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INVESTIGATING THE ROLE OF EMOTION PERCEPTION IN THE ADAPTIVE FUNCTIONING OF INDIVIDUALS ON THE AUTISM SPECTRUM

by

MARGARET B. HUDEPOHL

Under the Direction of Diana L. Robins

ABSTRACT

Cognitive functioning has historically been used to predict adaptive outcomes of individuals with autism spectrum disorders; however, research shows that it does not adequately predict these outcomes. Therefore, the current study explored the role of emotion perception in the adaptive functioning of individuals with ASDs. Emotion perception was assessed using the DANVA-2, which has audio and static face stimuli, and the DAVE, dynamic, audio-visual emotion movies. Adaptive functioning was assessed using the Vineland-II Socialization, Communication, and Daily Living domains. Results indicated that individuals with ASDs demonstrated significant impairments in both adaptive functioning and emotion perception compared to typical individuals. Findings did not demonstrate a relationship between emotion perception and adaptive functioning, controlling for IQ. Future research should broaden the approach when investigating possible mechanisms of change for adaptive outcomes to include exploration of social perception more broadly, of which emotion perception is one component, and its relationship with adaptive outcomes.

INDEX WORDS: Autism spectrum disorders, Adaptive functioning, Emotion perception, Dynamic emotion stimuli, Social perception

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MARGARET B. HUDEPOHL

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

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Margaret Banks Hudepohl
2009

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INTRODUCTION

Autism spectrum disorders (ASDs) is an umbrella term for a series of early-onset developmental disorders including Autistic Disorder, Asperger Disorder, and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS). ASDs are characterized by deficits in socialization, particularly social relatedness and emotional interaction, and communication, which often are accompanied by restricted interests and/or perseverative behaviors (American Psychiatric Association, 2000). Much research, therefore, has focused on the nature and outcome of these deficits, how to predict them, and possible interventions. More recently, the field has begun to incorporate more biologically-based methodologies, including structural and functional neuroimaging and psychophysiology, in order to investigate the neural underpinnings of these deficits.

An area of considerable focus within autism spectrum research investigates how the aforementioned deficits impact an individual's ability to function successfully in their everyday life. Many treatment protocols have been developed on the basis of this research and findings but have been implemented with variable success. Often, in studying the adaptive functioning of individuals on the autism spectrum, measures of cognitive and language functioning are used to predict outcomes (Howlin & Goode, 1998). It has become clear, however, that level of intellectual functioning is not sufficient to fully and completely predict how an individual with an ASD will interact in and meet the demands of day to day life (Klin et al., 2007).

Thus, there is a need for research addressing factors other cognitive functioning when assessing and predicting the adaptive functioning in ASDs. Therefore, this study examines the role of emotion perception in the adaptive outcomes of individuals on the autism spectrum.

Exploring the nature of this relationship would help identify possible predictors of adaptive functioning and potentially contribute to the development and/or refinement of treatments.

Adaptive Functioning

Adaptive functioning refers to the effectiveness with which one is able to perform the daily activities and meet the everyday demands of the environment that are required for personal and social sufficiency (Carter et al., 1996). Historically, in the literature, much emphasis has been placed on individuals' cognitive potential or impairment; however, an assessment of adaptive functioning illustrates how an individual puts to use their cognitive aptitude; that is, how they use their intellect to operate on a daily basis (Sparrow & Cicchetti, 1985).

Measures of adaptive functioning primarily focus on assessing behaviors such as conversation skills, proficiency in social interactions and developing relationships, personal hygiene, domestic chores and community activities. A widely used measure is the Vineland Adaptive Behavior Scales, Second Edition (Vineland-II), which separates the construct into three domains, Communication, Socialization, and Daily Living Skills, to assess for age-appropriate behavior. It is important to note that the goal when measuring adaptive functioning is to assess the individual's typical level of functioning; that is, not what the individual is capable of or their best performance, but their standard behavior in various situations.

Although ASDs and intellectual disability (ID) both require deficits in adaptive functioning as a core feature, ASDs should be distinguished from ID. Individuals diagnosed with ID are characterized by significantly below average intellectual functioning, onset before age 18, with coexisting significant adaptive functioning impairments that are not specific to particular skill areas. In contrast, whereas individuals on the autism spectrum often demonstrate cognitive impairment (Volkmar et al., 1987), this deficit is not required for diagnosis. When measures of the individual's intelligence (IQ) fall within the ID range, that is, below 70, these individuals are typically referred to as persons with "lower functioning" ASDs (LFA). Those individuals on the autism spectrum whose IQ is above the cutoff for intellectual disability are referred to as individuals with "higher functioning" ASDs (HFA; Klin et al., 2007). Although individuals with HFA do not demonstrate comorbid ID, there remains a significant range in the abilities and behaviors of these individuals, who are variably affected by cognitive impairment as well as attentional, perceptual, and other difficulties (e.g. Joseph, Tager-Flusberg, & Lord, 2002 & Sturm, Fernell, & Gillbery, 2004).

Adaptive functioning has been studied in a number of neurodevelopmental disorders, many of which are found to be comorbid with ASDs, leading researchers to conclude that, in many instances, different syndromes are characterized by specific profiles of adaptive functioning. For example, research with Fragile X syndrome has revealed that these individuals often show both a specific pattern and trajectory of adaptive behavior. The adaptive skill development of individuals with Fragile X syndrome often involves significant gains in the first ten years of life with a subsequent plateau of development in early adolescence extending into the young adult years. In patients over age 11, a profile emerges that typically reveals a relative strength in daily living skills, particularly in personal and domestic skills, with a comparative weakness in communication skills (Dykens et al., 1996; Fisch et al., 2002). In another neurodevelopmental disorder, Prader-Willi syndrome, which is characterized by hypotonia, developmental delay, and intellectual disability, daily living skills have proven to be an adaptive strength, particularly in comparison to deficits in socialization skills. While this pattern is similar to that of individuals with ASDs, the trajectory differs in that the specific strength in daily living skills for individuals with Prader-Willi syndrome actually becomes more pronounced with age whereas the magnitude of this strength is static in ASDs (Dykens et al., 1992; Fisch et al., 2002; Holland et al., 2003). Dykens and colleagues (1994) also investigated the adaptive functioning of children with Down syndrome. The authors found that these individuals demonstrate a significant weakness in communication skills, particularly their expressive abilities, in comparison to their daily living and socialization skills. This corroborates previous research findings that individuals with Down syndrome have a relative strength in socialization skills as compared to their communication abilities (Loveland & Kelley, 1991; Rodrigue et al., 1991). Children with Down syndrome exhibited significant adaptive functioning gains in early childhood (ages 1 to 6) with variable gains in later childhood years, demonstrating that a plateau in adaptive behavior development is not ubiquitous in this population (Dykens et al., 1994).

Adaptive Functioning and Autism Spectrum Disorders.

Assessment of adaptive functioning in individuals on the autism spectrum is important for multiple reasons, namely to assist in differential diagnosis and to shed light on the functional deficits of the individual. With regard to differential diagnosis, patterns of deficits in adaptive functioning can be early indicators of specific developmental disorders, such as intellectual disability and others previously mentioned. Previous research has found that individuals on the autism spectrum show a unique pattern of adaptive behavior. Individuals generally exhibit overall low levels of overall adaptive behavior (Fisch et al., 2002) and, more specifically within that, often show significant deficits in socialization skills, mild to intermediate communication impairments with daily living skills being a relative strength (Carpentieri & Morgan, 1996; Carter et al., 1998; Liss et al., 2001; Volkmar et al., 1987). Rodrigue and colleagues (1991) demonstrated that this considerable impairment in social skills holds even for very low-functioning ASD individuals, in contrast to their comparison group with Down Syndrome.

Also notable in the assessment of adaptive functioning is that individuals with ASDs tend to demonstrate adaptive impairments that are beyond what would typically be expected from their level of cognitive functioning (Carpentieri & Morgan, 1996; Carter et al., 1998; Freeman et al., 1988). In a recent study, Liss and colleagues (2001) noted that HFA individuals emerged as more impaired in socialization and daily living skills relative to their nonverbal IQ-matched contrast group than were the LFA individuals when compared to their nonverbal IQ-matched contrast group. This emphasizes the discrepancy between cognitive and adaptive functioning in individuals on the autism spectrum by demonstrating that, even as the cognitive potential of these individuals increases, their level of adaptive functioning does not correspondingly develop. This study also observed that restricted/repetitive behaviors as well as deficits in socialization and communication, the classic negative behaviors associated with ASDs, appeared to impede adaptive skills development in the HFA individuals to a much greater degree than in the LFA individuals, indicating that autistic symptomatology may contribute to the discrepancy between cognitive performance and adaptive functioning in the HFA population (Liss et al., 2001).

In addition to ruling out a primary ID diagnosis, an evaluation of the individual's adaptive behavior sheds light on their functional capabilities and deficits; that is, whether they are able to function independently or if some level of care is required. Over time, these assessments can aid in monitoring an individual's development and inform appropriate interventions and therapies (Carter et al., 1996).

Adaptive Functioning and Intellectual Functioning in Autism Spectrum Disorders.

Although cognitive impairment is not a prerequisite for an ASD diagnosis, the IQ of approximately 30 percent of individuals with any type of ASD falls within the range of intellectual disability. This varies by type of ASD, with rates increasing dramatically to around

70 percent in individuals who meet strict criteria for autism (Chakrabarti & Fombonne, 2001; Goin-Kochel, Peters, & Deering, 2007). Adaptive deficits, therefore, are particularly useful in distinguishing between ASDs with ID and ID alone. In studies of adaptive functioning with ASDs and ID populations, individuals with ID have generally shown significantly higher adaptive behavior levels than individuals with low functioning ASDs. One study compared IQ-matched ASD individuals with comorbid ID to children with Down syndrome and found that, whereas abilities were generally similar in communication and daily living skills, the adaptive social behaviors of the ASD/ID were significantly more impaired compared to the Down syndrome group (Rodrigue, Morgan, & Geffken, 1991). A similar study (Carpentieri & Morgan, 1996) compared individuals with ASDs to an IQ-matched heterogeneous ID group. This study revealed similar deficits in socialization skills in the ASDs group compared to the ID group. However, the researchers also observed significant deficits in communication skills in the ASDs group compared to the ID group, therefore, making deficits in social and communication skills the distinguishing factors between the ASDs group and IQ-matched ID group.

Overall, results from cognitive testing of individuals on the autism spectrum have not consistently shown a clear relationship with adaptive functioning. A study by Bacon and colleagues (1998) showed that awareness of social stimuli showed high correlations with ID and LFA groups but not for language-impaired or HFA groups. This was corroborated in a more recent study that found correlations between adaptive functioning and IQ in an LFA group; however, this correlation was less strong when looking at the HFA group, suggesting that IQ may be the rate-limiting factor in the development of adaptive behaviors at lower levels of functioning but in general maybe not as valuable a predictor as previously thought (Liss et al., 2001).

Even when researchers investigated IQ broken down into verbal and nonverbal components, a consistent relationship was not established. Schatz and Hamdanallen (1995) found that as their performance IQs increased, individuals on the autism spectrum showed fewer gains in social functioning and daily living skills than children with intellectual disabilities. In another longitudinal ASDs study, initial nonverbal IQ proved to be the best predictor of development of communication skills but was unrelated to improvement in social skills (Freeman et al., 1999). Contrary to this, Klin and colleagues (2007) found that the verbal IQ was the best predictor of communication abilities with neither verbal or performance IQ predicting social abilities. One study looked more closely at the verbal memory component of IQ, considering the relationship between receptive language abilities and level of adaptive functioning. Liss and colleagues (2001) found that in their low-functioning ASDs group, overall Quantitative (nonverbal) IQ was the best predictor of adaptive behavior. However, in their high-functioning ASDs group, the verbal memory score, as assessed by a list learning task, was the best predictor of adaptive functioning in their sample, leading them to suggest that these higher functioning individuals may utilize rote learning to acquire social skills. Although no clear association has yet been found, these findings indicate that individually, nonverbal or language and verbal memory tests may be more sensitive predictors of adaptive functioning in individuals on the spectrum than general measures of cognitive functioning.

In sum, previous research has elucidated a unique and pervasive pattern of adaptive behaviors in individuals on the autism spectrum. Regardless of their level of functioning, these individuals typically show significant deficits in socialization skills, mild to moderate communication impairments accompanied by relative strengths in daily living skills (Carpentieri & Morgan, 1996; Carter et al., 1998; Liss et al., 2001; Volkmar et al., 1987). Although a significant amount of research has investigated the relationship between intellectual level and adaptive functioning in this population, results from cognitive testing have not shown a clear association.

Emotion Perception

Emotion perception can be thought of as an individual's ability to interpret emotional experiences through the recognition, perception, and expression of emotion (Newman & Lorenz, 2003). To effectively communicate and interact socially, one must be able to successfully process emotional cues received from others. Emotion studies have investigated recognition through both facial information and through prosodic cues. Early development studies have shown that infants as young as six months are able to recognize positive and negative emotion via facial expression (Nelson, 1987; Walker et al., 1982). Izard (1971) demonstrated that older children, around three years of age, can match the appropriate emotion label when shown emotional facial expression photographs. Dimitrovsky (1964) showed that children ages 5 to 12 could select the appropriate stick-figure drawing depicting an emotion when asked to match the emotional prosody heard via audio track.

Only more recently have researchers begun to investigate emotional perception with cues from multiple domains presented simultaneously. deGelder and Vroomen (2000) showed that when typical individuals are presented with bimodal face and voice information, emotion identification is biased toward the facial information. More recently, Santorelli (2005) corroborated this finding using novel, dynamic audio-visual stimuli with mismatching emotional information from the face and voice, as individuals showed a facial bias when asked to identify the emotion. However, deGelder and Vroomen (2000) also found that when individuals were shown a photograph and audio track simultaneously and asked to ignore one or the other modality, results indicated that participants were still affected by the ignored modality. Taken together, these results suggest that in typically developing individuals, cross-modal integration of emotional information is inevitable. More recently, Kreifelts and colleagues (2007) used dynamic stimuli involving a video of an emotional facial expression played with a single word audio track. This approach demonstrated a perceptual gain when audio and visual information were presented; that is, the participants were better able to correctly perceive and identify the emotion when bimodal, rather than unimodal, information was provided.

Neuroanatomical Substrates of Emotion Perception.

At this point in time, there is still considerable variation in findings regarding the neural correlates of emotion perception. On a macroscopic level, the right hemisphere has been shown to be preferentially involved in the processing of emotional information in humans (Damasio et al., 2003). However, there are a number of more specific brain regions that are consistently found across relevant studies. Studies have taken a variety of approaches to reach these conclusions, with findings regarding brain regions that appear to be specifically activated to a certain emotion, areas that appear to be activated to a particular type of task (e.g. face processing), and regions that seem to correlate to the presentation of multimodal stimuli.

A handful of studies have investigated the neural correlates specific to individual emotions, with the proposal that there may be dissociable neural subsystems for various basic emotions; that is, that different brain regions may be important in the perception of different emotions. Perhaps the most widespread finding in this regard is that of the amygdala showing preferential activation in response to fearful faces (Hennenlotter & Schroeder, 2006). This was initially demonstrated with human lesion studies that found impaired recognition of fearful faces following amygdala damage (e.g. Adolphs et al., 1994; Anderson & Phelps, 2000;

Sprengelmeyer et al., 1999; Young et al., 1995). More recently, imaging studies have built on this finding in neurotypical individuals by demonstrating preferential amygdala activation in response to fearful faces (e.g. Breiter et al., 1996; Fischer et al., 2003; Morris et al., 1996; Phillips et al., 2004; Thomas et al., 2001; Yang et al., 2002). However, this does not appear to be a complete dissociation as other studies, which will be subsequently reviewed, have shown amygdala activation in response to other emotions, including anger, happiness, and sadness.

A second emotion that has garnered support for possible dissociable brain regions is digust (Hennenlotter & Schroeder, 2006). A number of clinical studies previously demonstrated that patients' with Huntington's disease often have a selective deficit in recognizing disgust (Gray et al., 1997; Hennenlotter et al., 2004; Sprengelmeyer et al., 2005) where pathological changes occur in the basal ganglia and some cortical regions such as the insular cortex. Functional imaging studies have since shown that these areas, the basal ganglia and insula, are activated preferentially in response to disgusted faces in healthy individuals (Phillips et al., 2004; Phillips et al., 1997, 1998; Schroeder et al., 2004; Sprengelmeyer et al., 1998; Wicker et al., 2003).

Other basic emotions, including anger, happiness, sadness, and surprise have neuroanatomical substrates that appear to be less well-defined at this point, based on the limited clinical data (Hennenlotter & Schroeder, 2006). Briefly, functional imaging studies have demonstrated that the orbitofrontal cortex (Blair et al., 1999), anterior cingulate (Sprengelmeyer et al., 1998; Strauss et al., 2005), and amygdala (Adams et al., 2003; Whalen et al., 2001; Yang et al., 2002) appear to be important in the processing of anger. In studies looking at the perception of happiness, imaging studies have implicated the basal ganglia (Morris et al., 1996, 1998), inferior orbitofrontal cortex (Dolan et al., 1996), anterior cingulate cortex (Dolan et al., 1996; Kesler-West et al., 2001), and the amygdala (Breiter et al., 1996; Pessoa et al., 2002; Winston et al., 2003; Yang et al., 2002). Regarding surprise, the right posterior parahippocampal gyrus appears to be the brain region most correlated to this emotion; however, this is based on just one functional imaging study and needs further exploration and replication (Schroeder et al., 2004). Finally, imaging studies have not demonstrated conclusive, dissociable areas with regard to sadness, although it appears that the left amygdala, and right inferior and middle temporal gyrus may be brain regions to further investigate (Blair et al., 1999).

Other studies have investigated brain regions that may correlate to specific emotional tasks, such as facial affect recognition, which is one of the primary methods for studying emotion perception at this time. A number of lesion studies have demonstrated that the right temporoparietal region is particularly important in the processing and recognition of emotional facial expressions (Damasio et al., 2003), a finding that has been corroborated by PET studies (e.g. Gur et al., 1994). Functional imaging studies utilizing still photographs of facial expressions to elicit emotion perception have demonstrated preferential activation in the fusiform gyrus (Adolphs, 2001; Gur et al., 2002; Keightley et al., 2003) and superior temporal sulcus (Adolphs, 2001; Iidaka et al., 2001; van de Riet et al., 2009) as well as the amygdala (Hariri, Brookheimer, & Mazziotta, 2000; Keightley et al., 2003) and insula (Keightley et al., 2003). Another study (Kilts et al., 2003) used PET to investigate whether neural pathways involving recognition of emotion in static facial expressions were dissociable from those involved in recognition of emotion in dynamic facial expressions. Kilts and colleagues found differences by stimulus type and emotion, including that static anger and happiness correlated with increased activity in the motor, prefrontal, and parietal cortical network, dynamic anger resulted in right-lateralized activations in the medial, superior, middle, and inferior frontal cortex and cerebellum, and finally dynamic happiness was associated with cuneus, temporal cortex, and middle, medial, and superior frontal cortex activation.

Although emotion perception, by its very nature, involves integration of information from multiple senses, or modalities, many studies investigating emotion perception have utilized unimodal stimuli such as photographs. More recently, researchers began creating dynamic versions of unimodal stimuli in an attempt to create more real-life stimuli. For example, one study compared brain activation to dynamic (i.e., neutral morphed to fearful or happy facial expression) versus static (i.e., fearful or happy) facial expression stimuli only and found that the left amygdala and many right hemisphere areas, including the occipital and temporal cortices and right ventral premotor cortex showed increased activation to dynamic stimuli (Sato et al., 2004).

As discussed previously, in very recent years, the field has begun moving toward the use of bimodal or multimodal emotional stimuli in some instances. This, in turn, has generated a handful of studies investigating the neural bases of emotion perception using more ecologically valid, multimodal measures. A handful of imaging studies have utilized stimuli with a visual and an auditory component; for example, having the participant view a static photograph while listening to a concurrent audio track. Dolan and colleagues (2001), in this manner, found preferential activation in the amygdala and fusiform gyrus. A later study replicated these findings but reported more specific brain regions, namely, the left basolateral amygdala and the right middle fusiform gyrus (FG) (Ethofer et al., 2006a) as well as the left posterior superior temporal sulcus (pSTS; Ethofer et al., 2006b). In a PET study with similar stimuli, the left middle temporal gyrus (MTG) and left anterior FG showed stronger activation to bimodal stimuli than either unimodal stimuli (Pourtois et al., 2005). When using bimodal stimuli of a more dynamic nature, Kreifelts and colleagues (2007) found neural correlates bilaterally in the posterior superior temporal gyrus (pSTG), an area adjacent to the sSTS, and the right thalamus. Similarly, also with dynamic AV stimuli, Robins and colleagues (2009) found increased activation in the right temporal pole, left anterior STS, and bilateral posterior STS, compared to unimodal emotion perception stimuli. Taken together, areas within and surrounding the STS, including the FG, MTG, and thalamus, appear to be crucial in the integration of audio and visual emotional information.

Emotion Perception and Autism Spectrum Disorders.

Early descriptions of autism documented the impairments that these individuals exhibited in the expression and understanding of emotion (Kanner, 1943). Given that emotion perception is a key aspect of communication and social interaction, which are components of most activities in an individual's life and are two of the primary deficits in individuals with autism spectrum disorders, much research has focused on this topic. The field has long examined the abilities of this population to both identify facial expressions and process emotional prosody in a speaker's voice as compared to typically developing individuals.

An early study by Braverman and colleagues (1989) with children on the autism spectrum revealed significant deficits in their ability to match photographs of faces portraying one of four emotions to the appropriate emotion label (happy, sad, mad, scared), a finding that has been supported in studies by many others through the years (e.g. Celani et al., 1999; Grossman et al., 2000; Klin et al., 1999; McDonald et al., 1989). Other studies exploring prosody-related abilities have demonstrated that these individuals also show greater difficulty in perception emotional prosody as compared to typically developing individuals (Boucher et al., 2000; VanLanker et al., 1989). Researchers have also investigated other emotion-related areas such as understanding and attributing emotions to others. For example, a study with children on the autism spectrum revealed significant difficulties in understanding and appreciating the inner mental state of others (Baron-Cohen al., 1985). More recently, Rieffe and colleagues (2000) found that individuals on the spectrum showed considerable difficulty understanding and explaining scenarios based on the characteristics of another's emotion.

A set of studies by Hobson (1986a & b) were the first of a few studies to examine emotion perception deficits using a crossmodal paradigm. Hobson asked participants to match photographs, sounds, and video footage of emotional information. Specifically, in the video condition, participants were shown 10-second videos, with no associated audio, of a masked actor making bodily gestures attributable to anger, unhappiness, happiness, or fear. Subsequent to each video, participants were asked to choose the emotional equivalent from five photographs of facial expressions. Participants were also exposed to audio sets of the four aforementioned emotions and asked to make a similar judgment regarding the emotional equivalent using facial expression photographs. The study findings indicated that children on the autism spectrum were not as adept as the control group, matched by nonverbal mental age, at discriminating and matching emotional stimuli (Hobson, 1986a & b). Loveland et al (1995) found similar results when using an intermodal technique to assess the abilities of individuals on the autism spectrum to detect affective incongruence between facial and vocal information. When asked to match an emotional audio track to the more appropriate of two emotional video tracks, participants with ASDs were significantly worse than individuals with Downs Syndrome.

Haviland and colleagues (1996) investigated perception of emotion of children on the autism spectrum by determining whether these individuals could detect correspondences between facial and vocal expressions of congruent emotions. The researchers videotaped facial expressions and added vocal expressions onto the videotapes in order to test whether children on the autism spectrum would preferentially look at an emotional facial expression that was accompanied by a congruent emotional vocal expression. Children on the autism spectrum showed decreased overall looking at the emotion expressions as compared to typically developing children. They showed a preference for looking at fearful facial expressions, regardless of whether the vocal expression was congruent in emotion. These children also increased their looking time to the sad facial and vocal expression movies. These results indicate that children on the autism spectrum do respond to simultaneous auditory and visual emotional information; however, this appears to occur in a pattern such that fearful and sad emotions are more salient or attention-catching to these individuals.

Lindner and Rosen (2006) more recently used the Perception of Emotion Test (POET; Egan, 1989) to assess the emotion perception abilities of individuals on the autism spectrum. The task included static facial expressions as well as videos of dynamic facial expressions presented by the actor with some movement. Regarding emotional prosody, audio tracks with neutral verbal content but vocal inflections as well as audio tracks with a neutral tone of voice but emotionally laden verbal content were used. Finally, in the combined modality, dynamic facial expression, prosody and verbal content were merged. The authors found that whereas children on the autism spectrum had more difficulty decoding emotions from static and dynamic facial expressions as well as tone of voice, they did not have significant deficits as compared to the typically developing group in decoding combined modalities.

There have been conflicting results in the limited research in this area; however, it is possible that these disparities are the result of methodological differences, particularly in the presentation of vocal emotional information. Lindner and Rosen (2006) note that the combined modality condition contained verbal content that may have pulled for individuals with ASDs to use verbal mediation to aid their understanding of the emotion. It is possible that this also occurred in the Haviland study as the vocal information presented was in the form of a sentence stating “I am ____” with the actor filling in an emotion label word (happy, sad, angry, fearful). Therefore, it is possible in both of these studies that the participants with ASDs were able to use the verbal content of the sentence to aid their responses, thus resulting in a decreased discrepancy between their abilities and those of typically developing peers.

Finally, only a few studies have investigated potential neural correlates and looked at differences in emotion perception specifically among individuals with ASDs and typically developing individuals. Dawson and colleagues (2004) demonstrated that children with ASDs, as early as age three, exhibit disordered neural responses (ERPs) to emotional stimuli when compared to typically developing children. A more recent functional imaging study of HFA and Asperger’s individuals found very different activation patterns compared to typically developing individuals (TD) on a face-processing task. The TD group exhibited greater activation in the left amygdala and orbito-frontal cortex whereas the HFA/AS group showed increased activation in the anterior cingulate gyrus and superior temporal cortex (Ashwin et al., 2007).

Emotion Perception and Intellectual Functioning in Autism Spectrum Disorders.

A number of studies investigating emotion perception in autism spectrum disorders have simultaneously looked at the effects of IQ, many with the idea that emotion perception may be verbally mediated. A number of studies have used verbal IQ (VIQ)-matched control groups for their clinical samples. Results showed that, when the ASDs participants are VIQ-matched to typically developing participants, there are no group differences in performance on emotion perception tasks (e.g. Grossman et al., 2000; Ozonoff et al., 1990; Prior et al., 1990). Grossman et al (2000) also matched by VIQ while testing facial emotion recognition with matching, mismatching, or irrelevant verbal labels. The ASDs group was only significantly worse at identifying emotions when the faces were paired with mismatching words, showing support for the idea that these individuals may be using verbal cues to aid their emotion perception abilities.

Although some support has been found for possible verbal mediation in this population, a consistent relationship has not been found as other research has shown the importance of nonverbal abilities. When Buitelaar and colleagues (1999) asked participants to recognize and match emotional expressions, they found that the participants' nonverbal or performance IQ (PIQ) significantly and differentially predicted emotion recognition ability in children on the autism spectrum. Loveland et al (1997) matched participants on both verbal and nonverbal IQ and had low-functioning ASDs and control groups as well as high-functioning ASDs and control groups. They found no differences in emotion recognition between ASDs and non-ASD groups; however, there were group differences when collapsing across the level of functioning. That is, when low-functioning ASDs and non-ASDs individuals were combined and high-functioning ASDs and non-ASDs individuals were combined, the low-functioning group showed significantly more difficulty assessing emotion when they were not provided with specific verbal information. The high-functioning group appeared to utilize nonverbal information in their judgments of emotion.

These studies show some support for the idea that verbal abilities may help individuals on the spectrum compensate at some level for their deficits in emotion perception; however, it is clear that nonverbal abilities are also important in emotion perception abilities. Moreover, researchers as yet have used only static emotion stimuli in studies examining cognitive abilities, which may not truly replicate the emotion perception abilities of these individuals in real-life situations.

The Current Study: Emotion Perception and Adaptive Functioning

Although there is a great deal of research investigating both emotion perception and adaptive functioning individually, to date, it remains unclear exactly how these two constructs are related. As Klin and colleagues (2007) point out, various cognitive measures have historically been used to assess and predict the adaptive outcome of individuals on the autism spectrum. When looking solely at IQ, it has been demonstrated repeatedly that within the HFA individuals in particular, having high cognitive functioning does not guarantee a better adaptive outcome. Findings from this study and others (see Howlin et al., 2004) note the importance of investigating other factors that may influence the adaptive outcomes of these individuals on the autism spectrum.

As emotion perception is a key component in communicative and social skills, this construct is a prime candidate for investigation. These are skills that translate into real-life situations such as attending and showing success at school or work, having relationships and developing the skills to live an independent life. Exploring how emotion perception is related to adaptive functioning, a current gap in the literature, could lead to the realization that with more emotion perception-focused interventions, the adaptive outcome of individuals on the spectrum may increase and result in better real-life prospects. Therefore, this study aims to investigate the relationship between emotion perception and adaptive functioning while utilizing a set of dynamic audio-video emotion movies, the DAVE stimuli (Robins & Schultz, 2004) to result in a more realistic manner of assessing these abilities as they create conditions more similar to the day-to-day situations and interactions individuals may encounter. The use of these novel DAVE stimuli will provide increased insight into the emotional perception abilities of these individuals on the spectrum while allowing for investigation of the relationship with adaptive functioning.

Primary Hypotheses

Cognitive functioning has long been used to predict adaptive functioning in the ASD population; however, research has shown that this may not be the best prediction model. As many adaptive abilities, such as communicative and social skills, inherently involve emotion perception, it is likely that this construct plays an important role in adaptive functioning. Therefore, the relationship between emotion perception, using the Diagnostic Analysis of Nonverbal Accuracy-Second Edition (DANVA-2; Nowicki, 2004), a widely used nonverbal emotion recognition task, and adaptive functioning, using the Vineland-II, was assessed in individuals with and without ASD while IQ was controlled for, given the equivocal findings in investigations of the relationship between verbal and nonverbal IQ and emotion perception abilities (e.g. Grossman et al., 2000; Prior et al., 1990; & Buitelaar et al., 1999; Loveland et al., 1997).

a. It was broadly hypothesized that emotion perception ability would mediate the relationship between diagnostic group (ASD or TD) and adaptive functioning (Figure 1). This general mediation model was individually investigated for each of the three Vineland-II adaptive functioning domains: Socialization, Communication, and Daily Living Skills.

b. Moreover, it was expected that there would be differences in the magnitudes of the indirect effects for each of the three Vineland-II domains. That is, it was hypothesized that the effects of emotion perception on adaptive functioning would be significantly different between the ASD and TD groups on each of these three domains. It was expected that the magnitude of the indirect effect would be greatest with the

Socialization domain outcome, followed by the Communication domain outcome, and finally, the Daily Living Skills domain outcome.

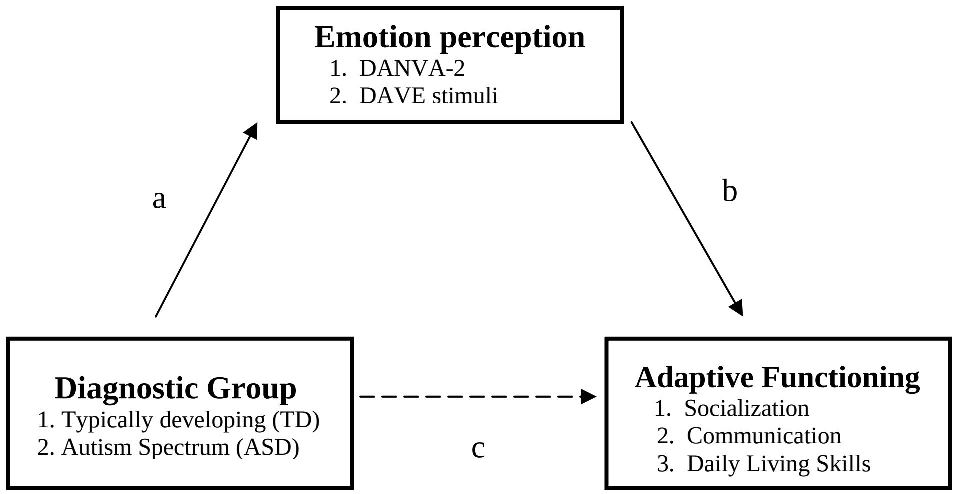

Figure 1. Mediational model with emotion perception, as assessed by the DANVA-2 or DAVE stimuli, as a mediator of the relationship between diagnostic group and three adaptive functioning outcomes.

Exploratory Hypotheses

Although investigating emotion perception using the DANVA-2 can provide useful information, particularly because the measure has previously been well-validated, this task, which has separate visual (i.e., static photograph) and audio (i.e., voice recording) components, is quite different from the real-world emotion perception involved in the dynamic, multimodal social exchanges that occur in the real world. The DAVE stimuli created by Robins and Schultz (2004) provide a multimodal measure of emotion perception through their integration of visual and auditory affective information. As this set of stimuli is not yet normed, these hypotheses were proposed as exploratory and age was included as a control variable. The relationship between emotion perception and adaptive functioning was also assessed using performance on a task involving selected movies from the DAVE stimuli. Again, given the equivocal findings of IQ research, IQ was a control variable.

a. It was, once more, broadly hypothesized that emotion perception ability would mediate the relationship between diagnostic group and adaptive functioning (please refer again to Figure 1). This general mediation model was individually investigated for each of the three Vineland-II adaptive functioning domains: Socialization, Communication, and Daily Living Skills.

b. Moreover, it was again expected that there would be differences in the magnitudes of the indirect effects for each of the three Vineland-II domains. That is, it was hypothesized that the effects of emotion perception on adaptive functioning would be significantly different between the ASD and TD groups on each of these three domains. It was expected that the magnitude of the indirect effect would be greatest with the Socialization domain outcome, followed by the Communication domain outcome, and finally, the Daily Living Skills domain outcome.

METHOD

Participants

Participants for this study were part of a larger, ongoing research project. They were recruited from local autism societies and parent support groups, clinic referrals, the undergraduate research pool at Georgia State University, and advertisements at locations such as local churches, schools, and other community organizations. Inclusion in this study was contingent on a number of factors. First, a range in IQ was expected within the sample with plans to exclude both control and individuals with ASDs with an IQ below 70 due to the requirements of the procedures. Second, control participants had to demonstrate a lack of ASDs symptomatology prior to testing, based on their score on the Social Communication Questionnaire. Control participants were also excluded based on significantly impaired emotion perception abilities on the Diagnostic Analysis of Nonverbal Accuracy-Second Edition for all ages and the Benton Facial Recognition Test for participants over age 15, or if they showed clinical elevations on the Inattention, Depression, and Conduct Problems subdomains of the BASC-2. Finally, in order to verify clinical diagnoses, participants with ASDs had to meet criteria for autism on the Autism Diagnostic Interview-Revised and had to meet criteria for autism or for an Autism Spectrum Disorder on the Autism Diagnostic Observation Schedule

Forty-four individuals, 19 with ASDs and 25 typically developing controls (TD) participated in the current study. Three control participants and one ASD participant met criteria for exclusion (please see the Results section for further detail), leaving a total sample size of 40 individuals. Within the ASDs group, there were five females and 13 males whose ages ranged from seven to 21 years (M=13.1, SD=3.9). Within the TD group, there were five females and 17 males whose ages ranged from nine to 19 years (M=13.9, SD=3.3). Full Scale IQ scores were in the average range for both the ASDs (*M*=103.38, *SD*=18.83, *range*: 75-131) and TD groups (*M*=108.77, *SD*=12.61, *range*: 78-128).

Measures

Primary measures.

Vineland Adaptive Behavior Scales, Second Edition (Vineland-II; Sparrow et al., 2005). A measure of adaptive behavior, the Vineland-II assesses how an individual is functioning in their environment and utilizing the skills needed to cope with the demands of everyday life. This study used the Survey Interview form of the Vineland-II in order to obtain relevant information from the parent(s) or caregiver in each of the three domains: Communication, Daily Living Skills, and Socialization. In addition to producing scores for each domain, the Vineland-II also yields an overall measure of adaptive functioning, the Adaptive Behavior Composite score.

The Vineland-II has a number of advantages. The large age range was ideal for the current study as children, adolescents, and adults can be assessed using the Survey Interview format. Additionally, by using the Survey Interview format, examiners could better ensure that the informant or client understood the nature of each question, thereby increasing the likelihood of gathering reliable data. Finally, the Vineland-II has been most widely used with the autism spectrum population in both clinical and research work and has ASD-specific norms (Carter et al., 1998).

The Vineland-II shows good psychometric qualities. Internal consistency reliabilities for the subdomains range from moderate to high with an average coefficient of .80. Coefficients for the domain scores range from upper .80s to low .90s and in the mid .90s for the Adaptive Behavior Composite. Test-retest reliabilities were excellent, ranging from .88 to .92 across the domains and were all above .90 for the Adaptive Behavior Composite. Factor analyses and intercorrelation coefficients indicate good construct and internal structure validity. The Vineland-II also shows good discriminatory validity, as it is able to differentiate between various diagnostic categories as well as between levels of severity within diagnostic categories (Sparrow et al., 2005).

The domain standard scores for Communication, Socialization, and Daily Living Skills were used to investigate adaptive functioning in the current study.

Diagnostic Analysis of Nonverbal Accuracy-Second Edition (DANVA-2; Nowicki, 2004). The DANVA-2 is a measure that uses nonverbal tasks to assess an individual's ability to perceive emotional information. It has four subtests: Adult Facial Expressions, Child Facial Expressions, Adult Paralanguage, and Child Paralanguage. Each of the four subtests was administered via computer to all participants in an order randomly generated for each individual. During the Adult and Child Facial Expressions subtests, which contain photographs of only adults and only children respectively, participants were asked to identify the facial expression portrayed by the actor in each of the 24 photographs per subtest. Alternatively, during the Adult and Child Paralanguage subtests, which contain audio tracks with only adult voices and only child voices respectively, participants were asked to name the emotion perceived from the actor's voice when s/he says the sentence "I am going out of the room now, but I'll be back later." For each audio item, participants were given the option to repeat the sentence as many times as desired. Responses were in forced-choice format, requiring participants to decide between happy, sad, angry, and fearful. The 24 items in each subtest consisted of six happy, six sad, six angry, and six fearful expressions, equally distributed between high or low intensity.

Despite being fairly new, the DANVA-2 shows strong psychometric qualities. The DANVA-2 Child and Adult Faces subtests, which include novel stimuli of varying high and low emotional intensity, both correlate highly with their original DANVA counterparts. Studies show coefficient alphas ranging from .64 for first-grade students to .77 for college students in the Adult Facial Expressions subtest and .70 to .74 on the Child Facial Expressions subtest. Test-retest reliabilities over a two-month period ranged from .74 in third-graders to .84 in college students on the Adult Faces and from .79 to .88 on Child Faces (Nowicki & Carton, 2001). Likewise, coefficient alphas for the Child Paralanguage subtest range from .73 in 4-year-old children to .73 in college students with a median test-retest reliabilities falling at .78 (Rothman & Nowicki, 2004). Coefficient alphas for the Adult Paralanguage subtest range from .71 in preschool children to .78 in college students with median test-retest reliabilities ranging from .73 to .93 over a four-week period. Upwards of 40 studies show support for and agree with the construct validity of the DANVA-2 as presented by Nowicki (2004). For example, various studies have shown support for the association between age of participant and DANVA-2 accuracy scores. Similarly, there has been support for the association between the ability to read emotional cues as measured by the DANVA-2 and social competence in children and adults. When used as a measure of emotional intelligence, a significant correlation was found between number of errors and age of child as well as between number of errors and security of attachment to parents.

Error scores from the DANVA-2 were used as the predictor variable in analyses for the proposed study. For each subtest, the number of errors was summed to produce a composite error score that ranged from 0 to 96.

Dynamic Audio-Visual Emotion stimuli (DAVE). Although the DANVA-2 has shown promise as a measure of emotion perception, the stimuli are presented in a format such that the participant is receiving information either visually or aurally during any given item. Novel, dynamic audio-visual movies, henceforth referred to as the "DAVE stimuli" (Robins & Schultz, 2004), were created and validated at the Yale Child Study Center to provide a dynamic multi-modal emotion perception task, thought to be a measure of emotion perception that was more similar to real-world experiences of social exchanges. One male and one female professional actor delivered 10 sentences in four emotions: happy, angry, fearful, neutral (see Table 1 & Figure 2; example stimuli also found at *http://www2.gsu.edu/~wwwpsy/robins.html*). Each sentence was emotionally ambiguous such that it could be credibly delivered in all four emotional tones. For example, "It's dark already" is *angry* if someone needed to get something done outside before night fell, *fearful* if the speaker is afraid of the dark, *happy* if the speaker is looking forward to doing some night-time activity, or *neutral* as a statement of fact. Movie clips of these AV stimuli, each approximately 2 seconds long, were split into audio and video tracks and remixed to generate a set of 320 movie clips; 80 containing audio and video tracks with matching emotions (e.g., angry face, angry voice) and 240 containing incongruent emotional cues (e.g., fearful face, happy voice) with lip synchrony preserved in all stimuli.

Table 1
Emotionally Ambiguous Sentences, Each Recorded in Four Affective

Clouds are in the sky.	Look in the box.
I didn't expect you.	Put it down.
It might happen	The dog is barking.
It's across the street.	The door is open.
It's dark already	Turn off the television.

Figure 2. DAVE stimuli examples: Still images from dynamic emotional movies (left to right: angry, fearful, happy).

The current study utilized 72 of these movies in showing participants four sets of 18 movie stimuli using DirectRT (Jervis, 1999) during the psychophysiological portion of the testing session (see procedure for details). Within each set of movies, six presented congruent AV information and nine presented incongruent AV information. All together, each participant observed 24 congruent emotion and 48 incongruent emotion movies. During the task, the participants were presented with an emotion word cue (e.g. “happy?”) for two seconds and asked to assess if it correctly represented the emotion expressed by the actor or actress in the immediately subsequent movie clip. After each movie clip, a question mark appeared on the screen for 9 to 11 seconds, during which time participants were instructed to respond to the question by clicking the left mouse button for yes and the right mouse button for no. Movie run order was randomly counter-balanced across participants. DirectRT collected each behavioral response in addition to reaction time data in Excel format.

Response data were used from the 24 congruent DAVE stimuli for each participant. Error scores were used as a predictor variable in analyses for the proposed study. For each set of movies, the number of errors was summed to produce a composite error score that ranged from 0 to 24.

Inclusionary and Exclusionary Measures.

Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). The WASI is a widely used brief assessment of cognitive functioning. The test is comprised of four subtests: Vocabulary, Block Design, Similarities, and Matrix Reasoning, each of which measures a discrete aspect of intelligence. In addition to individual subtest scores, the WASI generates a Full Scale IQ (FSIQ), a Verbal IQ (VIQ), and a Performance IQ (PIQ). Research has shown that the WASI has adequate reliability with coefficients ranging from .84 to .98. Moreover, the WASI is highly correlated with other measures of IQ such as the Wechsler Intelligence Scale for Children (WISC-III) and Wechsler Adult Intelligence Scale (WAIS-III). Full Scale IQ (FSIQ) scores from the WASI and WISC-III show a moderately high correlation ($r = .87$) with the Verbal (VIQ) and Performance (PIQ) scales slightly lower ($r = .82$ and $r = .76$ respectively). FSIQ scores from the WASI and WAIS-III show very high concurrency ($r = .92$) with the VIQ and PIQ scales again slightly lower ($r = .88$ and $r = .84$ respectively). The WASI also correlated highly with the Wechsler Individual Achievement Test (WIAT) with WASI IQ scores correlating at a moderate to high level with the WIAT composite scores ($r = .53$ to $.72$). Content validity is demonstrated by content coverage and content relevance (Psychological Corp., 1999). The WASI was administered to all participants to obtain a measure of verbal, performance, and overall (Full Scale) IQ.

Social Communication Questionnaire (SCQ; Rutter et al., 2003). The SCQ is a 40-item parent-report scale based on the ADI-R that assesses ASD symptomatology. The SCQ has good reliability, with coefficients ranging from .67 to .91 and factor analyses show good construct validity. The SCQ also has high discriminative validity as it has proved capable of differentiating ASDs from numerous non-ASD conditions (Rutter et al., 2003). Control participants were excluded from the current study if they score above the cutoff (raw score = 15), suggesting risk for ASDs on the SCQ.

Autism Diagnostic Observation Schedule (ADOS; Lord et al., 1999). The ADOS is a diagnostic tool for the assessment of communication, play, and social interaction for persons suspected to be on the autism spectrum. During the evaluation, the examiner initiates standard activities and conversation with the participant in order to observe certain behaviors that are historically recognized as key components of an autism spectrum disorder diagnosis. The ADOS has four modules, each for use at a particular developmental and linguistic level. Only Module 3, for verbally fluent children, and Module 4, for verbally fluent adolescents and adults, were utilized in the current study with all non-control participants. Results from initial studies show that both modules have adequate psychometric qualities. Interrater reliability for Module 3 items is high with a mean kappa weight of .65 across items. Similarly, interrater reliability for Module 4 items is high with an exact agreement mean of 88.3 percent and a mean kappa weight of .66 across the items. Interrater reliability coefficients for the individual domain scores range from .82 to .93. Test-retest coefficients for the domain scores range from .59 to .82. Cronbach's alphas ranging from .47 to .94 indicate good internal consistency (Lord et al., 2002). The ADOS was given to all non-control participants in the current study to verify their previous clinical diagnosis.

Autism Diagnostic Interview-Revised (ADI-R; Le Couteur et al., 2003). The ADI-R is a semi-structured interview intended to distinguish individuals with an autism spectrum disorder from those individuals with other developmental delays. The parent(s) or caregiver of the individual is asked various questions about their early development, communication, social development and play, repetitive and restricted behaviors, and behavior problems, all of which are scored according to the judgment of the interviewer. Several studies have shown that the ADI-R has strong psychometric properties. For example, interrater reliability kappas were generally high at .60 and above. Intraclass correlations were stronger, ranging from .52 to .97. Test-retest reliability was also very strong, with coefficients extending from .93 to .97 (Rutter et al., 2003). Factor analyses have shown good construct validity, with the majority of items loading on just one factor. Alpha coefficients ranged from .54 to .89, indicating acceptable internal consistency (Lecavalier et al., 2006). The ADI-R was administered to all non-control participants in the current study to verify their previous clinical diagnosis.

Benton Facial Recognition Test (BFRT; Benton et al., 1983). The BFRT is a 22-item measure that evaluates the individual’s facial perception abilities by assessing their capacity to recognize and match unfamiliar faces. Photographs of the faces are a combination of either full or partial light with either full-frontal or three-quarter profile orientation. On the Long Version of the BFRT, six items require the participant to make one match from six photographs to the sample photograph; the remaining 16 items involve three matches each to the particular sample photograph. The test is commonly used by neuropsychologists and the authors report extensive normative data for individuals over age 16 from various studies indicating good reliability and validity (Benton et al., 1983). Control participants over age 16 were to be excluded from the current study if they scored below the range of typical facial perception abilities (typical range =

39 to 54). Normative data for individuals under age 16 is limited and, although there are two studies (Paquier et al., 1999; Lindgren, 1977) that provide data for individuals between ages 6 and 14 (Baron, 2003), the data is equivocal. Based on those findings, individuals under age 16 were not excluded based on their BFRT performance.

Behavior Assessment System for Children, Second Edition (BASC-2; Reynolds & Kamphaus, 2004). The BASC-2 is an assessment via parent report of the participant's adaptive and problem behaviors in both the community and the home setting. The current study used the Parent Rating Scale (PRS) appropriate for each participant's age level. The BASC-2 PRS consists of 150 to 160 questions that make up 14 scales, which range from Adaptability to Learning Problems to Social Skills. There are also four composite scores: Externalizing Problems, Internalizing Problems, Behavioral Symptoms Index, and Adaptive Skills. The BASC-2 has strong psychometric properties to support its employment. Research has shown good reliability. Internal consistency levels across the general norm samples range from .80 to .95 for the composite scores and only slightly lower, .80 to .87 for the individual scales. These reliabilities are essentially the same in the clinical norm sample. The BASC-2 shows good re-test properties as coefficients fell in the low .80s to low .90s for all composites apart from Internalizing (.78) when the measure was given two times within 9 to 70 days. Interrater reliabilities are slightly lower but still moderately strong, ranging from .69 to .77. Strong scale intercorrelations are indicative of the validity of the BASC-2. The pattern and level of correlations is comparable across both the clinical and general norm samples. Moreover, the BASC-2 correlates strongly with other similar measures of behavior. For example, the BASC-2 and Achenbach System of Empirically Based Assessment (ASEBA) have correlation coefficients ranging from .65 to .84. Similarly, the Behavior Rating Inventory of Executive Functioning

(BRIEF) has correlations ranging from .58 to .86 with the BASC-2, with slightly higher correlations in the adolescent age range. Finally, the BASC-2 correlates at a moderate to strong level with the Conners' Parent Rating Scale-Revised, with the child age range producing higher correlations (Reynolds & Kamphaus, 2004).

The composite and scale scores on the BASC-2 were used to assess the severity of any DSM-IV symptoms and to determine if control participants had significant behavioral or psychological problems that may interfere with participation in the current study. Specifically, control participants were excluded if they demonstrated clinical elevations on the Inattention, Depression, and Conduct Problems subdomains of the BASC-2 (T-score > 70).

Procedure

Given that the proposed study is part of a larger, ongoing project, the following procedure was previously approved by the Institutional Review Board at Georgia State University as protocol number H06137. Additionally, a separate IRB, protocol number H08530, was submitted and approved for the current study.

All data was collected from participants individually. Participants provided written informed consent before beginning participation. All participants under the age of 18 years provided written assent and their legal guardian(s) provided written consent. Participants were given the option of completing the behavioral/neuropsychological and psychophysiological testing together in one session or separately in two sessions. Parents of control participants completed the SCQ prior to the start of testing. Trained undergraduate and graduate students administered testing tasks individually to participants during test sessions that took place in a quiet room in the Georgia State Psychology Department. Participants were offered the opportunity to take breaks as needed. Task order was counterbalanced across all measures as well as within measures when appropriate.

During the neuropsychological and behavioral testing section, participants underwent testing while the parent/legal guardian completed the age-appropriate BASC-2 and the Vineland-II interview. Parents of participants with ASD completed the ADI-R interview and all ASD participants completed the ADOS with a trained graduate clinician. The neuropsychological battery for each participant included the WASI, BFRT, and DANVA-2.

During the psychophysiological testing session, participants underwent a variety of psychophysiological measures in order to assess neurophysiological correlates of emotion perception as part of the larger, ongoing study. In this session, facial electromyography (EMG), heart rate, and skin conductance data were collected continuously while the participant was seated in front of a laptop computer on which they were shown the DAVE stimuli. Stimuli were presented to participants using DirectRT during the EMG portion of the research study. When presented with an emotion word cue (e.g., “happy?”) for two seconds, participants were asked to assess if it correctly represented the emotion expressed by the actor or actress in the immediately subsequent movie clip. After each movie clip, a question mark appeared on the screen for 9 to 11 seconds, during which time participants were instructed to respond to the question by clicking the left mouse button for yes and the right mouse button for no. Prior to beginning the task, participants were administered a practice run containing six DAVE stimuli. After getting comfortable with the task, each participant then viewed four sets of DAVE stimuli.

Participants were debriefed fully following completion of the entire protocol for the larger study. They were compensated for their time and efforts during the testing and psychophysiological components of the study.

RESULTSPreliminary Analyses

Data were entered into Microsoft Excel and subsequently analyzed in SPSS. Standard scores from the WASI and Vineland-II were used along with total error scores from the DANVA-2 and DAVE stimuli. Inclusion and exclusion criteria were assessed to identify any participants who would need to be eliminated from statistical analyses. It was not necessary to exclude any control participants based on SCQ or BASC-2 elevations as no control participants met criteria for ASDs on the SCQ or showed clinical elevations on the Inattention, Depression, and Conduct Problems sub-domains of the BASC-2 (T-score > 70). However, three control participants were excluded from the current study because their emotion perception abilities, as assessed by the DANVA-2, fell more than two standard deviations below the mean. Additionally, one ASD participant was excluded from analyses based on IQ criteria, as the Full Scale IQ for this participant fell below 70.

A power analysis was conducted in order to determine the sample size needed to detect the effects of interest. This analysis also allows for inferences to be made about the effect sizes associated with non-significant findings, specifically whether these may become statistically significant with a larger sample size. Prior data on which to estimate effect sizes could not be found given that prior studies have not explored emotion perception and adaptive functioning simultaneously; therefore the values were considered a rough estimate of the ideal sample size needed to determine if a significant effect exists. The G*Power 3 program (Faul et al., 2007) was used to conduct power analyses. For the analyses, power was set to .80 and alpha to .05. With one predictor variable and controlling for IQ, in order to detect a medium effect size (0.28), the ideal sample size for the study was 38 individuals, 19 ASDs and 19 TD. At the final sample size of 40 individuals, 18 ASDs and 22 TD, the power to detect desired effects was .83 when predicting a medium effect (0.28).

Descriptive statistics for pertinent variables are reported in Tables 2 and 3. Verbal and performance IQ were not significantly correlated in the TD group, therefore, both VIQ and PIQ were used when controlling for IQ, rather than the more broad measure of cognitive functioning, the Full Scale IQ. Age was included as a control variable for the DAVE but not the DANVA-2, given that the former stimuli are not yet normed but the latter are normed and validated by age.

An independent samples t-test was then conducted to determine if differences were present between the two groups on all test measures. As expected and consistent with results from past research, individuals with ASDs made significantly more errors in emotion perception on the DANVA-2 (M = 25.06) as compared to TD individuals (M = 16.86; $F(38) = 9.69$, p = .002). However, there was not a significant difference in emotion perception ability between ASDs individuals (M = 2.52) and TD individuals (M = 1.86) on the DAVE stimuli ($F(38) = 4.42$, *p = .096).*

Additionally, and also as expected based on previous research, there were group differences on each of the three adaptive functioning domains from the Vineland-II. Specifically, the performance of individuals with ASDs was significantly lower than that of the TD individuals on the Socialization domain ($F(38) = .574$, $p < .001$), the Communication domain, ($F(38) = .182$, $p = .001$), and the Daily Living Skills domain ($F(38) = .046$, $p = .001$); see Tables 2 and 3 for group means on each Vineland-II domain.

Correlation analyses were also conducted within each group, TD and ASD, to determine the presence or absence of multicollinearity. Multicollinearity is a phenomenon that arises when

Table 2
Descriptive Statistics and Correlations for Relevant Variables in TD group

Variable	Descriptives *M*	*SD*	range	Correlations 1.	2.	3.	4.	5.	6.	7.
1. PIQ	106.73	13.25	84-128	--						
2. VIQ	109.32	15.28	75-148	.24	--					
3. DANVA-2	16.86	3.93	12-25	-.46*	-.05	--				
4. DAVE	1.86	1.67	0-6	-.1	.19	.43*	--			
5. Soc.	101.41	14.54	79-134	.21	.13	.03	.01	--		
6. Comm.	96.81	16.28	68-122	.18	.50*	.02	.05	.713**	--	
7. DLS	95.86	15.29	72-127	.15	.28	-.02	-.21	.679**	.695**	

Note. n=22. PIQ = WASI Performance IQ; VIQ = WASI Verbal IQ; DANVA-2 = Diagnostic Assessment of Nonverbal Accuracy, Second Edition, total error score; DAVE = DAVE stimuli, total error score; Soc. = Vineland-II Socialization; Comm. = Vineland-II Communication; DLS = Vineland-II Daily Living Skills. * $p < .05$, ** $p < .01$.

Table 3
Descriptive Statistics and Correlations for Relevant Variables in ASD group

Variable	Descriptives M	SD	range	Correlations 1.	2.	3.	4.	5.	6.	7.
1. PIQ	102.83	22.35	64-133	--						
2. VIQ	103.5	16.17	71-127	.49*	--					
3. DANVA-2	25.06	10.54	10-51	-.41	-.23	--				
4. DAVE	3.00	2.52	0-8	.11	.003	.25	--			
5. Soc.	72.67	18.03	32-103	.34	.49*	-.11	.12	--		
6. Comm.	78.06	15.89	47-115	.39	.40	.01	.29	.85**	--	
7. DLS	78.11	15.85	45-109	.36	.46	-.15	.09	.95**	.89**	

Note. n=18. PIQ = WASI Performance IQ; VIQ = WASI Verbal IQ; DANVA-2 = Diagnostic Assessment of Nonverbal Accuracy, Second Edition, total error score; DAVE = DAVE stimuli, total error score; Soc. = Vineland-II Socialization; Comm. = Vineland-II Communication; DLS = Vineland-II Daily Living Skills. * $p < .05$, ** $p < .01$.

two or more predictor variables in a multiple regression model are highly correlated and results in the distortion or deflation of partial regression coefficients. Aside from correlations among the outcome variables (Vineland-II domains), which were explored individually, the correlation between any two variables did not exceed .8; therefore, it was determined that multicollinearity was not present.

Mediation Analyses

To evaluate the mediational hypotheses, bootstrapping in conjunction with Ordinary Least Squares (OLS) regression was utilized (Preacher & Hayes, 2004). Bootstrapping is a nonparametric statistical technique that does not utilize normal distribution assumptions during calculations. As such, this method accounts for the non-normality of sampling distributions of the mediated effects, given that indirect effects are typically not normally distributed. Moreover, this technique draws random samples of the data set with replacement, essentially equivalent to estimating from a random sample of the population, and thereby increases the power of the mediational analysis because it is no longer reliant on the assumption of normality. This method is also believed to provide the most accurate confidence intervals for indirect effects in mediation analyses (see Preacher & Hayes, 2004; Shrout & Bolger, 2002). The diagnostic group variable was dummy-coded as follows: TD = 0; ASD = 1. Estimates of indirect effects were obtained with bias-corrected bootstrap confidence intervals after 5,000 bootstrap samples were generated.

Emotion Perception, as Measured by the DANVA-2, as a Mediator of the Relationship between Diagnostic Group and Adaptive Functioning on the Vineland-II.

Emotion perception ability, assessed using the DANVA-2, was explored as a mediator in the relationship between diagnostic group and adaptive functioning. This mediational model was

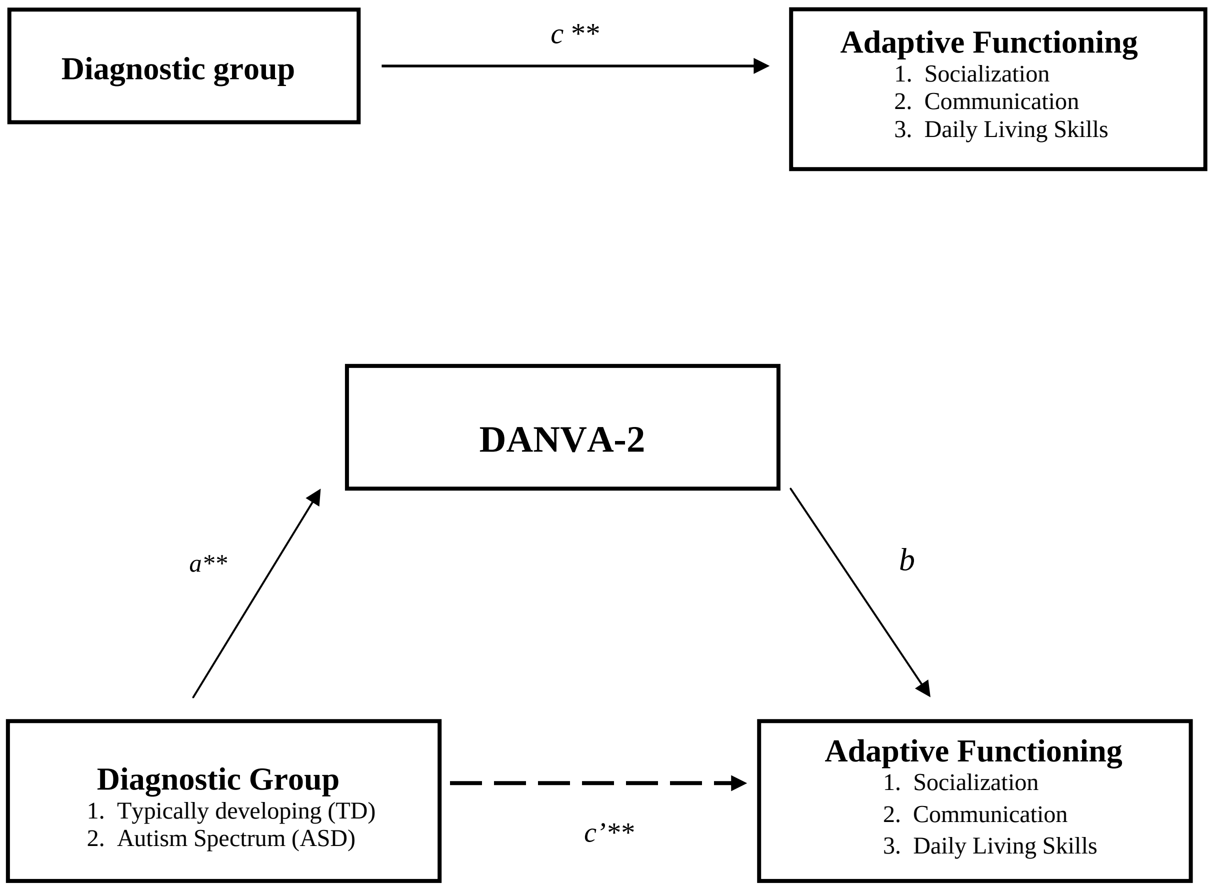

Figure 3. Top. Unmediated effect of diagnostic group on adaptive functioning as assessed by the individual adaptive functioning domains of the Vineland-II. *Bottom*. Effect of diagnostic group on adaptive functioning domain, mediated by emotion perception as measured by performance on the DANVA-2. ** $p < .01$

Table 4

Summary of Mediation Models Testing whether Emotion Perception, as Measured by the DANVA-2, Mediates the Relationship between Diagnostic Group and Adaptive Functioning Domain from the Vineland-II

Vineland-II domain	Path	B	SE	*p*-value	BCa 95% CI Lower	BCa 95% CI Upper
Socialization	a	7.50	2.31	.003		
	b	.093	.422	.827		
	c	-27.98	5.78	.000		
	c’	-28.68	6.66	.000		
	ab	.527	3.31		-5.96	7.23
Communication	a	7.50	2.31	.003		
	b	.329	.342	.343		
	c	-15.92	4.74	.002		
	c’	-18.39	5.39	.002		
	ab	2.46	3.33		-2.14	12.34
Daily Living Skills	a	7.50	2.31	.003		
	b	.024	.348	.945		
	c	-15.48	4.76	.003		
	c’	-15.66	5.49	.007		
	ab	.227	2.75		-5.20	5.82

investigated for each of the three Vineland-II domains: Socialization, Communication, and Daily Living Skills (see Figure 3). Results for each path of the model for each adaptive domain outcome are reported in Table 4.

To assess the hypothesis that the relationship between diagnostic group and adaptive functioning is mediated by emotion perception abilities, the mediational model was investigated for each of the three Vineland-II domains (see Figure 3). In order to examine the total effect of each model (path c in Figure 3), each adaptive functioning domain (Socialization, Communication, Daily Living Skills), was regressed onto diagnostic group. In this step, the total effect of diagnostic group on each of the three adaptive functioning domains was statistically significant (see Table 4) when controlling for IQ. This indicated that individuals on the autism spectrum demonstrated significantly lower socialization, communication, and daily living skills, respectively, compared to typically developing individuals.

Emotion perception, as measured by performance on the DANVA-2, was then regressed onto diagnostic group (path a in Figure 3) for each of the three adaptive domain outcomes. This effect was also statistically significant in the positive direction (see Table 4), indicating that individuals on the autism spectrum exhibited significantly greater levels of impairment in emotion perception ability than did typically developing individuals.

Finally, Socialization, Communication, and Daily Living Skills were regressed onto emotion perception ability (path b in Figure 3). The effect of emotion perception on each of these three adaptive functioning domains was not significant (see Table 4), indicating that emotion perception ability is not related to adaptive functioning. This step also examined the direct effect of diagnostic group on the three adaptive functioning domains while controlling for emotion perception ability (path c’ in Figure 3). An effect of mediation would yield a statistically nonsignificant result for this path; however, in the current analyses, this path was statistically significant for Socialization, Communication, and Daily Living Skills, indicating that mediation was not present. This was supported, moreover, by the finding that the bootstrap Bias Corrected and Accelerated (BCa) 95% confidence intervals for these indirect effects overlapped with zero, allowing the conclusion that these indirect effects were not significant (see Table 4).

Finally, it was also hypothesized that there would be differences in the magnitudes of the indirect effects for each of the three adaptive domain outcomes. In order to elicit these differences, unstandardized regression coefficients (independent B values) were to be compared across the three models to assess the relative strength of each in comparison to the other two models (Clogg, Petkova, & Haritou, 1995). However, as none revealed significant indirect effects, this series of comparisons was not completed.

Emotion Perception, as Measured by the DAVE stimuli, as a Mediator of the Relationship between Diagnostic Group and Adaptive Functioning on the Vineland-II.

Emotion perception ability, assessed using the DAVE stimuli, was investigated in an exploratory hypothesis as a mediator in the relationship between diagnostic group and adaptive functioning. This mediational model were investigated for each of the three Vineland-II domains: Socialization, Communication, and Daily Living Skills. Results for each path of the model for each adaptive domain outcome are reported in Table 5.

To assess the hypothesis that the relationship between diagnostic group and adaptive functioning is mediated by emotion perception abilities, the mediational model was investigated for each of the three Vineland-II domains (see Figure 4). In order to examine the total effect (path c in Figure 4), each adaptive functioning domain (Socialization, Communication, Daily

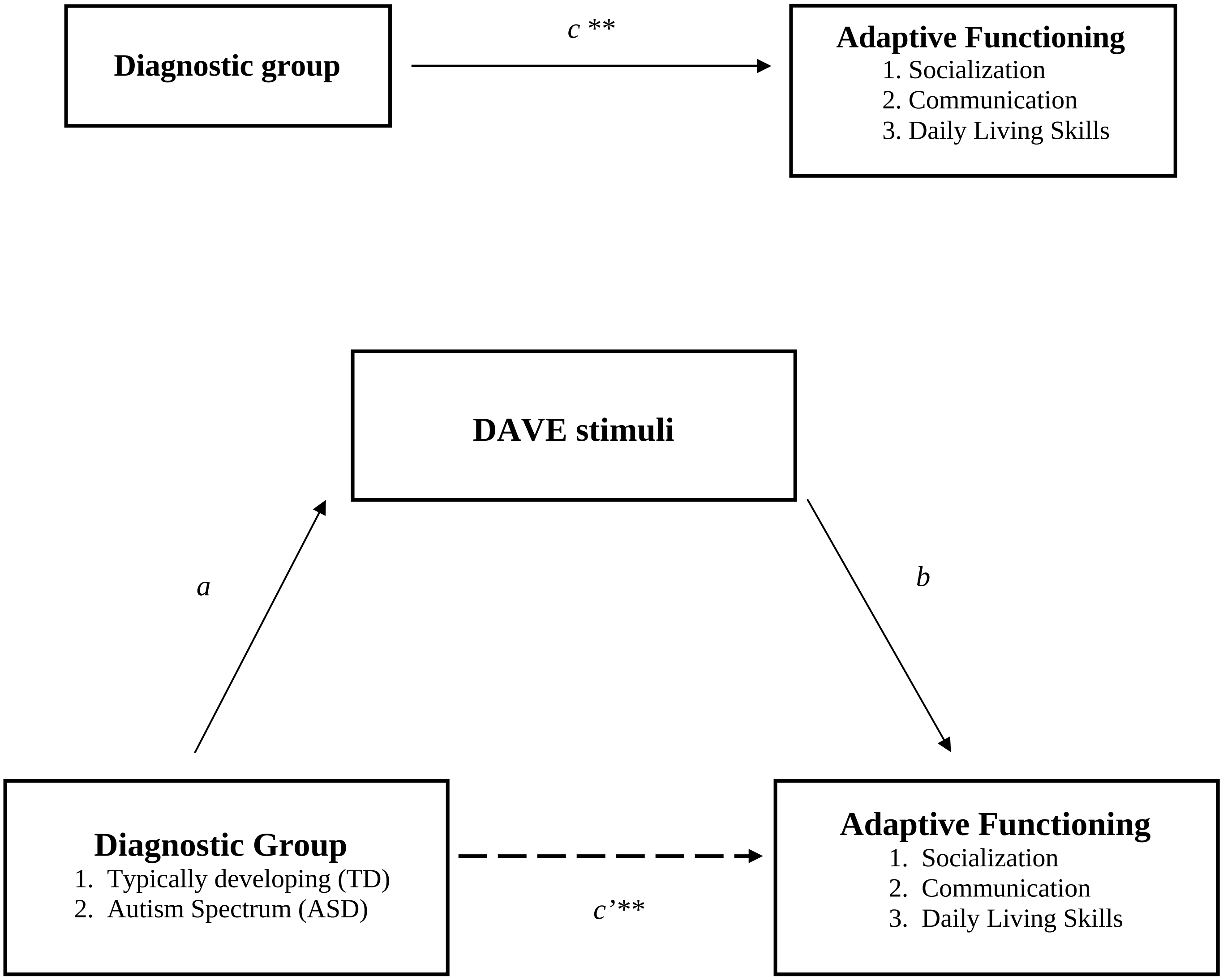

Figure 4. Top. Unmediated effect of diagnostic group on adaptive functioning as assessed by the Socialization domain of the Vineland-II. *Bottom.* Effect of diagnostic group on Socialization skills mediated by emotion perception as measured by performance on the DAVE stimuli task.
** $p < .01$

Table 5

Summary of Mediation Models testing whether Emotion Perception, as Measured by the DAVE stimuli, Mediates the Relationship between Diagnostic Group and Adaptive Functioning Domain from the Vineland-II

Vineland-II					BCa 95% CI	
domain	Path	B	SE	*p*-value	Lower	Upper
Socialization	a	1.04	.703	.149		
	b	-.265	1.34	.844		
	c	-30.68	5.49	.000		
	c’	-30.40	5.73	.000		
	ab	-.326	1.42		-4.64	1.73
Communication	a	1.04	.703	.149		
	b	.567	1.11	.614		
	c	-17.94	4.57	.000		
	c’	-18.53	4.76	.000		
	ab	.465	1.29		-1.21	4.59
Daily Living Skills	a	1.04	.703	.149		
	B	-.433	1.13	.703		
	c	-17.42	4.62	.000		
	c’	-16.97	4.82	.001		
	ab	-.517	1.48		-4.98	1.68

Living Skills), was regressed onto diagnostic group. In this step, the total effect of diagnostic group on each of the three adaptive functioning domains was statistically significant (Table 5) when controlling for IQ and age. This indicated that individuals on the autism spectrum demonstrated significantly lower levels of socialization, communication, and daily living skills, respectively, compared to typically developing individuals.

Emotion perception, as measured by performance on the DAVE stimuli task, was then regressed onto diagnostic group (path a in Figure 4). This effect was not significant for each of the three adaptive domain outcomes (Table 5); therefore, as per Baron & Kenny (1986), testing of this mediational model was discontinued.

Finally, it was also hypothesized that there would be differences in the magnitudes of the indirect effects for each of the three adaptive domain outcomes. In order to elicit these differences, unstandardized regression coefficients (independent B values) were to be compared across the three models to assess the relative strength of each in comparison to the other two models (Clogg, Petkova, & Haritou, 1995). However, as none of the three mediational models revealed significant indirect effects, this series of comparisons was not completed.

DISCUSSION

The purpose of this study was to examine the role of emotion perception as related to the adaptive functioning of individuals with autism spectrum disorders. This study investigated three primary areas of adaptive functioning, which included Communication, Socialization, and Daily Living skills. Secondarily, this study assessed emotion perception in two ways. The primary approach utilized a previously validated measure of emotion perception consisting of static photographs or audio recordings with affective prosody, presented in separate trials. However, the study also aimed to measure emotion perception in what is thought to be a more ecologically valid manner; therefore dynamic, emotion stimuli that integrated audio and visual cues were employed as a measure of emotion perception in exploratory analyses.

Primary Hypotheses

It was predicted that emotion perception would mediate the relationship between diagnostic group and adaptive functioning. This model was individually assessed for each of the three adaptive functioning domains. It was further proposed that emotion perception would differentially mediate the relation between diagnostic group and adaptive functioning per domain. It was expected that the magnitude of the indirect effect would be greatest with the Socialization domain, followed by the Communication domain, and finally the Daily Living Skills domain. These hypotheses were not supported.

Within our mediational model, two relationships were observed that were consistent with previous findings. First, diagnostic group was significantly related to adaptive functioning across each of the three domains, Socialization, Communication, and Daily Living Skills, when controlling for verbal and performance IQ. This finding is consistent with previous research that has shown that individuals on the autism spectrum demonstrate much lower levels of adaptive behaviors than typically developing individuals (e.g., Carpentieri & Morgan, 1996; Carter et al., 1998; Fisch et al., 2002; Liss et al., 2001; Volkmar et al., 1987). Second, diagnostic group was significantly related to emotion perception ability on the DANVA-2. This finding is consistent with many preceding studies that have shown that individuals with ASDs consistently exhibit emotion perception-related deficits across a variety of tasks and measures as compared to typically developing individuals (e.g., Boucher et al., 2000; Braverman et al., 1989; Grossman et al., 2000; Haviland et al., 1996; Lindner & Rosen, 2006).

In contrast to the above relationships, however, emotion perception abilities were not significantly related to any of the three domains of adaptive functioning measured in this study; therefore, the mediational model was not supported. The demonstration of a lack of relationship between emotion perception abilities and adaptive functioning in the current study raises the question of whether this relationship does exist but was not demonstrated or whether this relationship truly does not exist.

First, assuming that the relationship between emotion perception and adaptive functioning does exist necessitates exploration of these variables and the study design, which will also be discussed further in the Limitations section below, as it is possible that limitations in this study hindered the illustration of this relationship. It should be noted that, to date, no published research study has specifically investigated the relationship between emotion perception and adaptive functioning in ASDs, despite the myriad studies exploring these constructs independently. Klin and colleagues (2007) suggested that factors aside from cognitive functioning should be investigated to determine their influence on and relationship with the adaptive outcomes of individuals with ASDs as it has been repeatedly demonstrated that cognitive functioning does not adequately predict these outcomes in ASD. Thus, the current study was undertaken on the basis of that appeal, given the important role of emotion perception abilities in day-to-day activities and real-life situations, such as interpersonal success in the school and work environments.

Potential methodological reasons for the lack of observed relationship may be related to the measures utilized in the study. It is possible that emotion perception, as measured by the DANVA-2, is simply not associated strongly with the specific adaptive skills that the Vineland-II measures. The stimuli in the DANVA-2, as discussed in detail above, are presented in a unimodal format (i.e., audio or visual) and face stimuli are static; therefore, performance on this task may not be reflective of true interactions that individuals encounter on a day-to-day basis. Second, the Vineland-II is a very broad measure of adaptive functioning. Even when broken down into the three domain areas (Socialization, Communication, Daily Living Skills), these domains cover a very wide range of behaviors. Although emotion perception abilities are a part of socialization, the Vineland-II has very few items that address any emotion-related behavior. Therefore, it is possible that this measure may provide too broad an assessment of adaptive functioning for the purposes of this study, particularly in expecting a relationship between adaptive functioning and emotion perception ability, a very specific type of behavior.

When looking at emotion perception deficits more broadly, in some literature it is considered just one aspect of social perception (Feldman, White, & Lobato, 1982), which is the larger deficit in individuals with autism spectrum disorders. Social perception is defined as the ability to identify, recognize, and interpret the meaning and significance of the behavior of others (Johnson & Myklebust, 1967). It relies on components including facial cues, body language cues, prosody characteristics, space, distance, and social context (Nowicki & Duke, 1994). There are three processes that are thought to be part of social perception: *input/perception*, as measured by receptive tasks, *integration* of input from different modalities, and *output*, or behavioral responses, typically assessed by expressive tasks (Feldman, White, & Lobato, 1982). When an individual perceives various incoming cues, integrates them within their context, and provides output in the form of an appropriate behavioral response, successful social perception is the result. It seems possible, therefore, that the construct of emotion perception may be related to adaptive functioning as part of the larger construct of social perception and perhaps is too specific, individually, to demonstrate a relationship with adaptive outcomes.

With that in mind, when considering the processes that social perception is broken down into, the emotion perception task in the current study, the DANVA-2, measures the input/perception process only, with its request for the individual to determine the emotion. Moreover, the DANVA-2 assesses this process on a very basic level, first by presenting information in only a single modality at a time. In order to potentially expand the DANVA-2 from simple an emotion perception task assessing the input process, the receptive aspect could be improved upon while adding integration and output processes to the measure. This could include, 1) a receptive task that assesses the ability to interpret social cues from individual and multiple sources simultaneously (e.g., facial expression, gestures, tone of voice), 2) real-life contextual information to allow the individual to integrate the cues and contextual information, and 3) an expressive task asking individuals to independently produce emotions. This would create more life-like situations than the DANVA-2 currently provides to assess the subject’s social perception abilities while allowing the researchers to separately analyze each of the three aspects of the construct, in addition to comparing and contrasting performance within various modalities (Guli, 2004).

Research has noted that social perception is difficult to fully and accurately assess (Trimboli & Walker, 1993). The majority of measures have limitations similar to that of the DANVA-2 in that they assess a single modality (e.g., Boyatzis & Satyaprasad, 1994; Bullock & Russell, 1984) or do not integrate modalities (Nowicki & Duke, 1994). Moreover, Walker and Trimboli (1989) have noted the importance of contextual information in the interpretation of nonverbal cues, yet tasks are rarely designed to include such detail. Currently, the most comprehensive, validated measure of social perception appears to be the Child and Adolescent Social Perception measure (CASP; Magill-Evans, Koning, Cameron-Sadava, & Manyk, 1995). The CASP is composed of 10 videotaped scenes that have two to four characters each. For example, one scene portrays a girl playing a videogame. Another girl accidentally bumps the cord and disconnects the game. The girl playing the game is annoyed and the other girl apologizes (Magill-Evans et al, 1995). The scenes range in settings, behaviors, and emotions. The participant watches each scene individually and then answers a standardized set of questions, including being asked to describe what happened in the scene and the emotion and intensity of each character. Answers results in a total emotion score (i.e., identification of feelings), a nonverbal cues score (i.e., identification of nonverbal cues), and qualitative information about how the individual responded to the measure (e.g., response pattern, ability to integrate cues). Although the CASP has many strengths in comparison to other measures of social perception in its use of real-world situations in a dynamic format and open-ended response format, it too could be improved. Specifically, it would also be helpful to be able to look at how subjects perceive and respond to individual modalities in order to compare and contrast performance on modalities and assess for modality-specific deficits. It would also be useful to include a range of incongruent cues to reflect this real-life occurrence and determine subjects' ability to perceive, integrate, and respond.

Despite the use of a less than ideal assessment measure, early researchers found that, as social perception abilities of typically developing individuals improved, a superior ability to interpret the emotional responses of others was demonstrated, and these individuals were in turn better able to communicate more effectively and acceptably with others (Zabel, 1979). Thus, it is possible that, with a more appropriate measure of social perception and thus a comprehensive assessment of the behaviors involved in this construct, a relationship may be demonstrated with adaptive outcomes, of which emotion perception would be one component, in individuals with ASDs.

Second, it must also be considered that the proposed relationship between emotion perception and adaptive functioning actually may not exist. As mentioned earlier, to date, the direct relationship between emotion perception and adaptive functioning in ASDs has not been assessed empirically in a published study, which may be reflective of past failures to demonstrate a link. Also as discussed above, the lack of association between emotion perception and adaptive functioning in the current study may be reflective of the high degree of specificity that emotion perception brings to the relationship. It may be that this specificity precludes the expression of an association but that, when emotion perception is assessed as part of social perception, a relationship may emerge between social perception and adaptive functioning.

When considering the lack of association, however, it is critical to acknowledge that the lack of evidence for a relationship does not provide evidence for a lack of the relationship. Many studies imply the existence of this relationship, such as treatment outcome studies, which assess treatments with the goal of enhancing aspects of adaptive functioning by targeting and improving emotion-related behaviors. For example, Pioggia and colleagues (2005) have developed an android model (head and body) that expresses and recognizes basic emotions. They are using the humanoid for therapeutic purposes to enhance the emotion perception of individuals with ASDs in a purportedly more life-like manner than using static photographs or even computer-based dynamic images, and hypothesize that this, in turn, will increase the social abilities of these individuals. This group, therefore, is assuming a relationship exists between emotion perception and specific adaptive outcomes in their postulation that they can improve socialization skills by improving emotion perception. Other treatments for individuals with ASDs include an emotion perception component to their interventions and hypothesize improvements in a range of social and communicative behaviors (e.g., Cotugno, 2009; Guli et al., 2007; Leaf et al., 2009). It should be noted that none of these studies specifically includes a broad, validated measure of adaptive functioning as an outcome or pre/post measure. Instead, all specifically look at treatment effects of various aspects of socialization, a component of adaptive functioning, such as interpersonal skills, self-awareness, and cooperation. Two of the studies also included measures of communication skills; however, these were again not part of a larger measure of adaptive functioning. Thus, it seems imperative that additional research is undertaken to definitively address the link between components of, and overall, adaptive functioning.

Exploratory Hypotheses

A similar set of exploratory hypotheses examining the relationships between emotion perception and adaptive functioning was proposed with the goal of capturing emotion perception in a more ecologically valid manner. The dynamic, audio-visual emotion (DAVE) movie stimuli were used to assess emotion perception, predicting that emotion perception would again mediate the relationship between diagnostic group and adaptive functioning. This model was again individually assessed for each of the three adaptive functioning domains. Additionally, it was further proposed that emotion perception would differentially mediate the relation between diagnostic group and adaptive functioning per domain. It was anticipated that the magnitude of the indirect effect would be greatest with the Socialization domain, followed by the Communication domain, and finally the Daily Living Skills domain.

These hypotheses were not supported. Preliminary analyses demonstrated that there were not significant differences between the ASD and TD groups on emotion perception as measured by the DAVE stimuli. Investigation of the mean error scores of each group revealed that, although the ASD group did make more errors than the TD group, both groups made very few errors during this task. It appears that there may have been a restriction in range effect on participant performance with the selection of DAVE stimuli utilized for the study. It was unexpected that the participants with ASDs, members of a population that typically have difficulty with emotion-related tasks, would be able to perform well. This suggests that the task may have been less complicated for these individuals than real-world situations that involve emotion perception. This will be discussed further in the limitations and future directions sections.

Limitations

There are a number of limitations to this study that are important to consider when exploring the findings. There were two primary sample-related limitations. First, the number of participants in each group of the study is quite small; therefore, it is possible that significance or more promising effect sizes may be found with a larger sample. Second, although the age of participants in the current study was restricted from 7 to 21 in order to investigate the hypotheses in a child and adolescent population, it is possible that even this restricted age range is too broad.

Research has shown that there are significant age differences in emotion perception abilities within the development from childhood to late adolescence. For example, studies have demonstrated that the facial perception deficits of older children with ASDs are not as severe as those of younger children, when assessing basic emotions in a sample of 7 to 18 year olds (Grossman, Klin, Cater & Sparrow, 2000). Thus, it seems prudent, with a large enough sample, to split participants into sub-groups dictated by age for analyses in the future rather than controlling for age. Third, it is important to remember that all of the individuals with ASDs in the current study were grouped together when, in actuality, this is a spectrum disorder in which there is tremendous individual variation (Volkmar & Klin, 2000). To consolidate all individuals with ASDs into one group is to severely limit the expression of this variation. Therefore, in the future, it will be important to look within groups, when sample sizes allow, in order to examine these with-in group differences.

There were also a number of methodological and construct-related limitations to the current study, particularly involving the measures utilized in the study. In the primary hypotheses, emotion perception was assessed using the DANVA-2, a task with separate audio (i.e., voice recording) and visual (i.e., static photograph) components, that measures emotion perception in an analog fashion that is quite different from real-world emotion perception in dynamic, multimodal social exchanges. The study attempted to take this limitation into account in advance with the inclusion of the DAVE stimuli, which will be addressed qelow. Second, as discussed above, the DANVA-2 assesses only the input/perception process within social perception. If the broader construct of social perception is, in fact, related to adaptive outcomes, and emotion perception is just one component of social perception, an additional measure should be added that more fully assesses all processes of social perception.

As discussed earlier, a major limitation within the exploratory hypotheses of this study involved the use of the DAVE stimuli, which seemed to produce an artificial ceiling effect when assessing emotion perception abilities. The subset of dynamic movie stimuli chosen for this project involved basic emotions (i.e., happy, angry, fearful, neutral) with the audio-visual cues presented in a congruent format (e.g., happy face, happy voice). Moreover, these movies were all presented in a forced choice format (e.g., cue = Angry?; response = Yes vs. No). This, in turn, cued the viewer to one emotion to which s/he must compare all other emotions to determine the yes/no response. The full set of DAVE stimuli also includes incongruent audio-visual stimuli (e.g., happy face, angry voice); however, the congruent stimuli trials were chosen for practical scoring consideration. Responses to incongruent movies, although requiring more complex emotion processing, cannot easily be scored as right or wrong; therefore, it is challenging to use incongruent stimuli to measure an individual's emotion perception abilities.

Moreover, many studies, however, have shown that individuals with ASDs demonstrate improvement in their facial emotion recognition abilities with practice (e.g., Bolte et al., 2006; Golan & Baron-Cohen, 2006; Silver & Oakes, 2001). In the current study, the services that our sample of high-functioning ASD participants had previously or were currently receiving was not assessed; however, it is entirely possible that some or all of these individuals may have received training or other services that incorporated emotion recognition. If this were the case, it is likely that the basic format of the DAVE stimuli allowed for relative success. This, then, would account for the non-significant differences in emotion perception between the typically developing individuals and the participants with ASDs. It would additionally be helpful to begin recording information about the services that participants have received or are currently receiving, particularly those with emotion- or social-related components.

Future Directions

Relevant literature strongly suggests that emotion perception abilities are a key ingredient in the day-to-day functioning and success of all individuals. As discussed above, this relationship is implied in many studies, particularly treatment outcome studies; however, it has not been empirically assessed to date. The current study did not demonstrate a significant association between emotion perception and adaptive outcomes of individuals with ASDs. However, as emotion perception is just one component of social perception, it seems that it may have been too specific a factor to illustrate an association with adaptive functioning. Therefore, future research is needed primarily to address the possible role of the larger construct of social perception in the adaptive outcomes on individuals on the autism spectrum.

As mentioned above, research has noted that social perception is difficult to fully and accurately assess (Magill-Evans, Koning, Cameron-Sadava, & Manyk, 1995; Trimboli & Walker, 1993). Although the CASP assesses each of the three processes of social perception to some degree, the aforementioned improvements would further tighten this assessment. Ideally, a measure is needed that accurately measure the three different components of social perception: input, integration, and output. That is, the model would assess the components of social perception (i.e., facial cues, body language cues, prosody characteristics, space, distance, and social context) in a life-like manner, both within individual modalities (e.g., visual, auditory) and integrated across modalities, while obtaining independently generated responses to assess what information is and is not being utilized for interpretation (Guli, 2004).

In addition to the lack of a truly comprehensive measure of social perception, it appears that there is a gap in the literature investigating the relationship between these individual processes, possibly due to the dearth of standardized measures assessing social perception and its components as well as the difficulty inherent in trying to dissociate each from another. In this regard, it seems that the executive functioning literature may be helpful in informing social perception research. That is, as Lezak, Howieson, and Loring (2004) point out, it is known that executive functions consist of multiple components (i.e., volition, planning, purposive action, and effective performance), each entails a characteristic set of behaviors, and deficits typically involve multiple components. Although there are myriad tasks assessing executive functions, these typically evaluate one specific component or a sub-set of components as it is difficult to measure all executive functions in a comprehensive manner. Thus, as social perception is similarly composed of multiple processes, it may by useful to the assessment of executive functions as a model for assessing social perception. Namely, future research could aim to investigate the relationships between the processes of social perception and potentially identify tasks that focus on one process or a sub-set of these processes in an attempt to determine the feasibility of creating a truly comprehensive measure of social perception.

With regard to the DAVE stimuli, although individuals with ASDs performed as well as typically developing individuals on the task, this appears to be due to specific limitations in the measurement modality that decreased the complexity of the task to an artificially simple level compared to true, real-world interactions. In order to extend the testing of the DAVE stimuli to determine whether it is an efficacious and accurate measure of emotion perception, future studies should utilize a different response format when using the congruent audio-visual movies. After viewing each movie, participants should be asked to independently generate a response based on their perception of the emotion rather than be given a cue. This modification will help make the DAVE task more complex while keeping the dynamic, multi-modal format of the task. Moreover, although these stimuli may be more life-like than other emotion perception tasks (i.e., static photographs), they still lack a truly real-life sense. Enhancing this may be accomplished in a number of ways if not limited by feasibility, including incorporate additional cues, such as body language, and providing added context, such as gender (i.e., removal of shower cap that de-identifies actor/actress), background setting, and interactions with other actors/actresses. The latter, while decreasing the internal validity inherent with the more currently more controlled version of the DAVE stimuli, would seem to greatly enhance the life-like sense of this task. Adapting the DAVE stimuli to further this real-world applicability would make this task a much more sensitive measure of emotion perception.

In summary, results from the present study revealed that there is a significant association between diagnostic group (ASD or TD) and both adaptive functioning and emotion perception, such that individuals with autism spectrum disorders demonstrate significant impairments in both adaptive functioning and emotion perception compared to typically developing individuals. Findings did not demonstrate a relationship between emotion perception and adaptive functioning and the proposed mediation models were not supported. This lack of significant findings suggests that future research should broaden the approach when investigating possible mechanisms of change for adaptive outcomes to include exploration of social perception, of which emotion perception is one component, and its relationship with adaptive outcomes.

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