influence the accuracy of emotion perception in those with Asperger's syndrome, yet cue intensity has not been varied within any study of emotion

perception in this population. This study compared children with Asperger's syndrome with those with high-functioning autism in their ability to perceive nonverbal emotion cues using a measure that presents facial expressions and voices conveying emotions that vary in intensity.

This section presents the literature examining Asperger's syndrome and emotion perception. First, pervasive developmental disorders are described to provide a context for understanding Asperger's syndrome. Complications involving current diagnostic criteria for Asperger's syndrome are discussed. A new model for diagnosis that provides stronger support for Asperger's syndrome as a disorder distinct from other pervasive developmental disorders is presented. Next, the implications of the social dysfunction in Asperger's syndrome are highlighted. The relation between social development and emotion understanding is considered, with a particular focus on theory of mind skills and the role of nonverbal cues of emotion. Then, the emotion perception development of typical children is described. Studies of emotion perception abilities in both classic autism and higher-functioning individuals with pervasive developmental disorders are presented next. Finally, the role of cue intensity in understanding conflicting results in studies of emotion perception abilities in Asperger's syndrome is considered.

Differentiation of Asperger's Syndrome

Pervasive developmental disorders are "characterized by severe and pervasive impairment in several areas of development: reciprocal social interaction skills, communication skills, or the presence of stereotyped behavior, interests, and activities," that is deviant in quality relative to developmental age (American Psychiatric

Association, 1994, pp. 65). Autistic disorder, or autism, is considered the core pervasive developmental disorder. Leo Kanner (1943) first identified this disorder, which he described as marked by aloofness, indifference to social contact, and significant withdrawal. Kanner noted that those with autism also suffered from profound language delays and difficulties, impaired nonverbal communication, and repetitive movements.

Because there is a range of symptom severity in autism, descriptive terms are commonly used to depict the level of functional impairment within this diagnosis. "Classic autism" refers to the prototypical case as described by Kanner (1943). Those with classic autism typically have a total lack of language or minimal language that is predominantly nonfunctional. Nonfunctional language is self-directed in nature and can involve echolalia, which is when an individual repeats phrases that have been said to him or that he has heard on television. Repetitive behaviors seen in classic autism tend to involve unusual play patterns (e.g. preferring to line or stack objects) or focus on particular parts of a toy (e.g. spinning a wheel) (Kanner & Eisenberg, 1956). Stereotyped movements are also present, such as hand flapping or rocking. Those with classic forms of autism do not enjoy reciprocal social interaction and tend to be isolated (Kanner, 1943). Most individuals considered to have classic autism also meet criteria for mental retardation. On the other hand, "High-functioning autism" (HFA) is a term used to describe a group of individuals who meet criteria for autism and are socially withdrawn, but have better-developed skills in the areas of language and intellectual ability than those with classic autism (Schopler, Mesibov, & Kunce, 1998). They are likely to be able to express themselves, while still retaining abnormal speech features such as echolalia.

A disorder related to autism is Asperger Syndrome (AS). AS is the most recently acknowledged pervasive developmental disorder, though it was introduced nearly 60 years ago by Austrian psychiatrist, Hans Asperger (1944). Like autism, AS is characterized by social dysfunction. Those with AS tend to seek out social engagement, but have a markedly limited understanding of social conventions and rules. They approach social situations in an overly rigid, moralistic, and naïve manner (Wing, 1981). Their expressive language abilities are sometimes thought of as "hyper-developed" due to the presence of significant verbosity. The language difficulties seen in AS are restricted to the social use of language, such as a rigid and literal use of language and problems understanding conversational rules (Landa, 2000). They frequently engage in one-sided monologues of facts related to all-absorbing interests of a factual nature during attempts at social interaction (Frith, 1991; Klin, Pauls, Schultz, & Volkmar, in press; Volkmar, Klin, Schultz, Rubin, & Bronen, 2000). Although associated characteristics have been noted, such as motor clumsiness (Gillberg, 1989) and abnormal tone of voice modulation (Bonnet & Gao, 1996), dysfunction in reciprocal social interaction is uniformly considered the most obvious and debilitating trait of those with AS (Frith, 1991; Wing, 1981).

The characteristic social impairment in AS led to its recognition nine years ago in the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV; American Psychiatric Association, 1994) as one of the Pervasive Developmental Disorders. Clinical use of the term has since increased dramatically (Smith-Myles & Simpson, 2002; Volkmar et al., 2000). Although prevalence rates of AS have not been

established, estimates vary from 4.8 (Kadesjo, Gillberg, & Nagberg, 1999) to 7.6 (Ehlers & Gillberg, 1993) out of every 1000 children.

Despite the growing use of the AS diagnosis since its inclusion in the DSM-IV, a consensus has developed regarding the inadequacy of the DSM-IV diagnostic criteria for AS (Freeman, Cronin, & Candela, 2002; Klin, Volkmar, & Sparrow, 2000; Schopler et al., 1998; Szatmari, 2000). Several studies have shown that the current DSM-IV diagnostic criteria are too vague and do not allow for a valid differentiation of those with AS from autism (Kugler, 1998; Leekam, Libby, Wing, Gould, & Gillberg, 2000; Mayes & Calhoun, 2001; Ozonoff, South, & Miller, 2000). When the DSM-IV was developed, there was an awareness of the great heterogeneity of symptoms in pervasive developmental disorders and a need for subtyping in order to promote advancement through research (Klin et al, in press; Kugler, 1998). Literature reviews used by the American Psychiatric Association committee also supported the growing awareness of AS. However, minimal empirical information on specific points of differential diagnosis was available when the DSM-IV criteria were developed (Szatmari, 1998). Therefore, the resultant AS and autism criteria in the DSM-IV are identical in many respects (e.g. identical requirements for social impairment). The only AS criteria that are not exact replicas of the autism criteria specify that language and cognitive development must not be delayed (American Psychiatric Association, 1994). This does not, however, clearly differentiate AS from autism because delayed language development is listed only as a possible (not necessary) symptom of autism and cognitive functioning is not mentioned in the autism criteria. The ambiguously defined DSM-IV criteria for AS have resulted in

the interchangeable use of AS with other diagnostic labels to denote lesser variants of classic autism, including HFA and pervasive developmental disorder not otherwise specified (Volkmar et al., 2000; Volkmar et al., 1994). Pervasive developmental disorder not otherwise specified is a subthreshold category reserved for those who do not meet criteria for another pervasive developmental disorder yet display deviant social or communication development (American Psychiatric Association, 1994).

Klin et al.(in press) directly compared individuals with AS, autism, and pervasive developmental disorder not otherwise specified when based on DSM-IV criteria, criteria based on the presence of speech delay, and a newly developed set of criteria to determine the extent to which the validity of AS as a distinct disorder is dependent on the diagnostic criteria. Klin et al.'s (in press) newly developed criteria are more detailed than the DSM-IV criteria in that they require the presence of social dysfunction despite being socially motivated, evidence of verbosity and pragmatic language concerns, and the development of all-absorbing interests of a factual nature. These criteria provided the greatest differentiation between AS and other pervasive developmental disorders based on IQ, genetic liability, and comorbid symptomatology (Klin et al., in press). Using the new diagnostic criteria, those with AS had a greater verbal than performance IQ. This supports previous findings that have also indicated a distinct IQ profile for those with AS (Klin, Volkmar, Sparrow, Cicchetti, & Rourke, 1995; Wing, 1981). Aggregations of symptoms in parents and grandparents also suggested differences for those with AS when diagnosed with the new criteria. Specifically, parents and grandparents of individuals with AS had the highest rate of social difficulties (Klin et al., in press). In addition, the

presence of anxiety problems in parents and grandparents of those with AS was higher than those with autism and lower than those with pervasive developmental disorder not otherwise specified. Patterns of comorbidity also differentiated those with AS from those with pervasive developmental disorder not otherwise specified. Overall, Klin et al.'s (in press) findings add to studies that have found AS to be distinct from HFA (Klin, Volkmar et al., 1995; Szatmari, Archer, Fisman, Streiner, & Wilson, 1995; Volkmar et al., 1996). This is in contrast to the view that AS and HFA are actually the same thing and that AS does not exist as a separate disorder (e.g. Macintosh & Dissanayake, 2004; Ozonoff et al., 2000; Schopler et al., 1998).

The diagnostic criteria for AS proposed by Klin et al. (in press) address specific concerns regarding the DSM-IV criteria. In particular, the DSM-IV criteria for AS have been criticized for being overly exclusive, resulting in an underestimate of the prevalence of AS in the population (Szatmari, 1998; Volkmar & Klin, 2000). This is primarily due to a precedence rule in the DSM-IV that requires a diagnosis of AS to be excluded if all criteria for autism are met. This precedence rule was adopted based on stronger psychometric support for the autism DSM-IV criteria in lieu of the ambiguity and lack of research on the DSM-IV criteria for AS. It has been suggested that reversing the precedence rule while providing greater detail in the criteria for AS would result in a more accurate representation of these disorders. Therefore, the criteria developed by Klin et al. (in press) provide greater specificity in the AS criteria and switched the precedence rule, such that meeting all criteria for AS would rule out a diagnosis of autism.

The greater detail in the new AS diagnostic criteria developed by Klin et al. (in press) reflect commonly accepted conceptualizations of AS (Smith-Myles & Simpson, 2002; Volkmar et al., 2000; Wing, 1981) and better follow Asperger's (1944) original description. The Klin et al. (in press) criteria are also consistent with changes made in the written description of AS in the recent text revision of the DSM-IV (American Psychiatric Association, 2000). First, in order to meet criteria for AS with Klin et al.'s new diagnostic criteria, one must have not only acquired language skills, but there must also be the presence of verbosity. The atypical language features, such as echolalia, that are seen in classic and HFA are not present in AS. Rather, language concerns are restricted to pragmatic problems such as a one-sided style, tangential content, and difficulty with conversational rules. The repetitive behaviors of those with AS are characterized by the development of all-absorbing factual interests called circumscribed interests. Individuals with AS tend to acquire a great deal of information about these topics and frequently insert it into conversation with others. These circumscribed interests are required for diagnosis based on the new criteria and form the majority of the repetitive behaviors seen in AS. The repetitive motor mannerisms or stereotyped play patterns seen in autism must not be present for a diagnosis of AS. Individuals with AS must have been socially motivated in their early years in contrast to the social avoidance in both classic autism and HFA (Smith-Myles & Simpson, 2002; Tantam, 1988). Despite their social motivation, individuals with AS are very unsuccessful in their social attempts and suffer from severe social difficulties that cause a great deal of impairment.

Challenges related to the social dysfunction in AS are numerous and become more profound with the increasing complexity of social demands throughout life (Tantam, 2000). Volkmar et al. (2000) described a case of an 11-year-old boy with AS who had the verbal abilities of a 17-year-old but was inept socially, with social skills at the 3-year-old level. A 12-year-old boy with AS described the pain and frustration associated with difficulty understanding the social world: "...It's a vicious circle. 1. I get teased. 2. I make myself miserable and cynical. 3. I get teased again....The best school would be one where I spent my time working with machines -- remove the human factor" (Tantam, 2000, pp.147). A cycle of peer rejection typically begins early in life due to the social awkwardness of those with AS (Volkmar et al., 2000). As many as 64% of children with AS experience severe victimization, in the form of physical aggression or extreme teasing (Tantam, 2000). Because children with AS are typically interested in having friends (Volkmar & Klin, 2000), this victimization and rejection often leads to loneliness and depression (Ghaziuddin, 2002; Wing, 1981). A review of studies found a pattern of psychiatric disturbance indicating that approximately 40% of adults with AS suffer from clinical depression (Howlin, 2000). One study found that as many of 80% of adolescents with AS had been prescribed anti-depressants (Barnhill & Myles, 2001). Many adults with AS are without significant social relationships (Gutstein & Whitney, 2002), because social competence does not improve merely as a function of age (Smith-Myles & Simpson, 2002). Identifying specific components of social competence that are limited in children with AS may be an important first step in helping those with AS decrease this pattern of rejection and psychopathology.

In summary, AS is a pervasive developmental disorder characterized by significant social dysfunction despite reasonably intact intellectual and verbal functioning. Due to vague diagnostic criteria in the DSM-IV, AS has frequently been used interchangeably with HFA to signify milder forms of classic autism. However, carefully defined diagnostic criteria and clinical impression suggest that it differs from HFA based on the presence of social motivation, circumscribed interests, and verbosity in AS. The social dysfunction in AS is characteristic of the disorder and leads to marked impairment in social functioning, including rejection and victimization.

The Function of Emotion Understanding in Social Development

Theory of Mind

There has been increasing focus on the role of emotion in both normative and atypical developmental processes and social functioning (Dunn, 1999; Lewis & Sullivan, 1996; Southam-Gerow & Kendall, 2002). The ability to understand the emotions of others is just one of many emotion skills that have been linked to social adjustment (Denham, 1998). This is largely due to the foundational role of emotion understanding in social cognition (Denham, Zoler, & Couchouod, 1994). One aspect of emotion understanding that is particularly salient in interpersonal relationships and social cognition is the ability to discern how another individual is feeling (Denham, 1998).

An individual's emotional state provides unique information to others during an interaction (Bemporand, Ratey, & O'Driscoll, 1987; Clore & Parrott, 1991). Emotional communication is typically "spontaneous rather than premeditated, and is largely unconscious rather than deliberate" (Bemporand et al., 1987, pp. 478). Expressions of

emotion, therefore, provide more valid information on another's viewpoint than verbal communication (Nowicki & Duke, 1992). Perceiving emotions in others underlies a person's ability to appreciate another's *true* perspective (Dunn, 1999; Hobson, 1986a, 1993). Research suggests that there is a developmental progression that begins with understanding others' emotional states and develops into a more sophisticated understanding of cognitive states (Dunn, 2003). For example, infant emotion recognition generally involves a reaction to others' emotions, but later develops into a tool to understand how the other person's internal state and behavior are linked (Dunn, 2003). A mastery of emotion understanding is, therefore, critical to theory of mind, or the ability to infer the thoughts and beliefs of others (Ozonoff, Pennigton, & Rogers, 1991).

Theory of mind is thought of as "the foundational base of human interaction" (Klin, 2000, pp. 831). Without an understanding of how others may be feeling or thinking, it is difficult to coordinate one's behavior for appropriate social interaction (Badenes, Estevan, & Bacete, 2000; Gutstein & Whitney, 2002). For preschool children, this skill influences their ability to respond appropriately in play (Denham, 1998). In fact, understanding the perspectives of others can be predictive of friendship success (Slomkowski & Dunn, 1996). In addition, an abundance of research has focused on theory of mind as the possible underlying cause of the social dysfunction in pervasive developmental disorders (e.g. Baron-Cohen, 1989, 1991; Baron-Cohen, Leslie, & Frith, 1985; Serra, Minderaa, van Geert, & Jackson, 1999).

In summary, emotion understanding is a critical component of social cognition because of the unique information regarding one's perspective that one's emotional state

provides. The ability to perceive emotional states in others is a skill that develops prior to more sophisticated theory of mind abilities. Theory of mind is necessary for successful social interaction and involves developing an integrated view of another individual's beliefs, thoughts, and feelings. Given the developmental progression of emotion understanding skills followed by theory of mind skills, emotion understanding can be considered an essential foundation to appropriate social development.

Nonverbal Cues of Emotion

Emotion understanding involves the ability to correctly perceive, recognize, and label emotional cues (Denham, 1998). Southam-Gerow and Kendall (2002, pp. 200) identified the following levels of emotion understanding: "recognition of emotion expression (i.e., facial and body) and knowledge about (a) the causes of their (and others') emotions, (b) the cues for their (and others') feelings, (c) multiple emotions, (d) methods of intentionally using emotion expression to communicate to others (or vice versa; e.g. display rules and hiding emotions), and (e) methods of coping with emotions (i.e., knowledge about emotion regulation)." Given the increasingly sophisticated nature of the development of emotion understanding, one must first recognize and correctly perceive cues of emotion before emotion information can appropriately regulate an interaction. As noted by Denham (1998, p. 61), "comprehension of emotional expressions can be seen as the perceptual bedrock for further understanding of emotions."

Expressions of emotion are often nonverbal and include facial expression and tone of voice. There are specific patterns of facial expression and qualities of tone of voice that act as signals for basic emotions (Denham, 1998). Facial expressions are

thought to be discrete from a very young age (Ackerman, Abe, & Izard, 1998). Research on facial expressions indicates that emotional expressions similar to those of adults are present in infancy (Strongman, 1987). In addition, Izard (1972, 1977) and Eckman, Friesen, and Ellsworth (1972) have demonstrated that facial expressions of emotion, such as those for fear, anger, and sadness, are similarly used and understood cross-culturally.

Information about emotional states gathered from nonverbal cues plays an important role in understanding cognitions and behavior. Nonverbal cues of emotion often modify verbal information and thus need to be quickly integrated for effective communication (Klin, Jones, Schultz, Volkmar, & Cohen, 2002; Strongman, 1987). Misreading nonverbal emotional cues may result in failure to assess the other person's perspective and the true meaning of the situation, which precludes an adaptive response (Klin et al., 2002). For this reason, Denham (1998, p. 179) argues, "children who have acquired developmentally appropriate emotion knowledge are at a distinct advantage at many crucial moments during play." Individuals with nonverbal perception difficulties are often not aware that they have missed or misread a nonverbal cue and are even less likely to be aware of how such problems can interfere with social interaction (Nowicki & Carton, 1997).

Delays or limits in the perception of nonverbal cues of emotion have been related to social and emotional adjustment difficulties. Difficulty with the perception of cues of emotion based on a measure that presented photographs of facial expressions and audiotapes of tone of voice representing different emotions was related to lower peer status (Nowicki & Duke, 1992), lower feelings of competence (Nowicki & Carton, 1997),

and parent-rated social difficulties (Baum & Nowicki, 1998) in typically-developing children. In addition, Denham et al. (2003) found that three or four year old children's knowledge of emotions in others was related to teachers' ratings of their social competence during kindergarten.

This link between emotion perception and social functioning is independent of overall intellectual functioning (e.g. McClanahan, 1996; Nowicki & Mitchell, 1998). It is assumed that emotion perception skills are, "a discrete set of skills that are not related to general cognitive ability in regards to intelligence scores" (Nowicki, 2003). Consistent with this assumption, several studies have found that accuracy in the perception of nonverbal cues of emotion was not related to IQ in typically-developing samples (e.g. McClanahan, 1996; Nowicki & Mitchell, 1997).

In summary, the accurate perception of nonverbal cues of emotion must occur in order to use emotion information to regulate an interaction. Patterns of facial expression and tone of voice cues represent discrete emotional states. These nonverbal cues are present in infancy and used cross-culturally. Emotion cues help to clarify verbal information and, therefore, provide critical information for appropriate regulation of interactions. Difficulties in the perception of emotion cues are related to both concurrent and future social problems in typically-developing children. On the other hand, emotion perception skills are thought to develop separately from overall intelligence as measured by traditional IQ tests.

Emotion Perception Development in Typical Children

In general, infants are able to notice differences in facial expressions as early as three- to seven-months old and understand that the expressions convey information (Kopp & Neufeld, 2003). Research has suggested that infants change their expressions and emotional state in response to others' emotional signals (Dunn, 2003). For example, infants as young as nine-months-old seemed to mimic the emotional states of their mothers' in reaction to events or objects (Meltzoff, Gopnik, & Repacholi, 1999). In addition, young infants are also differentially responsive to tone of voice (Dunn, 2003).

Most studies have found that the vast majority of children have mastered the perception of emotion cues by the end of their preschool years (Denham, 1998). Emotion perception skills are fairly stable once the foundational skills are established in preschool (Brown & Dunn, 1996). Brown and Dunn (1996) found that individual differences in emotion understanding at three years old were the same at six years old, such that those children who were the most skilled or most delayed remained so after the three-year time span. This highlights the importance of early skill acquisition. Even though emotion understanding skills may become slightly more sophisticated with age, crucial development in this area occurs prior to three years of age (Brown & Dunn, 1996).

Although a basic understanding of nonverbal cues of emotion seems innate and universal across cultures (Ackerman et al., 1998; Eckman et al., 1972; Izard 1972, 1977), there are many individual differences in the rate of acquisition of this skill. Many aspects of children's emotion understanding skills are related to the parent-child interaction (Malatesta & Haviland, 1985). At a basic level, parents influence the development of

emotion skills in their children through their parenting and their own emotional expressiveness (Denham, 1998). In addition, many specific emotion-related parental acts are related to emotion perception development. Emotion understanding is enhanced when parents engage in discourse with their children regarding emotions that both the child and parents are experiencing (Denham, 1998). In a study of preschool children, Denham et al. (1994) found that the extent to which mothers spontaneously explained their emotions was positively related to children's emotion understanding. The impact of parental discourse on emotions is also moderated by the accuracy with which the parent his/herself is perceiving the emotions, such that parents who are more accurate in their discussions of emotions have children who have more successful emotion understanding abilities than those children whose parents are inaccurate in their emotion perception (Denham, 1998).

In summary, the ability to perceive nonverbal cues of emotions is evident in infants as young as three months old. Most children have refined their emotion perception skills by the end of preschool. There are strong continuities between this development at a young age and later emotion understanding, suggesting that the majority of foundational skills are developed in preschool. Individual differences in emotion perception abilities are related to both personality characteristics and interactions with others. Parents seem to have the greatest influence on emotion perception development through parenting, their own emotional expressions, and engaging in discourse on emotions with their children.

Emotion Perception in Children with Pervasive Developmental Disorders

Emotion perception can play a role in pervasive developmental disorders as well. An examination of this issue is important given the emphasis that has been placed on theory of mind skills as the possible underlying deficit in pervasive developmental disorders (Baron-Cohen, 1989, 1991; Baron-Cohen et al., 1985; Serra et al., 1999) and the importance of emotion understanding skills in theory of mind (Dunn, 2000). Research demonstrating this role is clearest with classic autism, though some studies have also addressed emotion perception development in higher functioning individuals with pervasive developmental disorders.

In this section, evidence for deficits in emotion perception in pervasive developmental disorders is considered separately for those with classic autism and higher-functioning individuals with pervasive developmental disorders. Cue intensity is explored as a possible explanation for inconsistencies in findings of emotion perception deficits in higher-functioning individuals with pervasive developmental disorders, including those with AS.

Classic Autism

Studies have found that children with classic autism have a marked deficit in their ability to perceive nonverbal cues of emotions (Braverman, Fein, Lucci, & Waterhouse, 1989; Hobson, 1986a, b; Hobson, Ouston, & Lee, 1989; Tantam, Monoghan, Nicholson, & Stirling, 1989; Turk & Cornish, 1998), though conclusions regarding whether impairment is specific to emotion perception tasks have been inconsistent (Ozonoff et al., 1991; Pierce, Glad, & Schreibman, 1997). Children with classic autism were significantly

impaired, relative to children with mental retardation and typically-developing controls, in their ability to determine which drawn or photographed facial expressions and gestures correspond to videotapes of individuals making gestures and vocalizations representing various emotions (Hobson, 1986a, b). Studies that ask children with autism to label nonverbal cues of emotion in photographs have also provided evidence for impairment in emotion perception, with scores one standard deviation below those of typically-developing controls (Hobson et al., 1989; Tantam et al., 1989). Furthermore, Braverman et al. (1989) found that the level of difficulty correctly perceiving nonverbal emotional cues was related to the level of social dysfunction, such that those who were poorer at emotion perception suffered from greater social dysfunction.

High-functioning Individuals with Pervasive Developmental Disorders

Despite numerous clinical accounts of difficulty with nonverbal communication (Bonnet, & Gao, 1996; Landa, 2000; Volkmar et al., 2000; Wing, 1981), few studies of nonverbal emotion have focused on higher functioning individuals within pervasive developmental disorders than those with classic autism, such as those with AS, and they have produced inconsistent results. Because AS was not routinely differentiated from other pervasive developmental disorders in this country until the 1994 *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association), earlier studies would have necessarily grouped individuals with AS with individuals who are considered to be higher functioning than those with classic autism, including HFA and pervasive developmental disorder not otherwise specified. The emotion perception abilities of children with AS have never been directly compared with those of children

with other pervasive developmental disorders to determine if combining them into one group is appropriate. Moreover, the diagnostic criteria vary across studies and the AS diagnostic label was commonly used interchangeably with HFA and pervasive developmental disorder not otherwise specified even after the DSM-IV came out due to the inadequacy of the diagnostic criteria. This makes it difficult to identify results applicable solely to those with AS even after 1994. The extent of emotion perception difficulties in those with AS is, therefore, unclear. The best estimate of the extent of such difficulties in AS is based on studies of individuals with pervasive developmental disorders that are higher functioning than those with classic autism, including AS, HFA, and pervasive developmental disorder not otherwise specified.

Some studies have found that individuals with AS and HFA are impaired in their emotion perception abilities. In three case studies, Nijiokiktjien et al. (2001) found that children with AS were impaired in their ability to match two similar facial expressions and identify emotions depicted by digital photographs on a computer screen. The authors did not describe the normative sample for the measures or the basis for determining impairment. Although the accuracy across participants was varied, they reported that one participant was only able to identify happy faces correctly even after prompting and multiple trials. Koning and Magill-Evans (2001) asked 21 adolescent boys with AS and 21 typically-developing adolescent boys matched on cognitive ability to watch videotaped vignettes of children in typical social interactions that were filtered so that the words were unintelligible but the tone of voice was retained. The task then required them to state how each person in the video was feeling and how they determined that

information. The results indicated that those with AS were deficient in their ability to identify and label the characters' emotions, performing more than one standard deviation below the mean. Those with AS also reported using fewer cues to infer the emotion than normal controls, focusing primarily on facial expressions and largely ignoring tone of voice. Macdonald et al. (1989) similarly found that adults with HFA performed more than one standard deviation below the mean for typically-developing controls in their ability to match photographs of facial expression to contexts and their ability to label facial expressions of emotion. These deficits were found regardless of chronological age or cognitive ability.

On the other hand, some studies have found that individuals with AS and HFA are not impaired compared to typically-developing controls in their emotion perception abilities. Adolphs, Seers, and Piven (2001) summarized findings from a series four studies of eight participants with HFA in which they were asked to identify emotions from facial expressions. The mode of presentation of the facial expressions was not specified. Although participant performance was heterogeneous, Adolphs et al. (2001) found that, overall, the participants performed similarly to typically-developing peers in the recognition of basic emotions from facial expressions. Serra et al. (1999) did not find significant differences between children with "lesser variants of autism," including those with AS, and typically-developing controls in their ability to infer emotions of others from stories and recognize facial expressions in photographs. Fein et al. (1992) conducted a study in which 15 children with various pervasive developmental disorders were compared to typically-developing children. Analyses were conducted two separate times,

with the children matched on nonverbal intelligence and then matched on verbal intelligence (Fein et al., 1992). The task required them to match photographed facial expressions of emotion to photographs of affect-laden contexts. The results indicated that there were no differences between groups in their performance on this task.

In summary, previous research has found an emotion perception deficit for individuals with classic autism. The extent of emotion perception difficulties in those with AS is much less clear. The primary reasons for this problem are that AS was not identified as a separate disorder until 1994 and the current diagnostic criteria for AS do not adequately distinguish it from other pervasive developmental disorders. Therefore, most studies of the emotion perception abilities of higher-functioning individuals with pervasive developmental disorders, such as those with AS, have combined individuals with AS or HFA into one group. Studies that reported using only one of these groups also do not provide a clear understanding of the emotion perception abilities of individuals with AS or HFA because of the inadequacy of the diagnostic criteria to clearly differentiate the two disorders. Therefore, it is not surprising that studies of higher-functioning individuals with pervasive developmental disorders have yielded inconsistent findings regarding an emotion perception deficit. A direct comparison of individuals with AS and HFA when diagnosed using empirically-supported criteria would help clarify if the diagnostic problems have led to the inconsistent findings.

Nonverbal Cue Intensity

Some of the discrepancy regarding whether individuals with AS have a deficit in their ability to accurately perceive emotions may be related to the intensity of the cue.

Various methodologies have been used to assess emotion perception abilities, such as matching photographs of facial expressions to contexts (Fein et al., 1992; MacDonald et al., 1989) and labeling facial expressions of emotion in photographs (Nijiokiktjien et al., 2001; Serra et al., 1999). Although results have been inconsistent across methods, results have also been inconsistent even when the same assessment method was used. Many studies also found heterogeneous performance both across participants and within a single participant's performance (e.g. Adolphs et al., 2001; Nijiokiktjien et al. 2001), which may account for some of the inconsistent findings. However, little attention has been paid to whether characteristics of the cues could influence this pattern of results.

Studies with typically-developing children have found that cue intensity is an important variable that influences both the amount of error in perception and the relation between errors and social difficulties. Using a measure that presented photographs of facial expressions and audiotapes of tone of voice that systematically varied the intensity of the cue, the relation between social adjustment and errors reading emotions was dependent on the intensity of the cue (Baum & Nowicki, 1998; Nowicki & Carton, 1993). Specifically, only errors on low-intensity cues were significantly correlated with parent-rated social difficulties (Baum & Nowicki, 1998).

Limitations in the perception of low intensity facial expression cues can be expected for children with pervasive developmental disorders because they do not pay attention to information conveyed through the eyes (Klin et al., 2002) and the greatest amount of emotional information is conveyed through the eyes (Baron-Cohen, Wheelwright, & Joliffe, 1997; Eckman, 1972). For example, Klin et al. (2002) collected

eye-tracking data from high-functioning adults with autism during film clips and found that they focused on eyes two and a half times less than typically-developing controls and instead focused more on the mouth. Focusing on the mouth may cause these individuals to miss many relevant and subtle cues, especially given that the eyes contain significantly more emotional information than the mouth (Baron-Cohen et al., 1997). Those with AS and HFA may therefore be able to perceive high intensity emotions that change the shape of the mouth dramatically, but have difficulty decoding low intensity cues of emotion that require information from the eyes.

Although individuals with AS and HFA may both have difficulty perceiving low intensity cues, children with HFA are likely to have even *more* difficulty with low intensity cues than those with AS based on influences on emotion perception skill development. Specifically, it seems that an understanding of *basic* (and high intensity) emotional expressions is innate (Ackerman et al., 1998; Eckman et al., 1972; Izard 1972, 1977). However, a greater sensitivity to emotional expressions is to some extent socialized by parents and peers through discourse on emotions and attention to parental acts of emotional expression (Denham, 1998). It is reasonable to assume that children with HFA would benefit even *less* from the parental socialization of these skills given the decreased social interest and presence of language delays in HFA (American Psychiatric Association, 1994; Smith-Myles, 2002; Tantam, 1988) in contrast to the normal language development and social interest in AS (Klin et al., in press). These parental modeling and coaching influences are likely to influence the perception of emotions from both facial expressions and tone of voice. Although previous research has not focused on tone of

voice, this may also be a key factor for understanding deficits in the accurate perception of tone of voice cues in particular given the importance of parent verbal communication.

In summary, the inconsistencies in findings of emotion perception development in individuals with AS may be related to cue intensity although this possibility has not yet been explored. Individuals with AS and HFA may have difficulty with low intensity cues based on evidence that individuals with pervasive developmental disorders tend to ignore information from the eyes, which is critical for perceiving low intensity cues of emotion. In addition, difficulty with the perception of low intensity cues is likely to be even *more* pronounced for children with HFA than children with AS. Individuals with HFA are less likely to benefit from the influence of parents and peers in refining emotion perception skills than those with AS due to the social withdrawal and language delays present in the early development of children with HFA.

STATEMENT OF THE PROBLEM

Perception of nonverbal cues of emotion is a fundamental component of successful social interaction (Hobson, 1986a; Klin et al., 2002). Children with AS suffer severe impairment in social functioning, which has been associated with isolation and depression (Howlin, 2000). The social dysfunction observed in individuals with AS may be related to limitations in their perception of nonverbal cues of emotion which is a prerequisite to higher levels of emotion understanding. There is evidence that children with classic autism are impaired in their ability to perceive nonverbal cues of emotion (Braverman et al, 1989; Tantam et al., 1989). In those with AS, clinical accounts of difficulty with nonverbal communication abound (Volkmar et al., 2000; Wing, 1981). However, few studies of nonverbal emotion have focused on individuals with AS or HFA. Results of studies that have addressed this issue have yielded inconsistent findings, thus providing mixed support for an emotion perception deficit in AS.

There are several possible reasons for the discrepant findings of emotion perception abilities in AS. First, previous studies have not clearly tested the emotion perception skills of children with AS. Children with AS are typically combined into a single group with individuals with HFA or pervasive developmental disorder not otherwise specified and compared to typically-developing controls in studies of emotion perception (e.g. Adolphs et al., 2001; Fein et al., 1992; Serra et al., 1999). Combining AS with other pervasive developmental disorders, particularly HFA, may obscure results. HFA is a descriptive term for individuals who have autism but have better developed language abilities than individuals with classic autism. Given that individuals with HFA

and classic autism suffer from the same underlying disability, it is possible that individuals with HFA have a similar deficit in emotion perception to individuals with classic autism (e.g. Braverman et al., 1989; Hobson, 1986a, b; Turk & Cornish, 1998). Based on this likelihood of limitations in emotion perception for individuals with HFA, the combination of those with HFA and AS into a single group in studies of this skill makes it difficult to determine the extent of emotion perception problems in AS. Individuals with AS and HFA may both have an emotion perception deficit, but this may be more pronounced in HFA given the differences in early developmental history between the two groups and the importance of this time period for emotion perception development. A direct comparison between those with AS and HFA in emotion perception skills would clarify whether some of the inconsistent findings of an emotion perception deficit in AS are due to the inappropriate combination of these two disorders into a single group. Because current DSM-IV diagnostic criteria do not adequately differentiate AS from other pervasive developmental disorders (Kugler, 1998; Ozonoff et al., 2000), empirically-supported diagnostic criteria must be used in order to properly make this comparison.

Cue intensity may also play a role in the inconsistent findings of emotion perception abilities of those with AS. Research has suggested that individuals with pervasive developmental disorders tend to ignore information conveyed from other's eyes (Klin et al., 2002). Individuals with AS and HFA are, therefore, likely to have even greater limitations in the perception of low intensity facial expression cues than typically-developing children given the critical role of the eyes in conveying subtle cues (Baron-

Cohen et al., 1997; Eckman et al., 1972). However, cue intensity has not been systematically varied in studies of the emotion perception skills of individuals with pervasive developmental disorders, which could be related to some of the inconsistent findings. Exploring the accuracy with which these individuals perceive low intensity cues is also particularly important because accuracy in the perception of low intensity cues is more related to social functioning than accuracy in the perception of high intensity cues in typically-developing populations (Baum & Nowicki, 1998; Nowicki & Carton, 1993).

The role of socialization in developing sensitive emotion perception skills suggests that children with HFA may have *even more* difficulty perceiving low intensity cues than children with AS. Although largely innate (Ackerman et al., 1998; Eckman et al., 1972; Izard 1972, 1977), some of the subtle emotion perception skills are influenced by parental socialization in typically-developing children (Denham, 1998). It is likely that parents engage in even *less* discourse about emotions with their young children with HFA than children with AS due to the presence of more social isolation and language delays in those with HFA (Klin et al., in press).

Parental coaching and modeling of emotion perception skills is likely to influence the development of the perception of emotions from both facial expressions and tone of voice. However, because the greatest amount of socialization occurs through discourse and verbal parental expression of emotion, it may be that differences in low intensity cue perception between AS and HFA are greatest for the perception of tone of voice cues. The ability to perceive emotional cues through tone of voice has not been studied in individuals with AS or HFA. Koning and Magill-Evans (2001) found that children with

pervasive developmental disorders largely ignored tone of voice when attempting to decode emotions in others, but it is unclear from this research whether this is due to difficulty perceiving emotional information from tone of voice and how children with AS and HFA may differ in this skill. Therefore, it will be important to clarify not only how children with AS and HFA differ in the perception of facial expressions, but also how they differ in the perception of tone of voice.

In conclusion, AS is a continuous and lifelong pervasive developmental disorder characterized by social dysfunction. The accurate perception of nonverbal cues of emotion is necessary for the successful regulation of social interaction. The extent of the emotion perception abilities of those with AS is uncertain. This is due to the use of diagnostic criteria that do not adequately differentiate AS from other pervasive developmental disorders and the resultant combination of AS and HFA into one group. In addition, a possible moderator of the relation between emotion perception abilities and diagnosis, cue intensity, has been largely ignored in studies of pervasive developmental disorders. Little attention has been paid to nonverbal cues of emotion other than facial expression, such as tone of voice.

Social dysfunction is one of the most debilitating features of AS. Greater understanding of the role of emotion perception in individuals with AS may bring a clearer understanding of this social dysfunction. Understanding the specific processes involved in emotion perception deficits may also help to identify important areas for intervention that ultimately improve the interactions and lives of individuals with AS.

This study examined the ability of children with AS and HFA to perceive nonverbal cues of emotion. Empirically-supported criteria were used to establish diagnoses. A standardized, reliable, and valid measure of nonverbal communication decoding accuracy that presents facial expressions and voices conveying different emotions that vary in intensity was used to test emotion perception. The following hypotheses were tested:

1. Higher emotion perception accuracy is related to greater adaptive and social functioning and lower levels of social dysfunction. This hypothesis is based on the importance of emotion understanding in theory of mind skills, which are critical for successful social interaction.

2. Emotion understanding and theory of mind skills are considered distinct from IQ. Therefore, emotion perception accuracy is not expected to be related to IQ.

3. Both children with AS and HFA are expected to have poorer emotion perception skills than typically-developing children (as represented by the normative means provided in the manual of the emotion perception measure) because of the social difficulties that characterize these disorders and the importance of emotion understanding in social functioning.

4. Because the literature on classic autism has found a deficit in emotion perception, it was hypothesized that the HFA group would have more difficulty with emotion perception than participants with AS. Therefore, a main effect of diagnosis was expected for both facial expressions and tone of voice.

5. An interaction effect was hypothesized such that intensity would moderate the relation between diagnosis and emotion perception accuracy. Specifically, because of the likely differences in the socialization of more sensitive emotion perception development between diagnostic groups, it was hypothesized that there would be a stronger association between diagnosis and emotion perception for low- than high-intensity emotions

METHODS

Participants

Children were eligible for participation if they were between the ages of 8 and 16 years old. The age range was restricted to promote internal validity. The minimum age of 8 was chosen because most children with AS or HFA are typically identified as having a disability (or question of one) by then. The maximum age of 16 was chosen to be consistent with the maximum age for the intelligence test used in this study. Recruitment continued until a total of 30 participants met the study's diagnostic criteria for AS or HFA. This was the number of participants indicated as necessary for a power of .80 to answer the study's primary hypotheses regarding emotion perception differences between groups based on the actual effect size from the sixteen participants that completed the study assessments. Recruitment and data collected were completed in 11 months.

Recruitment for study participants occurred primarily through word of mouth and the use of a flyer (see Appendix A). A letter describing the study and flyers were sent to professionals throughout the state who work with children with pervasive developmental disorders (e.g. psychologists, pediatric neurologists, developmental pediatricians, etc.). The professionals who received the letters included individuals who were invited by the Commonwealth Autism Services, a state-wide advocacy agency for individuals with autism, to participate in a task force to address issues regarding the assessment and diagnosis of autism and related disorders. In addition, the Commonwealth Autism Services posted the IRB-approved flyer on their web page, which is a widely used resource for parents across the state. The central Virginia chapter of the Autism Society

of America also printed the flyer in one of their regular mailings that went to approximately 600 families within Virginia. Some parents of participants were informed of the study when they called a specialized developmental disorders diagnostic clinic that serves children ages five and under seeking a diagnostic evaluation on a child that was too old for the clinic. Finally, a small minority of participants were recruited through parents of other children in the study.

A verbal description of the study and an IRB-approved written consent form was provided to the parent/guardian, and an IRB-approved assent form was provided to each potential participant prior to participation. The principal investigator informed participants and their parent/guardian about what was involved with the study, potential risks and benefits, confidentiality and its exceptions, who to contact should they have any questions, and the incentives for participation. One of the incentives included written feedback on all assessments that were conducted as part of the study. A template was used to provide parents with a written record of all scores as well as information on the child's strengths and weaknesses in terms of intellectual ability, adaptive functioning, overall adjustment, symptom severity, and emotion perception abilities. In addition, a diagnostic impression was provided. All parents who had questions regarding the written feedback were provided an opportunity to talk with the examiner over the phone or in-person regarding the results. The children who participated in this study were also offered a chance to participate in a free social skills group. A total of four groups were conducted to serve 17 study participants. The other study participants chose not to come to the social

skills groups (in these cases, the parents were typically more interested in the free diagnostic evaluation).

Participants included 26 males and 4 females between the ages of 8 and 15 years old (M_{AS} = 11.47, SD_{AS} = 2.06; M_{HFA} = 11.00, SD_{HFA} = 2.66). The majority of participants were Caucasian (24), 3 were African-American, two were biracial, and one was Asian-American. Sixteen participants met study criteria for AS and 14 met criteria for HFA. Two additional participants did not meet the study's diagnostic criteria for either disorder and were therefore excluded from analyses. Another two participants completed only portions of the study (parent interview in both cases) before deciding to withdraw from participation due to their personal time constraints.

The primary difference between the diagnostic criteria used in this study and the DSM-IV (American Psychological Association, 2000) is the greater specification of the AS criteria and reversal of the precedence rule (criteria are explained in detail under *Procedure*). The results indicated that 6 of the 16 participants with AS would have been classified as HFA if the DSM-IV precedence rule had been used (meeting criteria for autism excludes an AS diagnosis). This led to an agreement of 63% for AS diagnoses between diagnostic systems.

Measures

Three measures of adjustment and functioning were used in the current study in order to provide a description of the sample composition, including the *Weschler Intelligence Scale for Children – Three, Child Behavior Checklist,* and *Scales of Independent Behavior-Revised.* These measures provide information on intellectual

ability, psychological impairment, and adaptive behavior respectively. Obtaining a profile of overall functioning is important in describing the sample given the variability of functioning and presentation within children with pervasive developmental disorder diagnoses (Mottron, 2004; Szatmari et al., 2002; Tanguay, 2000). In addition, these measures were used to test hypotheses regarding the relation between emotion perception abilities and IQ, social functioning, and adjustment.

The diagnostic instruments used in this study were chosen in order to replicate the diagnostic procedure used by Klin et al. (in press). These measures are specific to pervasive developmental disorders, including the *Autism Diagnostic Observation Schedule, Autism Diagnostic Interview-Revised,* and *Yale Special Interests Survey.* The Autism Diagnostic Observation Schedule and Autism Diagnostic Interview-Revised are considered the gold standard for research (Tanguay, 2000) and are the only measures recognized by the National Institute of Health as acceptable for studies of pervasive developmental disorders. The diagnostic protocol that was used in this study is based on a battery using information and cutoff scores and items from the Autism Diagnostic Observation Schedule and the Autism Diagnostic Interview-Revised. The Yale Special Interests Survey was also used to gather additional information on preoccupying interests which are an important component of the diagnostic criteria for AS that was used in the current study.

Wechsler Intelligence Scale for Children

All participants were administered the full *Wechsler Intelligence Scale for Children – Third Edition* (WISC-III, Wechsler, 1991), which is the most widely-used

measure of intelligence. The WISC-III full scale score was used to describe the sample characteristics and to test the hypothesis that emotion perception and IQ would not be related. It provides an estimate of overall (full scale), verbal, and nonverbal (performance) intelligence. The WISC-III was standardized on a sample of 2,000 children representative of the U.S. Census, has excellent internal consistency reliability (.91 - .96), test-retest reliability (.86 - .95), and strong evidence for concurrent and construct validity (Wechsler, 1991).

Child Behavior Checklist

The *Child Behavior Checklist* (CBCL; Achenbach, 2001) is an empirically based caretaker report instrument designed to obtain ratings of behavioral and emotional problems of children. Boele, Dickhut, and Poustka (1999) examined the utility of the CBCL for pervasive developmental disorders and found that it was able to identify a clinically relevant profile of elevations in social, thought, and attention problems. Scales from the CBCL were used in this study to test the hypothesis that emotion perception accuracy is related to social adjustment and functioning.

A parent of each participant rated how well each CBCL item described their child. Possible ratings are "0" (not true), "1" (somewhat or sometimes true), and "2" (very true or often true). The CBCL provides a total behavior problem score, an externalizing score, an internalizing score, competence scores, and several syndrome scale scores. All scale scores are assigned standardized t-scores and a percentile rank. The CBCL has well-established psychometric properties (Achenbach, 2001). The CBCL was standardized with a sample of 2,368 children between the ages of four and eighteen representative of

the United States population, including both children referred for psychiatric treatment and non-referred children. The CBCL has extensive evidence of construct validity, discriminant validity, content validity, criterion-related validity, and internal consistency (.88 to .96) (Furlong & Wood, 1994).

Scales of Independent Behavior-Revised

The *Scales of Independent Behavior-Revised* (SIB-R; Bruininks, Woodcock, Weatherman, & Hill, 1996) is a caretaker report instrument designed to assess problem behaviors and adaptive behavior skills that impact adjustment across environments. Adaptive behavior is a multidimensional construct comprised of skills associated with personal independence and social competence (Oswald & DiSalvo, 2003). Adaptive behavior has been identified as an important construct to measure in the assessment of pervasive developmental disorders (Luiselli et al., 2001; Szatmari et al., 2002; Volkmar et al., 1987). Scales from the SIB-R were used in this study to test the hypothesis that emotion perception accuracy is related to social adjustment and functioning.

The SIB-R consists of 259 items, which measure motor skills, social interaction and communication skills, personal living skills, community living skills, internalized maladaptive behavior, asocial maladaptive behavior, and externalized maladaptive behavior. In addition, overall measures of broad independence and problem behaviors are determined. Interpretive information that is provided includes norm-referenced age-equivalents and percentile ranks, relative mastery indexes, skill level, performance implications with age-level tasks, and an estimated level of support needed for daily living. The SIB-R was standardized with a sample of 2,182 participants that was

representative of the United States 1990 census data in terms of gender, race, Hispanic origin, occupational status, occupational level, geographic region, and type of community (Bruininks et al., 1996). The SIB-R has extensive evidence of construct validity, criterion-related validity, internal consistency, and test-retest reliability (Bruininks et al., 1996).

Autism Diagnostic Observation Schedule

The Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) is a semi-structured play assessment designed to elicit behaviors that are important to the diagnosis of pervasive developmental disorders (Lord et al., 2000). Although the ADOS scoring algorithm was not designed to differentiate AS, it allows for the observation of behaviors necessary for a diagnosis of AS and the diagnostic algorithm used in this study was formulated based on ADOS scores.

The ADOS requires a skilled examiner to initiate a hierarchy of planned social contexts. Item ratings range from 0 to 3, corresponding respectively to "no abnormality," "mildly abnormal or slightly unusual," "definitely abnormal," and "markedly abnormal to the point that the behavior interferes with the interview." Item scores are summed in the areas of social behavior and communication and represent dysfunction in these areas. Cut-offs in these areas are provided for pervasive developmental disorder not otherwise specified and autism. Items are coded regarding play and stereotyped behaviors but are not used in the algorithm due to the difficulty in accurately assessing these characteristics in a short period of time. Using a sample of 78 individuals with autism, 69 individuals with pervasive developmental disorder not otherwise specified, and 66 individuals

without diagnoses of pervasive developmental disorders, Lord et al. (2000) found adequate interrater reliability (mean kappas of .66-.78) and acceptable Cronbach's alpha internal consistency (.86-.91 for the social domain, .74-.84 for communication, and .63-.65 for stereotyped and repetitive behaviors). The ADOS correctly identified 95% of those with autism and 92% of those who did not have a pervasive developmental disorder (Lord et al., 2000).

Autism Diagnostic Interview-Revised

The Autism Diagnostic Interview - Revised (ADI-R; Lord, et al., 1993) is a standardized caregiver interview designed to elicit information necessary for the differential diagnosis of pervasive developmental disorders (Lord et al., 1993). Although the ADI-R scoring algorithm was not designed to differentiate AS, it gathers the information necessary for a diagnosis of AS and the diagnostic algorithm that was used in this study was formulated based on ADI-R scores.

An abridged form of the ADI-R recommended for diagnostic purposes, which consists of the 49 items that are included in the scoring algorithm, was used in the current study. The items are scored "0" (no indication of a relevant quality of autism), "1" (some indication of abnormality), and "2" (indication of marked abnormality). The item scores are summed in the areas of communication, social interaction, and restricted, repetitive behavior and represent dysfunction in these areas. Cut-offs are provided in each of these areas for autism. Information on the age at onset is also gathered. Two studies assessed the psychometric properties of the ADI-R (Lord et al., 1994). Cronbach's alpha assessments of internal consistency were .95 for the social area, .69 for restricted and

repetitive behaviors, and .84 for communication items. Interrater reliability was adequate, with a mean kappa of .70. Mean scores for the children with autism significantly differed compared to children who were diagnosed as mentally handicapped or language-impaired (Lord et al., 1994).

Yale Special Interests Survey

The Yale Special Interests Survey (Volkmar & Klin, 1996) is a caregiver questionnaire designed to provide information on special interests associated with the diagnoses of pervasive developmental disorders. Results from the Yale Special Interests Survey were used to determine whether participants met criteria for AS regarding circumscribed interests. Information is gathered separately for special interests during the following developmental periods: Preschool Age (ages 2-6), Elementary School Age (7-12), and Adolescence (13-18). Items about special interests are rated as "sometimes," "quite a bit," or "almost always." In addition, qualitative information on the topic of interest, age started, and age stopped is also gathered.

Diagnostic Analysis System of Nonverbal Accuracy Scale

Participants were administered four subtests from the *Diagnostic Analysis System of Nonverbal Accuracy Scale - 2* (DANVA): Adult Facial Expressions, Child Facial Expressions, Adult Paralanguage, and Child Paralanguage (Nowicki, 2003). This measure was chosen because all subtests allow for the assessment of participants' ability to identify four emotions (happiness, sadness, anger, and fear) that systematically differ in level of intensity (high or low). This made it possible to test hypotheses regarding the importance of cue intensity. In addition, the DANVA has subtests that test for the

perception of tone of voice cues which is a type of emotion cue that has been largely ignored in previous studies.

For the facial expression tasks, photographs were presented, one at a time, each for a 1-second exposure period. The paralanguage tests require the participant to listen to an audiotaped presentation of the sentences, "I am going out of the room now. I will be back later," as read by male and female children and adults. For both the facial expression and paralanguage tasks, the participant was asked to identify the facial expression or tone of voice depicted as "happy," "sad," "angry," or "fearful." They were provided an answer sheet that lists the four emotions, and were given the option to circle the emotion they believe is being presented, point, or verbally give the answer. The Adult and Child Facial Expressions subtests each consist of 24 photographs of male and female expressions with an equal number of high and low intensity emotions across the four possible emotions (Nowicki & Carton, 1993). The Adult Paralanguage subtests consists of 24 cues varying in intensity and the Child Paralanguage subtest consists of 16 cues varying in intensity. Scores are generated based on the child's correct identification of emotions.

Each DANVA subtest was constructed independently and stimuli were selected on the basis of a preset percentage of judges agreeing on the identification of a particular emotion. The DANVA has been standardized with participants differing in age, sex, race, cultural background, intellectual ability, and psychological adjustment (Nowicki, 2003). The manual provides normative means and standard deviations for child and adult faces and voice based on a compilation of over 20 studies of typically-developing children

broken down by age (Nowicki, 2003). Construct validity data indicate that scores correlate in the predicted directions with sociometric status and emotional disturbance. Cronbach's coefficient alphas have ranged from .77 to .88 and four-week test-retest reliabilities have ranged from .74 to .90.

Procedure

Each child was administered the DANVA by an individual who was blind to diagnosis. A diagnostic evaluation was conducted by the principal investigator. The diagnostic algorithm used in this study replicates the new diagnostic system developed by Klin et al. (in press). These diagnostic criteria for AS have greater face validity and discriminative validity for AS than the DSM-IV criteria. This new diagnostic system for AS also reflects changes made in the text accompanying the DSM-IV criteria for AS in the recent DSM-IV text revision (American Psychiatric Association, 2000). The diagnostic protocol based on the ADI-R, ADOS, and Yale Circumscribed Interests is described in detail below.

Diagnostic Criteria for High-Functioning Autism

The following criteria were used to assign a diagnosis of HFA:

1. Participant exceeds ADI-R cut-offs for autism in all domains (onset, social, communication, interests/behaviors).

2. Participant exceeds the ADOS cut-offs for autism in all domains (social, communication, and social/communication total).

3. Participant must not meet study criteria for AS. The DSM-IV criteria require a diagnosis of autism to be given if all criteria for autism are met even if criteria are met for

AS. Based on Klin et al.'s (in press) criteria, this "precedence" rule of the DSM-IV is reversed, i.e., if the participant met criteria for AS, the diagnosis of AS is made rather than autism.

4. Participant must have enough language skills to meet the communication requirements for module 3 of the ADOS. These criteria require "verbal fluency" and state: "Verbal fluency is broadly defined as having the expressive language of a typical four year-old child: producing a range of sentence types and grammatical forms, using language to provide information about events out of context and producing some logical connections within sentences (e.g., "but" or "though"). There may be some continued grammatical errors." This criteria was added in order to operationally define *high-functioning* and was not part of Klin et al's (in press) criteria for autism. This definition is consistent with common conceptualizations of individuals with HFA meeting criteria for autism but having better-developed language abilities than those with classic autism (Schopler et al., 1998).

In summary, to meet criteria for autism, a participant must have evidence of social dysfunction, communication impairment, and repetitive behaviors to the degree that ADOS and ADI scores exceed all of the autism cutoffs. In addition, the participant must not meet AS criteria. Finally, language skills must be high enough to complete module three of the ADOS.

Diagnostic Criteria for Asperger's Syndrome

The following criteria were used to assign a diagnosis of AS:

1. Participant exceeds the cutoff for autism in the social domains of the ADI-R and ADOS, which are indicators of social dysfunction.

2. Participant must be reported to be socially motivated during the "most abnormal period" (ADI-R defined as between the ages of 4 to 5 years). Social motivation is defined as absence of social isolation and presence of frequent verbal social approaches to adults and peers regardless of social appropriateness or effectiveness. Specifically, although the participant may avoid peers or approach them in inappropriate ways, he is not socially isolated (e.g., seeking and relating with family members). The presence of social motivation and absence of social isolation were determined by questions on the ADI-R.

3. Participant may or may not exceed cutoffs in the communication domains of the ADI-R and ADOS, but there is presence of *verbosity* (e.g. reports that the child "talks too much") and *pragmatic deficits* (e.g. one-sided style, tangential content) as determined by parent report on the ADI-R and observation in the ADOS.

4. Participant meets onset criteria for AS only if language concerns were restricted to pragmatic deficits (i.e., speech and formal language skill acquisition was intact) or language patterns are reported to have been precocious, with early achievement of milestones as indicated by questions that assess speech development in the ADI-R.

5. Participant may or may not exceed cut-offs in the interests domain of the ADI-R, but there is presence of a circumscribed interest of a factual nature (e.g. a topic about which one can acquire a great deal of factual information), that is all-absorbing (e.g. the person spends a great portion of free time involved with the topic) thus interfering with

learning of other things, and which has a deleterious impact on reciprocal conversation because the person tends to frequently insert it in conversations with others. This is assessed by the Yale Special Interest Survey and items on the ADI-R and ADOS.

6. Participant's problems in pretend play must be restricted to the content of play (i.e., pretend play is observed but it involves unusual objects or themes) as determined per report in an item on the ADI-R and observation during the ADOS.

7. There must be an absence of unusual sensory seeking/reactions and of motor stereotypies as noted by items on the ADI-R and ADOS.

In summary, to meet criteria for AS, a participant must have evidence of social dysfunction, social motivation, verbosity, pragmatic deficits, normal speech development milestones, circumscribed and interfering interests, the use of pretend play, and the absence of motor stereotypies. Information on these characteristics is gathered from items on the ADOS, ADI, and Yale Special Interests Survey, though the only scale cut-offs that the participant must exceed are the social scales of the ADOS and ADI (participant may or may not exceed the communication and behavior cutoffs). Meeting all of these criteria excludes a diagnosis of HFA.

RESULTS

Descriptive Statistics

The WISC-III, CBCL, and SIB-R were included in the study to provide a more general description of the level of functioning among participants. In addition, WISC-III scores were hypothesized to be unrelated to emotion perception whereas social functioning adjustment as measured by the CBCL and SIB-R were expected to be related to emotion perception. Analyses were conducted to explore any potential group differences in these scales in order to provide a better description of the sample and to provide a framework to interpret later tests of the hypothesized relation between these scales and emotion perception.

Means, standard deviations, and *F*-test results of select CBCL scales are shown in Table 1 by diagnostic group. ANOVAs that examined potential differences in CBCL scores between participants with AS and those with HFA revealed no significant differences, $p > .05$. Both groups had mean scores in the *Clinical* range on the

Table 1.
Means and Standard Deviations for Selected CBCL Scales by Diagnosis

	Asperger's			Autism				
Scale	*N*	*M*	*SD*	*N*	*M*	*SD*	Cohen's *d*	*F*
Social Competence	15	38.40	11.55	14	32.43[a]	6.98	.62	2.78
Total Competence	15	36.93[a]	9.64	12	30.75[b]	6.70	.74	3.55
Externalizing Problems	16	64.06[b]	8.33	14	60.36[a]	8.89	.43	1.38
Internalizing Problems	16	67.94[b]	8.27	14	66.71[b]	10.77	.12	0.12
Total Problems	16	70.56[b]	7.33	14	68.29[b]	9.03	.27	0.58
Withdrawn/Depressed	16	66.31[a]	10.81	14	69.71[a]	9.80	-.32	0.80
Social Problems	16	72.31[b]	10.26	14	71.57[b]	9.37	.07	0.04
Thought Problems	16	73.13[b]	7.21	14	73.07[b]	10.66	.00	0.00
Attention Problems	16	71.13[b]	12.60	14	70.93[b]	13.40	.01	0.00

Note. No significant differences, $p > .05$. All mean scores are t-scores that have a mean of 50 and a standard deviation of 10. [a]Scores are in the *Borderline Clinical* range. [b] Scores are in the *Clinical* range.

Internalizing Problems, Total Problems, Social Problems, Thought Problems, and Attention Problems Scales. In addition, the HFA group's Total Competence mean score and the AS group's Total Problem mean score were in the *Clinical* range, and the HFA group's Total Problems score was in the *Borderline Clinical* range.

Means, standard deviations, and *F*-test results of the SIB-R standard scores are shown in Table 2 by diagnostic group. ANOVAs that examined potential differences in SIB-R scores between participants with AS and those with HFA revealed that the AS group had a significantly higher mean community living score ($M = 88.54$, $SD = 20.16$) than the HFA group ($M = 69{,}17$, $SD = 23.98$). Although the AS means were higher on all scales, no other significant differences were found at $p < .05$. With the exception of the motor and community living scales for the AS group, all mean scores were at least one standard deviation below the standardization mean of 100. There was a large amount of variability in adaptive behavior scores for both groups in all categories.

Table 2.
Means and Standard Deviations for SIB-R Scales by Diagnosis

	Asperger's			High-functioning Autism				
Scale	*N*	*M*	*SD*	*N*	*M*	*SD*	Cohen's *d*	*F*
Broad Independence	13	83.69	17.73	12	70.50	27.27	.57	2.09
Social/Communication	15	82.73	13.74	13	75.54	20.53	.41	1.21
Motor	15	88.93	20.89	13	78.15	32.50	.39	1.12
Personal Living	15	79.80	21.28	13	76.92	22.17	.13	0.12
Community Living	13	88.54	20.16	14	69.17	23.98	.87	4.81*

Note. * $p < .05$. All mean scores are standard scores based on a scale mean of 100 and a standard deviation of 15.

Means and standard deviations of WISC-III scale scores are shown in Table 3 by diagnostic group. ANOVAs revealed that those with AS had significantly higher Full

Scale, Verbal, and Performance IQs than the HFA group with Cohen's *d* effect sizes of greater than one. The Verbal-Performance differences were also explored in order to determine if the trend of greater verbal than performance scores found in Klin et al.'s (in press) study was replicated in the current study. Although there was a trend for those with AS to have a greater positive difference between their Verbal and Performance IQ (VIQ – PIQ $M = 11.45$, $SD = 20.05$) than the HFA group ($M = -0.35$, $SD = 17.74$), this difference was not statistically significant, $t(27) = 1.67$, $p > .05$. This may have been due to limited power to detect this difference. Post-hoc power analyses indicated that this test for a pattern of VIQ-PIQ differences between groups had a power of approximately .35.

Table 3.
Means and Standard Deviations for WISC-III Scores (N = 29)

	Asperger's (*N*=15)	High-functioning Autism (*N*=14)		
	Mean (SD)	Mean (SD)	Cohen's *d*	*F*
Full Scale IQ	113.07 (14.57)	84.21 (18.80)	1.71	21.51**
Verbal IQ	117.20(15.77)	85.50 (23.43)	1.58	18.51**
Performance IQ	105.73 (18.63)	85.86 (13.29)	1.22	10.79*

Note. IQ scores are from the Wechsler Intelligence Tests for Children-III and are based on a mean of 100 and standard deviation of 15. **Significant at $p < .001$. *Significant at $p < .01$.

Relation of DANVA to IQ and Measures of Social Functioning

It was hypothesized that higher emotion perception accuracy would be related to higher adaptive and social functioning and lower levels of social dysfunction. Therefore, positive correlations were expected between DANVA accuracy and CBCL competence scores and SIB-R adaptive behavior scores. Negative correlations were expected between DANVA accuracy and ADOS and ADI social scores and the CBCL social problems scale.

Table 4 displays the correlations between the DANVA scales and the social scales of the ADI and ADOS and select CBCL and SIB-R scales. All significant correlations were in the expected direction suggesting that lower DANVA accuracy scores were related to greater social impairment and lower social competence.

Table 4.
Correlations Between DANVA Scales and Select Scales of Social Functioning and Adjustment

	DANVA Scales						
	Total	Total Faces	Low Intensity Faces	High Intensity Faces	Total Voices	Low Intensity Voices	High Intensity Voices
ADOS Social (*n*=30)	-.08	.12	.19	-.08	-.18	-.22	-.11
ADI Social (*n*=30)	-.38*	-.25	-.23	-.23	-.39*	-.45*	-.29
CBCL							
Total Competence (*n*=27)	.38	.28	.19	.34	.36	.43*	.25
Social Competence (*n*=29)	.28	.14	.12	.13	.31	.40*	.19
Social Problems (*n*=30)	.03	-.02	-.13	.21	.06	.14	-.02
SIB-R							
Broad Independence (*n*=25)	.33	.36	.35	.25	.25	.36	.08
Social/Communication (*n*=28)	.24	.16	.18	.05	.25	.31	.15
Community Living (*n*=25)	.47*	.44*	.40*	.37	.39	.44*	.27

Note. * = Significant at the $p < .05$ level. ** = Significant at the $p < .01$ level.

The DANVA Overall Total score was significantly negatively correlated with the ADI-R Social score ($r = -.38$) and positively correlated with the SIB-R community living score ($r = .47$). DANVA Total Faces ($r = .44$) and Low Intensity Faces ($r = .40$) were also both significantly positively correlated with the SIB-R community living score. DANVA Total Voices was negatively correlated with the ADI Social score ($r = -.39$).

The Low Intensity Voices scale was significantly correlated with the most measures, including a negative correlation with the ADI Social score (r = -.45) and positive correlations with the CBCL total competence score (r = .43), CBCL social competence score (r = .40), and SIB-R Community Living score (r = .44). DANVA High Intensity Faces and High Intensity Voices scales were not significantly correlated with any scale. In addition, none of the DANVA scales were significantly related to the ADOS social score. In summary, hypothesis one was supported for some, but not all, measures of social functioning and emotion perception.

Emotion perception accuracy was not expected to be related to IQ. However, analyses indicated that the Full Scale, Verbal, and Performance IQ scores were all significantly and highly correlated with each DANVA scale (see Table 5). The Full Scale IQ Score was generally the highest correlated with the DANVA scales. Thus, hypothesis two was not supported.

Table 5.
Correlations Between IQ and DANVA Scales for the Full Sample

	FSIQ	VIQ	PIQ
DANVA Total	.76**	.68**	.62**
DANVA Total Faces	.64**	.50**	.63**
DANVA Low Intensity Faces	.53**	.41*	.49**
DANVA High Intensity Faces	.73**	.57**	.78**
DANVA Total Voices	.69**	.64**	.52**
DANVA Low Intensity Voices	.69**	.62**	.57**
DANVA High Intensity Voices	.60**	.60**	.40*

Note. * = Significant at the $p < .05$ level. ** = Significant at the $p < .01$ level.

Correlational analyses between DANVA scales and IQ were re-run separately by diagnostic group in order to determine the role in group in creating the IQ-DANVA correlations. Table 6 shows the correlations for the AS group and Table 7 shows the

correlations for the HFA group. In general, IQ and DANVA scores were not as consistently correlated when the tests were run separately by diagnostic group. However, because of the sample size for these tests, they were likely under-powered to detect significance. Nonetheless, the correlations were generally lower when conducted separately by group which suggests that some of the relation between IQ and emotion perception may be related to different IQ distributions between groups.

Table 6.
Correlations Between IQ and DANVA Scales for the AS Group, N = 15

	FSIQ	VIQ	PIQ
DANVA Total	.59**	.36	.40
DANVA Total Faces	.80**	.38	.74**
DANVA Low Intensity Faces	.76**	.39	.63*
DANVA High Intensity Faces	.68**	.27	.76**
DANVA Total Voices	.18	.21	-.06
DANVA Low Intensity Voices	.35	.27	.20
DANVA High Intensity Voices	-.05	.09	-.32

Note. * = Significant at the $p < .05$ level. ** = Significant at the $p < .01$ level.

Table 7.
Correlations Between IQ and DANVA Scales for the HFA Group, N = 14

	FSIQ	VIQ	PIQ
DANVA Total	.64*	.56*	.59**
DANVA Total Faces	.36	.34	.25
DANVA Low Intensity Faces	.27	.28	.15
DANVA High Intensity Faces	.52	.44	.53
DANVA Total Voices	.66*	.54*	.68**
DANVA Low Intensity Voices	.52	.40	.57*
DANVA High Intensity Voices	.72**	.62*	.72**

Note. * = Significant at the $p < .05$ level. ** = Significant at the $p < .01$ level.

Test of Emotion Perception

Table 8 shows the mean, standard deviation, and range for all DANVA subscales by diagnosis. The normality of these distributions was examined separately by diagnosis given the assumption that the diagnostic groups would perform differently on tests of

emotion perception. Skewness and kurtosis were examined by calculating the ratio of skewness and kurtosis to standard error respectively. The assumption of normality was rejected if the ratio was greater than the absolute value of two (Cohen, Cohen, West, & Aiken, 2003). In addition, histograms, normal probability plots, and detrended probability plots were examined to visually inspect normality (Cohen et al., 2003). All of the distributions were normal (e.g. no skewness or kurtosis) with the exception of Low Intensity Voices for the AS group, which was negatively skewed. This suggested a potential problem with outliers for the Low Intensity Voices Scale for the AS group.

Table 8.
DANVA Means, Standard Deviations, and Ranges by Diagnosis

	Asperger's ($N = 16$)			Autism ($N = 14$)		
Scale	*M*	*SD*	Range	*M*	*SD*	Range
Low Intensity Faces	71.33	12.04	45.8 – 87.5	64.57	13.15	41.6 – 87.5
High Intensity Faces	92.69	7.08	79.2 – 100.0	84.40	5.54	75.0 – 95.8
Low Intensity Voices[a]	68.99	11.25	37.5 – 83.0	46.75	16.06	20.8 – 75.0
High Intensity Voices	74.49	11.07	54.1 – 91.7	59.21	20.50	25.0 – 87.5

Note. All means represent percent correct. [a]After correcting for outliers, the mean for the AS group is 71.70, the standard deviation is 7.67, and the range is 58.8 to 83.0.

Cohen et al.'s (2003) guidelines for examining the influence of outliers were followed. They suggest examining diagnostic statistics using a regression equation with the variable that had an indication of potential problems with outliers as the dependent variable (Cohen et al., 2003). Diagnostic statistics that were examined include: (1) Leverage – how far an observed value is from the mean value; (2) Discrepancy (Externally Studentized Residual) – How far the outlier would be from the regression line if it was omitted from the estimate; (3) DFFITS – A measure of influence that indicates

the number of standard deviations that the prediction of the outlier would change if it was omitted from the estimate; and (4) DFBETAS – Another measure of influence that provides information on how the regression coefficients would change if the outlier was omitted from the estimate.

Using this method, the only scale with an indication of a problem with outliers was DANVA low intensity voices for the AS group. Results with the low intensity voices scale for the AS group identified several cases that exceeded Cohen et al.'s (2003) guidelines for proposed cutoffs signifying cases with an atypical amount of influence. However, two cases in particular exceeded the guidelines by over five times, suggesting that these outliers were very low and had an abnormally large amount of global influence.

One remedial action described by Cohen et al. (2003) includes deleting the outliers and re-examining the remaining data (while later reporting results with the full data set in footnotes). The normality of the Low Intensity Voices distribution for the AS group was re-evaluated without these two cases. The results indicated that the distribution was no longer skewed (skewness = 0). Therefore, these two cases were excluded from further analyses that involved the Low Intensity Voices measure. This changed the Low Intensity Voices AS distribution in the following ways: mean increased from 68.99 to 71.70, standard deviation decreased from 11.25 to 7.67, and the lowest score changed from 37.5 to 58.8.

Facial Expressions

The first set of analyses compared scores from the two groups in this study to the normative means from the instrument manual. Comparisons were based on overall scores

because the normative means were not available broken down by intensity. *t*-tests were conducted to compare accuracy in the perception of faces in general to the estimated population value based on the normative means to the AS and HFA groups. It was hypothesized that both children with AS and HFA would be significantly less accurate in their perception of facial expressions than typically-developing children as represented by the normative means. The results indicated that the AS group's mean percent of facial expressions correct ($M = 82.05$, $SD = 8.73$) did not significantly differ from the standardization sample ($M = 81.85$, $SD = 5.44$), $t\ (15) = .09$, $p > .05$. On the other hand, *t*-tests revealed that the HFA group had a significantly lower mean percent of facial expressions correct ($M = 74.87$, $SD = 8.90$) than the standardization sample ($M = 81.85$, $SD = 5.44$), [$t\ (13) = -2.93$, $p < .05$] and participants with AS ($M = 82.05$, $SD = 8.73$) [$t\ (28) = 2.23$, $p < .05$]. Figure one shows the group means for faces.

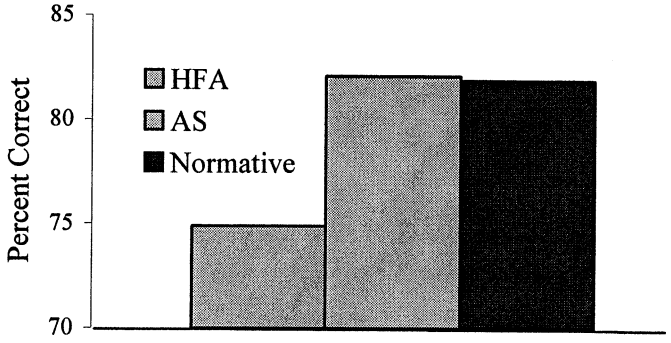

Figure 1. Mean Percent of Faces Correct Across Study Groups and Normative Sample

A mixed-effects ANOVA was conducted for DANVA low and high intensity faces in order to examine the within-subjects effect of cue intensity and the between subjects factor of diagnosis. The AS group was expected to be more accurate in their

perception of both low and high intensity facial expressions. In addition, a stronger relation was expected between diagnosis and perception accuracy for low intensity as opposed to high intensity faces. ANOVA results revealed a significant main effect of diagnosis, $F(1, 28) = 5.57, p < .05$. As shown in Figure 2, children with AS were more accurate in their perception of facial expressions than children with HFA. The interaction effect, however, was not significant, $F(1, 28) = 0.15, p > .05$.

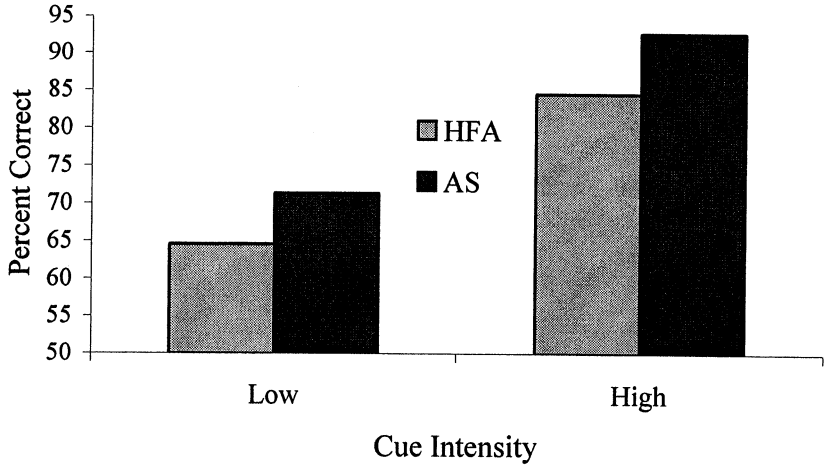

Figure 2. Mean Percent of Facial Expressions Correct by Intensity and Diagnosis

As a follow-up to the finding that IQ was unexpectedly related to the DANVA scales, the analysis was rerun with IQ as a covariate. Full Scale IQ was chosen because it was the most highly related of the IQ scales to the DANVA. There were no significant differences between diagnostic groups in their perception of facial expressions when IQ was a covariate, $F(1, 26) = .10, p > .05$. Figure 3 shows the marginal means for children with AS and HFA by intensity with IQ controlled.

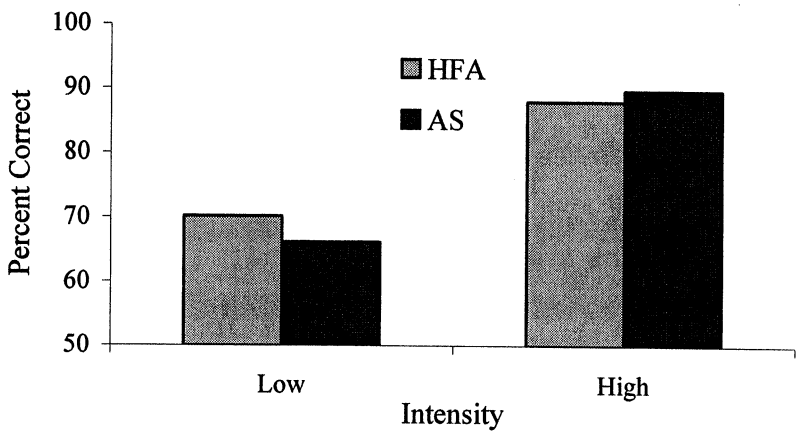

Figure 3. Mean Percent of Facial Expressions Correct by Intensity and Diagnosis, Controlling for IQ

In summary, hypothesis three was supported for HFA but not for AS because the HFA group was significantly poorer at emotion perception than typically-developing children whereas the AS group was not. Hypothesis four was supported because the HFA group was significantly worse at perceiving facial expressions than the AS group. However, this hypothesis was not supported when IQ was controlled. Finally, hypothesis five was not supported because cue intensity did not moderate the relation between diagnosis and the perception of emotion in facial expressions.

Tone of Voice

Comparisons between the two groups in this study and the normative means were based on overall tone of voice scores because normative means were not available broken down by intensity. *t*-tests were conducted for accuracy in the perception of voices in general to compare the estimated population value based on the normative means for typically-developing children to the AS and HFA groups. It was hypothesized that both children with AS and HFA would be significantly less accurate in their perception of tone

of voice cues than typically-developing children as represented by the normative means. However, the results indicated that the AS group's mean percent of voices correct (M = 71.73, SD = 9.19) did not significantly differ from the normative means (M = 74.87, SD = 7.08), t (15) = -.36, $p > .05$. In contrast, a t-test revealed that the HFA group had a significantly lower mean percent of tone of voice cues correct (M = 52.98, SD = 17.68) than the normative sample (M = 74.87, SD = 7.08), [t (13) = -4.11, p = .001] and participants with AS (M = 71.73, SD = 9.19), [t (26) = 4.23, $p < .01$.] Figure 4 shows these group means.

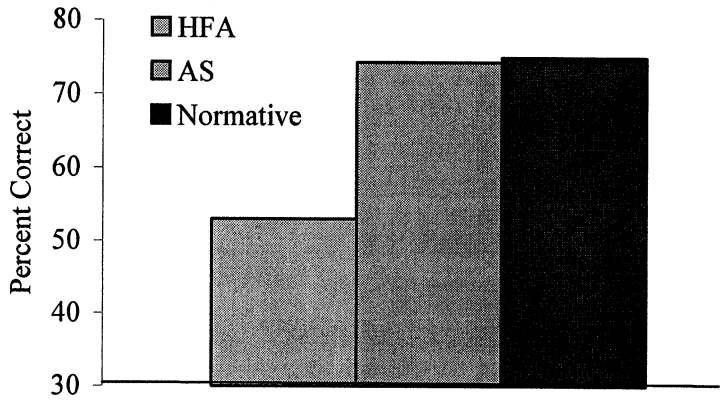

Figure 4. Mean Percent of Voices Correct Across Study Groups and Normative Sample

A mixed-effects ANOVA was conducted for DANVA low and high intensity voices in order to examine the within-subjects effect of cue intensity and the between subjects factor of diagnosis. The AS group was expected to be more accurate in the perception of both low and high intensity tone of voice cues. In addition, a stronger relation was expected between diagnosis and emotion perception accuracy for low

intensity as opposed to high intensity tone of voice cues. ANOVA results revealed a significant main effect of diagnosis, $F(1, 26) = 17.92, p < .001$[1]. As shown in Figure 5, children with AS were more accurate in their perception of tone of voice cues than children with HFA. The interaction effect approached significance, $F(1, 26) = 3.09, p = .09$[2].

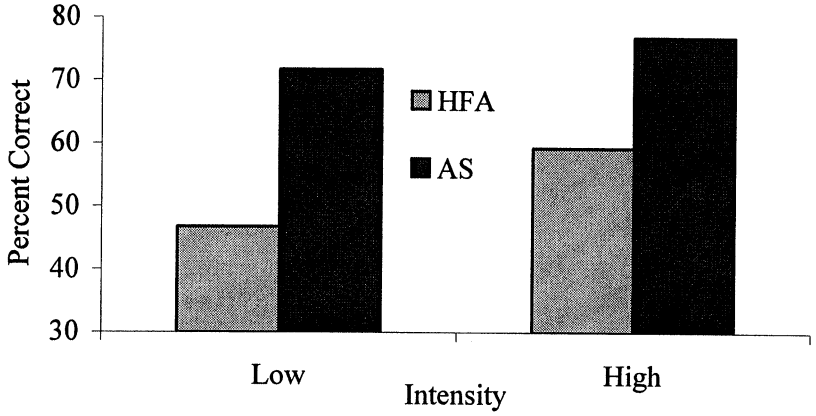

Figure 5. Mean Percent of Voices Correct by Intensity and Diagnosis

As a follow-up to the finding that IQ was related to the DANVA scales, the analysis was rerun with Full Scale IQ as a covariate. Although the main effects of cue intensity and diagnosis were not significant, a mixed-effects ANCOVA revealed a significant interaction between them, $F(1, 24) = 8.88, p < .01$[3]. Because this interaction effect was significant, analyses were conducted separately for low intensity voices and high intensity voices to clarify the direction of the interaction effect. The results of an

[1] If the outliers had not been deleted, the main effects would have still been significant, $F(1, 28) = 13.78, p < .001$.

[2] If the outliers had not been deleted, the interaction effect would have still not been significant, $F(1, 26) = 2.69, p = .11$.

[3] If the outliers had not been deleted, the main effects would have still not been significant and the interaction would be nearing significance, $F(1, 26) = 3.66, p = .06$.

ANCOVA controlling for full scale IQ indicated that participants with AS were significantly more accurate in their perception of *low* intensity voices ($M = 72.40$, $SD = 7.49$) than participants with HFA ($M = 46.75$, $SD = 16.06$), $F(1, 24) = 6.11$, $p < .05$. On the other hand, the results of an ANCOVA controlling for full scale IQ indicated that those with AS and HFA did not significantly differ in their perception of *high* intensity voices, $F(1, 24) = .13$, $p > .05$. As shown in Figure 6, these analyses suggest that those with AS and HFA were similarly accurate in their perception of emotion through high intensity voices but children with AS were significantly more accurate in their perception of low intensity tone of voice cues than those with HFA when controlling for IQ.

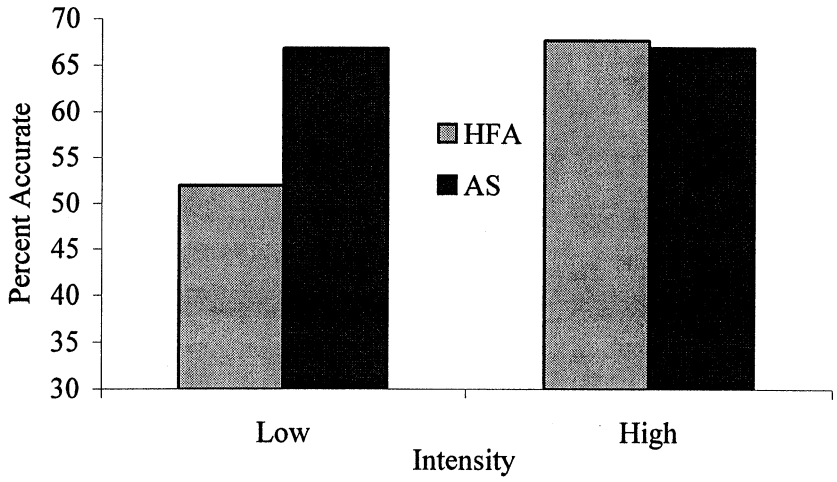

Figure 6. Mean Percent of Voices Correct by Intensity and Diagnosis, Controlling for IQ

In summary, hypothesis three was supported for HFA but not for AS because the HFA group was significantly poorer at perceiving emotion from tone of voice cues than typically-developing children whereas the AS group was not. Hypothesis four was supported because the HFA group was significantly worse at perceiving tone of voice

cues than the AS group. However, this hypothesis was not supported when IQ was controlled. Finally, hypothesis five was supported because cue intensity moderated the relation between diagnosis and the perception of emotion in tone of voice cues. Specifically, participants with AS and HFA did not differ in their perception of high intensity tone of voice cues, but participants with HFA were significantly less accurate in the perception of low intensity cues than those with AS (this approached significance without IQ in the model and was significant with IQ in the model).

DISCUSSION

This study sought to examine differences in the emotion perception abilities of children with AS and HFA when diagnosed using empirically supported diagnostic criteria. The results indicated that the mean score for children with AS did not differ from normative means for typically-developing children on a test of the perception of emotions in facial expressions and tone of voice. In contrast, participants with HFA were significantly less accurate in the perception of emotion in facial expression and tone of voice than both the normative means and participants with AS. Emotion perception accuracy was related to IQ contrary to hypotheses that were based on the lack of a relation between them in typically-developing samples. As a follow-up to this finding, analyses were also run with IQ as a covariate. When controlling for IQ, participants with AS and HFA did not significantly differ from each other in their perception of facial expressions. However, cue intensity significantly moderated the relation between diagnosis and accuracy of emotion perception for tone of voice cues even when the impact of IQ was controlled. Children with AS and HFA perceived high intensity tone of voice cues with similar accuracy, whereas those with HFA had significantly more difficulty with low intensity tone of voice cues. Low intensity tone of voice cues was the test of emotion perception that was most consistently related to level of social functioning, but emotion perception accuracy in general was not as strongly related to social functioning as expected.

As hypothesized, the finding that children with HFA performed worse than the standardization sample in their perception of nonverbal cues of emotion is consistent with

the literature that suggests a deficit in these skills for children with *classic* autism (e.g. Braverman et al., 1989; Hobson, 1986a, b; Turk & Cornish, 1998). In fact, the magnitude of difference in emotion perception skills between the HFA group and standardization sample was similar to studies of children with classic autism that found differences of one standard deviation or more (Hobson et al., 1989; Monaghan et al., 1989). The current findings are also consistent with some of the research on individuals with HFA that found similar deficits of greater than one standard deviation below the mean of typically-developing controls in emotion perception (Macdonald et al., 1989).

On the other hand, some earlier studies of higher-functioning individuals with pervasive developmental disorders have found no difference in emotion perception abilities when compared to typically-developing controls (e.g. Adolphs et al, 2001). Previous studies that have examined these skills with higher-functioning individuals with pervasive developmental disorders often used poorly defined diagnostic groups (such as "lesser variants of autism") or a heterogeneous group of children with various pervasive developmental disorders (e.g. Fein et al., 1992; Serra et al., 1999). Unlike these previous studies, the current study used empirically supported diagnostic criteria (Klin et al., in press) to more clearly define AS. Using these more specific diagnostic criteria, those with AS were significantly more accurate in their emotion perception than participants with HFA, and children with AS did not differ from the normative sample of the instrument in the perception of facial expressions or tone of voice cues whereas those with HFA did. This may explain some of the inconsistent findings from studies that combined these groups in their comparison to typical populations.

Two aspects of the diagnostic criteria that were used to distinguish AS and HFA in this study provide a possible explanation for this finding. Those with AS were required to have social interest during the preschool years and they could not have had language delays (Klin et al., in press). In contrast, those with HFA may have had language delays and greater social withdrawal and isolation (Klin et al., in press; Myles & Simpson, 2002). These language and social differences during the preschool years may be critical in understanding differences in emotion perception development given the importance of this time period for emotion perception development (Brown & Dunn, 1996; Denham, 1998). Although a large degree of emotion perception skill is thought to be innate (Ackerman et al., 1998; Eckman et al., 1972; Izard 1972, 1977), evidence also suggests that sensitivity to expressions of emotions can be socialized through parent-child interaction (Denham, 1998). Specifically, parental emotional expressiveness and discourse about emotions have been indicated as influential in emotion perception development (Denham, 1998). It is possible that parents of children in the HFA group did not talk about emotions to their children as much as the parents of the AS group because of the greater levels of withdrawal and language delays in the HFA group. In summary, the increased withdrawal and decreased language in HFA may lead to decreased parental interaction, which could explain the limitations in emotion perception abilities in children with HFA.

Despite this theory for why individuals with HFA may have less opportunity to benefit from the socialization of more sensitive emotion perception skills than those with AS, it is still somewhat surprising that the mean for the AS group did not differ from the

normative means for typically-developing children. Given the extent of social difficulties in children with AS (Frith, 1991; Wing, 1981) and the link between emotion perception abilities and social functioning (e.g. Baum & Nowicki, 1998; Denham et al., 2003), those with AS would be expected to have poorer emotion perception abilities than typically-developing children. The current finding that their ability to read expressions of emotion is similar to their peers suggests that their difficulties must stem from deficits in more advanced emotion understanding skills. For example, they may not pay attention to these cues in the natural environment or they may not know how to respond to them once the cues are perceived (e.g. Serra et al., 1999).

Although the children with AS were more accurate in their perception of facial expressions than the children with HFA as expected, this difference was not significant when IQ was controlled. This finding contradicts the assumption that receptive nonverbal processing skills are not related to overall intellectual level (Nowicki, 2003). In addition, previous studies of emotion perception that used the DANVA found that IQ was not related to emotion perception performance (Baum, 1997; Baum et al., 1996; McClanahan, 1996; Nowicki & Mitchell, 1997).

There are several possible explanations for the influence of IQ in this study. First, the previous studies that did not find a link between IQ and DANVA performance had a much more restricted range of IQ scores than the current study. When the range of a variable is restricted, the proportion of variance associated with other variables is smaller and the correlation is therefore smaller (Cohen et al., 2003). The previous studies that did not find a link were mostly focused on typically-developing populations and so the

majority of participants had IQ's around the standardization mean (Baum, 1997; Baum et al., 1996; McClanahan, 1996; Nowicki & Mitchell, 1997). On the other hand, in the current study, the groups significantly differed in IQ and there was a remarkable range of cognitive functioning among participants. The correlations in the current study may have been inflated artificially because the sample was somewhat bi-modal in terms of IQ scores. There is some support for this explanation because the correlations between emotion perception and IQ were generally lower when they were tested separately for each diagnostic group. The representativeness of the bi-modal IQ distribution for AS and HFA is an important factor in interpreting the IQ-emotion perception relation. By better defining the groups using Klin et al.'s (in press) diagnostic criteria for AS, actual differences in mean IQ scores between individuals with AS and HFA might have become more apparent. The IQ-emotion perception relation found in this study may suggest that typical IQ tests measure more than just cognitive ability in populations with pervasive developmental disorders. It has been suggested that although IQ tests are often *reliable* in autism, they may not be *valid* in that the ability to understand other's thoughts and feelings may influence measures of IQ (Frith & Happé , 1998; Scheuffgen, Happé, Anderson, & Frith, 2000). Although this hypothesis is somewhat speculative, it would provide a clear explanation for the association found between IQ and emotion perception in this study.

In contrast to the overshadowing influence of IQ on group differences for facial expressions, there were diagnostic differences in the perception of tone of voice cues both without IQ in the model and when it was controlled. As hypothesized, participants with

AS were more accurate in their perception of facial expressions than participants with HFA when IQ was not in the model. When IQ was controlled, the relation between diagnosis and emotion perception was moderated by cue intensity. Those with AS perceived high intensity and low intensity tone of voice cues with similar accuracy whereas participants with HFA had poorer performance on the low intensity cues. The finding that both groups performed fairly well on the high intensity tone of voice cues with means similar to typically-developing children suggests that they may have the same innate understanding of basic emotion expressions as typically-developing children (Ackerman et al., 1998; Eckman et al., 1972; Izard 1972, 1977). The HFA group's greater difficulty with low intensity cues, on the other hand, provides further evidence that the children with HFA may not benefit as much from the socialization of emotions in the early years. This is supported by the fact that they only had more trouble with the *subtle*, low intensity tone of voice cues and that a key point of differential diagnosis between groups is the early developmental history when socialization of sensitivity to emotions is most important (Denham, 1998).

Analyses examining the relation of nonverbal cues of emotion to measures of social functioning indicated that low intensity tone of voice cues were related to more social measures than the other DANVA scales. This highlights the importance of acquiring skill in perceiving more subtle cues of emotion. Furthermore, neither high intensity facial expression or tone of voice cues were related to any of the measures of social functioning. This finding is consistent with studies using typically-developing samples that found that accuracy in the perception of *low* intensity cues, but not *high*

intensity cues, was related to social competence (Baum & Nowicki, 1998). On the other hand, the finding that the perception of facial expressions was only significantly associated with community living adaptive behavior skills (but not with any of the social measures) is inconsistent with previous research suggesting a link between the perception of facial expressions and social skills (e.g. Denham, 2003, Nowicki & Duke, 1992). This could be due, in part, to the restricted range of social functioning in this sample (Cohen et al., 2003). Specifically, all children were fairly socially impaired; participants in both groups had to exceed ADOS and ADI-R cut-offs for social dysfunction in order to meet diagnostic criteria. In addition, with the exception of the SIB-R community living scale, there were no significant differences between groups on other measures of social functioning, including the CBCL and SIB-R.

The ADOS, which is a measure of *current* social functioning, was not related to any DANVA measure. This may be because the ability to read nonverbal cues is "the perceptual bedrock for *further* (emphasis added) understanding of emotions" (Denham, 1998, p. 61). Although accurate emotion perception provides the foundation for success, the emotional information must be *integrated* for effective communication and social interaction (Klin et al., 2002). Children with HFA and AS may not be paying attention to the cues in natural social interactions, they may not know what to do with emotion information once they perceive it, or they may know *what* they are supposed to do but not know *how* to do it. Therefore, children with HFA and AS may benefit from more instruction in how to use nonverbal emotion cues to produce an adaptive social response.

This is particularly true for the AS group that was reading cues with similar accuracy to the standardization sample but still having notable social difficulty.

There are several limitations to this study. First, the measure of emotion perception did not assess these skills in a way that is similar to a naturally-occurring social interaction. The participant's attention was specifically drawn to the emotion cue and the cues consisted of photographs and audiotapes. This makes it difficult to understand how they use these skills in a social interaction. However, it was an effective way to determine whether they have deficits in this foundational skill before exploring its use in a more natural framework.

It is somewhat difficult to compare this study to other studies given the use of different diagnostic criteria for AS (Klin et al., in press). However, there are some benefits to having used the Klin et al. (in press) criteria for AS. First, they have more empirical support than the DSM-IV criteria (Klin et al., in press), which have been shown to be inadequate in several studies (e.g. Kugler, 1998; Wing et al., 2000; Ozonoff et al., 2000). The criteria used in this study are also more consistent with Asperger's (1944) original descriptions of the disorder, commonly accepted conceptualizations of AS (Smith-Myles & Simpson, 2002; Volkmar et al., 2000) and the description of AS in the text-revision of the DSM (American Psychiatric Association, 2000). Finally, because the criteria are based on the use of standardized diagnostic measures, it would be easy to replicate. This is an improvement over other studies that used less clearly defined groups (e.g. Serra et al., 1999). Furthermore, comparisons to Klin et al.'s (in press) study that originally established the new criteria suggest that use of these new, more specific criteria

for AS led to similar samples in this and Klin et al.'s (in press) study. In the current study, when DSM-IV diagnostic criteria were applied, 6 of the 16 children with AS in this study would have been diagnosed with HFA. This agreement rate of 63% between diagnostic systems is the same as Klin et al. (in press found) when they compared diagnostic systems (63%). On the other hand, the significant Verbal-Performance IQ difference found in the original study that used these diagnostic criteria (Klin et al., in press) was not replicated in the current study. However, this was likely due to low power to detect this difference and there was a trend in the correct direction. In fact, the mean difference between verbal and performance IQ scores for the AS group was 11 in both studies (Klin et al., in press). Although power was adequate for tests of the primary hypotheses regarding differences in emotion perception between groups, power may have also been a limitation for group comparisons that were more descriptive (e.g. SIB-R and CBCL).

One difficulty in interpreting the results of the current study is the high degree of relation between IQ and emotion perception abilities, which is in contrast to findings with typically-developing children. It will be important for future research to clarify whether typical measures of IQ reflect some of the difficulties that children with pervasive developmental disorders have understanding thoughts and feelings. Developing a clear understanding of this will inform research methods. Specifically, controlling for IQ would be inappropriate if it meant eliminating an essential group difference rather than random noise (Kazdin, 1998). The IQ differences found in this study are consistent with other research (e.g. Mottron, 2004) so future studies should explore the importance of IQ

in defining these groups and whether these IQ distributions are representative of group membership. The strong relation between IQ and emotion perception in this study suggests that scores on typical measures of IQ may reflect the social functioning deficits characteristic of this population. However, this hypothesis is fairly speculative at this point and research will need to be conducted that addresses this issue directly.

In order to determine potential early intervention strategies for emotion perception skills, future studies should test potential explanations for differences between HFA and AS in emotion perception. Specifically, it will be important to test whether decreased socialization of emotion perception skills is one of the underlying reasons for the emotion perception deficit in HFA. Studies should clarify whether parental discourse on emotions does mediate the relation between diagnosis and emotion perception accuracy, and whether this path is moderated by the parent's emotion perception accuracy. Future studies should also focus on how children with AS and HFA use or do not use emotion perception skills in their everyday social interactions. It will be important to discern whether they pay attention to emotion cues when they are not being asked to do so. In addition, future studies should explore whether children with AS and HFA have an understanding of how to modify their interaction based on the emotion information and if they are able to do so. Finally, this study represents one of the first to examine the ability to perceive tone of voice cues in these populations. Therefore, future research should expand on this foundation by continued investigation of tone of voice perception in pervasive developmental disorders.

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Appendix A. Recruitment Flyer

Does your child have high-functioning autism, Asperger's syndrome or pervasive developmental disorder not otherwise specified?

Youth aged 8-16 may be eligible to participate in a VCU research study. This study is examining the emotion perception abilities of children with pervasive developmental disorders who can talk in sentences.

What would you do?

- You would be interviewed and asked to fill out questionnaires
- Your child would participate in a play assessment, emotion perception assessment, and an intelligence test

What would you get?

- Your child will be invited to participate in a FREE SOCIAL SKILLS GROUP
- You will get valuable feedback on your child's strengths and weaknesses in: overall adjustment, symptoms of his/her diagnosis, personal independence skills, intellectual ability, and emotion perception abilities
- You will help us learn more about pervasive developmental disorders and possible areas for intervention

VCU IRB approved flyer 5/03

For more information, please call: 804-828-4725

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Appendix B. Diagnostic Criteria Cut-off Scores

Autism Criteria	Asperger's Syndrome Criteria
ADI-R Onset ≥ 1 Social ≥ 10 Communication ≥ 8 Behaviors ≥ 3	social dysfunction ADI-R social domain ≥ 10 ADOS social domain ≥ 6
ADOS Social ≥ 6 Communication ≥ 3 Social/Communication ≥ 10	social motivation ADI-R item 43 = 0 or report of similar approaches to adults
"Precedence rule" reversed (i.e., AS over autism)	verbosity and pragmatic deficits only ADOS observation ADI-R items 13, 18, and 19 = 0 ADOS A-4 = 0
Participant must meet language criteria for Module 3 of the ADOS[1]	normal speech development milestones ADI-R items 8 and 9 both = 0
	circumscribed and interfering interest ADI item 47 ≥1 Yale Special Interests survey – report of interest that parent reports child talked about "most of the time" May have ADOS item D-4 ≥ 1
	uses pretend play ADI-R item 40 = 0 and/or pretend play during ADOS
	absence of motor stereotypies ADI-R items 52 and 53 = 0 ADOS item D-2 = 0

[1]Note, this is not part of Klin et al.'s (under review) criteria and was added for an operational definition of "high-functioning"

Vita

Carla A. Mazefsky was born on June 4, 1977, in Connecticut. She graduated from Joel Barlow High School in Redding, Connecticut in 1995. She then completed a year as an exchange student in Dilsen-Stokkem, Belgium. She received her Bachelor of Science in Psychology with High Honors from the College of William and Mary in Williamsburg, Virginia in 2000. She received a Master of Science in Clinical Psychology from Virginia Commonwealth University in 2002.