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THEORY OF MIND AND LANGUAGE RELATE TO BASIC EMOTION RECOGNITION IN CHILDREN WITH AUTISM SPECTRUM DISORDERS

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Abstract

Autism is a neurodevelopmental disorder that past studies have shown may result in difficulties with recognizing emotional expressions from the face, although the nature of the impairments in recognizing emotions for individuals with autism remains unclear (Akechi et al., 2009). This study compared a group of 24 children with an autism spectrum disorder (ASD) diagnosis (M = 8.92 years, range: 7-12 years) to an age-matched control group of 24 typical developing children (M = 7.79 years, range: 7-12 years) on their ability to recognize basic emotional expressions. To examine group differences in emotion recognition, pictures of the eye regions of faces were presented with one of four basic emotion expressions (happy, sad, angry, or scared), and the children were asked to label which of the four emotions they thought best matched the picture. The study also examined how the basic emotion recognition measures correlated with two measures of language abilities and two measures of theory of mind abilities. The study found that there was a significant difference between the ASD and TD group on overall basic emotion scores, as well as for happy and scared expressions as separate measures. In the ASD group, basic emotion scores were also correlated with two theory of mind task scores and two language measures (syntax age equivalence and verbal IQ equivalence), as well as with age. However, none of these predictor variables were related to emotion recognition for the typically developing group. The results demonstrated that those with ASD have some emotion recognition impairments and that their development of emotion recognition skills is positively related to both language ability and theory of mind skills.

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Introduction

Emotion recognition is a vital human skill that allows people to function appropriately in all areas of their lives including in social situations, personal relationships, and work settings. Emotions can be conveyed through hand gestures and body language. However, most emotion research focuses on the emotions that come from the face. The face shows emotions through many very subtle changes, with much of the emotion being portrayed through the mouth and the eyes. The capacity to distinguish emotions from facial expressions is essential for successful social interaction. Practicing social skills and experiencing facial expressions may also be necessary for the typical development of facial emotion recognition (Harms, Martin, & Wallace 2010). Knowing this, it is understandable that those with autism spectrum disorders (ASD), a group of disorders characterized in part by difficulties with social interaction, social interest, and limited eye contact, may experience impairments in facial emotion recognition (Bal et al., 2009).

Emotion Recognition in Typical Developing Children

Emotion recognition is important for all individuals to properly function in social situations. Social interactions rely on the ability to accurately recognize the emotion of others so that the individual can determine the correct or appropriate response in a certain situation (Bal et al., 2009). Even as early as infancy, faces become a focal point, as children are more likely to fixate on face-like stimuli than scrambled patterns (Pelphrey et al., 2002). In addition to aiding in facial expression interpretation, emotion recognition provides children with a necessary foundation in emotional knowledge to further develop and establish more complicated social skills such as empathy, prosocial behavior, and social problem solving skills (Izard et al., 2001). Social skill development increases emotion knowledge and proper emotion expression, which has shown to contribute to peer acceptance (Mostow, Izard, Fine & Trentacosta, 2002).

Izard et al. (2001) examined the connection between the ability to interpret emotion expressions and long-term social behavior in 72 children at both the age of 5 and the age of 9 (Izard et al., 2001). At age 5, the children were assessed by a verbal ability test, three different behavioral style questionnaires (which assesses temperament), and an emotional recognition and labeling task (Izard et al., 2001). At age 9, the children were evaluated by their teachers by a Social Skills Rating System, which gives scores for positive and negative social behaviors such as cooperation, self-control, assertion, and hyperactivity (Izard et al., 2001). This study found that controlling for temperament and verbal ability, earlier emotional recognition and knowledge predicted positive behaviors such as assertion, cooperation, social skills, and academic competence later in childhood, while an early lack of emotion knowledge was correlated with behavior problems (Izard et al., 2001). The results showed that development of emotion recognition in early childhood related positively to adaptive and appropriate social behaviors and negatively to issues in behavior and learning (Izard et al., 2001).

Dynamic systems theories have helped to organize findings on how emotion recognition and emotion expression skills are interrelated in empirical work to date, as well as helping to formulate predictions for outcomes in future work (Nelson, 2000; Nelson & Arkenberg, 2008; Nelson et al., 2001, 2004; Thelen & Smith, 1994, 2006). Learning new emotional skills and deploying existing skills in varied contexts are embedded in complex dynamic interplay with language, perception, social perspective-taking, and other social processes that are at work at the same time and in the same context. From this viewpoint, it can be expected that if a child lags behind others in their development of language or theory of mind skills, then these will in turn slow down their rate of progress in developing new emotion recognition skills.

Empirically, in the case of emotion recognition deficits in relation to relatively low language skills, multiple authors have found this pattern for both preschool children and for children in the age range of 5 to 12 years (e.g., Baker & Cantwell, 1982; McCabe and Meller 2004; Nelson et al., 2011; Spackman, Fujiki, Brinton, Nelson, & Allen, 2005). For all children in their gradual progress toward more refined emotion recognition skills, it is important to note that advances are most likely to occur in social context where some kind of social feedback occurs to the child. Consider the example of joking. If a child has misinterpreted another's joking utterance as an angry utterance, then that interpretation may be revised when the child immediately encounters further theory of mind clues on the face (a wink) or in a new utterance or response (*Hey, I was just kidding).*

These findings suggest that lacking emotion recognition or emotion knowledge may prevent children from becoming socially adjusted adolescents and adults later in life (Izard et al., 2001). While typically developing children may have some difficulties with emotion recognition that prevents the proper formation of social skills, children with intellectual disabilities or developmental disorders are at an inherent emotional disadvantage because of the characteristics that often define their diagnoses.

Emotion Recognition in Autism

Emotion recognition, in those with developmental disorders and intellectual disabilities, has become a major focus in current research to better understand how these individuals process emotions differently than typically developing individuals (Bal et al., 2009). One particular disorder that has been consistently investigated in this area of research is autism. Autism is a neurodevelopmental disorder that results in impaired social skills, communication difficulties, and repetitive behaviors (Humphreys, Minshew, Leonard, & Behrmann, 2007). Autism falls into a spectrum of severity called autism spectrum disorders (ASD). Those with ASD vary in their abilities to form relationships, however even the most socially skilled often have trouble reading emotions and social clues in human faces (Gross, 2004). These difficulties may be explained partially by the evidence that children who are diagnosed with autism spend less time looking at faces during infancy and early childhood (Grice et al., 2005). This suggests that they may lack a developmentally appropriate tendency to orient towards faces in early childhood (Grice et al., 2005). It has been claimed that ASD will result in difficulties with facial expression recognition, although the extent of their deficiency remains unclear and merits additional study (Akechi et al., 2009). The consensus of past research is that those with ASD and other developmental disorders have impairments in basic and complex emotion recognition compared to those who develop typically (Gross, 2004).

Gross (2004) examined the perception of four basic emotions in children (range: 3-15 years) with ASD, developmental disabilities, and clinical controls. The participants were shown colored photographs of the entire faces of humans, dogs, and orangutans, each depicting happiness, sadness, anger, surprised, and neutral emotions (Gross, 2004). The participants were asked to point to the photograph of the face for each emotion (Gross, 2004). The results of this study found that those with ASD performed comparable to the other groups only when identifying happiness in human faces, while clinical controls performed better than those with ASD in the other three emotions, suggesting that for the picture set employed in this study, happiness was the easiest emotion to recognize (Gross, 2004).

Wallace, Coleman, and Bailey (2008) found that individuals with ASD have trouble recognizing certain emotions in comparison to controls, especially confusing fear with anger. Wallace et al. (2008) presented pictures of faces (either upright or inverted), to adolescents and adults (range: 16-51 years) with ASD, and compared to a typically developing group matched on IQ and vocabulary (range: 16-54 years). The results showed that the individuals with ASD were less able to recognize emotions for both upright and inverted faces compared to controls. In addition, when presented with parts of a face in isolation (such as the eye region or mouth region rather than presenting full pictures of faces), the ASD group had much more difficulty recognizing fear from the eye region of the face and recognizing disgust from the mouth region of the face (Wallace et al., 2008).

Humphreys et al. (2007) developed a study to examine if impairments exist in basic emotion recognition in young adults ($M = 24$ years) with high-functioning autism compared to typical controls ($M = 28$ years). Clear differences between the two groups existed on basic emotion recognition scores (Humphreys et al., 2007). There was an observable difference in emotion recognition between those with ASD and those who were typically developing, however certain emotions appeared to be more difficult to interpret than others. In one report, fear appeared to be the most difficult for the ASD group to recognize, but the group also had trouble interpreting disgust and happiness (Humphreys et al., 2007). There is not a resounding consensus as to which emotions are the easiest to recognize, although interpreting fear or being scared has been seen as the most difficult in many studies (Kuusikko et al., 2009; Humphreys et al., 2007; Wallace et al., 2008).

Understanding Basic and Complex Emotions From the Eyes

It is clear that individuals with ASD experience impairments in emotion recognition, however there are differences in the ability to process emotions depending on which area of the face is being studied. Negative emotions are generally more expressed in the upper region of the face, while positive emotions are focused in the lower region of the face (Dimberg & Peterson, 2000). This suggests that only focusing on certain regions of the face, and failing to look at others, will limit the amount of emotional cues that an individual will process.

Difficulties in eye contact are one of the first documented symptoms of autism, which may be a factor that influences particular emotion recognition impairments in ASD individuals (Grice et al., 2005). The results from previous studies have shown that individuals with ASD were better at judging the identity of faces and recognizing emotions when showed only the mouth region of a face, but impaired at judging facial identity from only the eye region in comparison to the typical developing controls (Spezio, Adolphs, Hurley, & Piven, 2007). Younger children especially appeared to rely on the mouth region of the face to decipher identity (Spezio et al., 2007).

Joseph and Tanaka (2003) studied 9 and 11 year old typical developing children and high-functioning autistic children on their ability to recognize a portion of a person’s face in the context of the entire face and with the part in isolation. The study used large touch screen computers and presented the children with a picture of a face (upright or inverted) in the center of the screen for 3.5 seconds and then tested them by having them choose which of the next two faces provided on the screen (which differed by only one feature) were the same as the previous (Joseph & Tanaka, 2003). They repeated the same procedure, however the children were only presented with the choices of the isolated features by which the original two whole faces differed (Joseph & Tanaka, 2003). Results of the study found that the autistic group performed better than the typical controls in the mouth-only items, while they showed a significant deficiency when presented with the eye-only items (Joseph & Tanaka, 2003). This study shows that there is a particular significance of the mouth region of the face when those with autism process information from faces (Joseph & Tanaka, 2003).

Gross (2004) also investigated emotion recognition in the face. The study showed not only pictures of the entire faces, but also those of the upper region and lower region of the face. The study found that there were no significant differences in performance between full faces and partial faces in the autistic group, whereas the other groups performed much better when provided with the entire face (Gross, 2004). The autistic group also performed no better than chance when only viewing the upper face, while they performed significantly better than chance when viewing the full face and lower regions of the face (Gross, 2004). This suggests that those with autism obtain more information about emotions in the lower part of the face than they do in the upper region (Gross, 2004).

Other studies have reinforced the finding that those with ASD are much less able to read emotions in the upper face and eyes compared with the lower face, probably because of the averted eye gaze that characterizes ASD (Gross, 2004; Back, Ropar, & Mitchell, 2007; Wallace et al, 2008; Joseph & Tanaka, 2003). In addition, success at interpreting emotions will actually decrease in individuals with ASD when information from the eyes is withheld, suggesting that although eye gaze may be averted, they need to see the eye area of the face in order to properly recognize emotions (Back et al., 2007).

Emotions can come from all areas of the face, but individuals with autism process these areas differently. Those with autism need to have all of the regions provided in the face and to actually attend to all regions in order to better recognize the emotion. Only giving autistic children portions of a face may limit their accuracy in identifying the emotion being portrayed because they show significant impairment in identifying emotions from the eyes. Many studies use eye regions only in emotion recognition research because of the known impairments that those with ASD exhibit and to investigate why those impairments exist.

Theory of Mind, Language, and Relationship with Basic Emotion

One important aspect of emotion recognition is how reading emotions in the eyes is related to the concept of theory of mind. Theory of mind is concerned with the ability that people have to comprehend their own and other people's mental states by attributing beliefs, desires, intentions, and emotions to themselves or to other people (Angston & Jenkins, 1999; Tager-Flusberg, 2007). There is evidence that children demonstrate theory of mind skills starting as early as one year old through actions such as expecting emotions from others, establishing eye contact, and showing concern for the sorrow of others (Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001). As children get older, they begin to use words to describe mental states, understand that others can have false beliefs, take variations in social context into account, and learn to avoid offending others (Baron-Cohen et al., 2001).

Baron-Cohen et al. (2001) developed a task for both children and adults called reading the mind in the eyes (RMTE) to quantify the ability to perceive what someone is thinking or feeling through a picture of the eye region of the face. This task has allowed for testing more complex emotional and mental states such as distrust or regret (Baron-Cohen et al., 2001; Wallace et al., 2008). Recent studies have investigated the possible connection between language and theory of mind.

Fisher, Happe, & Dunn (2005) conducted a study to examine the relationship between language measures and theory of mind in children with ASD and other learning disabilities. The study consisted of 58 children with ASD (M = 10.74) and 118 children with moderate learning disabilities (M = 12.13) who were all given one grammar test, one vocabulary assessment, and two false belief tasks (Fisher et al., 2005). The results showed that there was a much stronger relationship between the language measures (especially the grammar test) and theory of mind performance in the ASD children than in those with learning disabilities (Fisher et al., 2005). The results suggest that certain levels of grammatical ability may be necessary for proper understanding of theory of mind concepts in children with ASD (Fisher et al., 2005).

Humphreys et al. (2007) found that there were clear differences between the high-functioning autistic group in comparison to the typical controls in their study. The study also investigated the connection between language measures and basic emotion processing and found that overall emotion processing correlated with verbal IQ in the autistic group (Humphreys et al., 2007). Wallace et al. (2008) also examined the relationship between language abilities and basic emotion recognition and found that language ability was significantly correlated with basic emotion processing scores in the clinical group.

Mostow et al. (2002) studied the relationship between emotion recognition skills and social skills in 201 elementary school aged children (*M* = 7 years and five months). The assessments of verbal ability and social skills were completed using vocabulary tests, teacher completed Social Skills Rating System scores, and peer interviews (Mostow et al., 2002). To assess emotion recognition skills, the participants were shown colored pictures of children's faces and asked what the child in the picture was feeling (Mostow et al., 2002). A particularly interesting finding of the study was that emotion recognition skills appeared to mediate the relationship between verbal ability and social skills (Mostow et al., 2002). This supports the theory that emotions play a role not only in proper social skill development, but also in verbal intelligence.

Individuals with autism have impairments in processing information about their own or others' mental states and they may use different cognitive techniques to do so (Tager-Flusberg, 2007). The research supports the theory that these differences may be responsible for some of the social and communication difficulties that those with ASD experience (Tager-Flusberg, 2007). These studies also show that there is a clear positive relationship between theory of mind and language, as well as between language and basic emotion recognition. This suggests that theory of mind, language ability, and emotion recognition may all be connected. These findings warrant further investigation into the nature of this relationship.

Current Study

In this study, 24 children with an autism spectrum disorder diagnosis and 24 typically developing age-matched controls, from the age of 5 to 12 years, were given a task to assess their ability to read basic emotions from the eye regions of faces. The basic emotions task involved sixteen items with pictures of eyes conveying four different basic emotions: sad, angry, happy, and scared. There were four items for each emotion with eye gaze varying between gaze at the participant and gaze away. The results of this task were first used to compare emotion recognition skills between the two groups, and then used in comparison with these predictor variables: age, two language measures (syntax scores and verbal IQ), and two theory of mind tasks (reading the mind in the eyes task and strange stories mental states task).

One key objective of this study was to analyze the recognition of four basic emotions in typically developing children and children with autism spectrum disorders. The expected result was that the ASD group would not perform as well as the typical developing group on the basic emotion recognition measure. In addition, it was predicted that that theory of mind and language measure scores would show a clear relationship with the basic emotion scores in the ASD group because both prior theory and empirical work suggests that language ability and theory of mind may be important facilitators of refinement of emotion recognition skills.

Methods

Participants

Autism Spectrum Disorder (ASD) Group. There were 24 children with autism spectrum disorders (ASD), ages 5 to 12 (20 male and 4 female), with an average age of 8.92 years. They completed the basic emotion task and the entire test battery. As identified by a parent report questionnaire, the children in this study had received a primary diagnosis of autism, Asperger's syndrome, or PDD-NOS.

Age-Matched Typical Developing (TD) Group. There were 24 children with typical development, ages 5 to 12 (14 male and 10 female), with an average age of 7.79 years. They completed the basic emotion task and the entire test battery. The two groups do not differ significantly on age, $t(48) = 2.03$ $p < .5$, or on nonverbal IQ scores, $t(48) = 1.02$, $p < 1$ (see table 1). The groups did vary on gender, however this does not affect the results of this study. The children with autism scored significantly higher on the SRS as expected, which was the diagnostic parent report of autistic symptomology.

Table 1: Sample characteristics of participants in both the autism spectrum disorder (ASD) group and typical developing (TD) group. The table includes the means, standard deviations, and ranges for: age, SRS score, and nonverbal IQ. Also, the table shows the percentages of genders in both groups.

	Age		SRS		Nonverbal IQ		Gender	
	M(SD)	Range	M(SD)	Range	M(SD)	Range	%M	%F
TD	7.79(2.04)	5 - 12	24.25(14.49)	2 - 60	102.42(16.97)	72 - 136	58.3	41.7
ASD	8.92(1.79)	5 - 12	106.22(26.56)	51 - 153	97.42(17.13)	66 - 126	83.3	16.7

Measures

Basic Emotion Task. Pictures of the eye regions of faces with four emotion labels (happy, sad, angry, or scared) were presented with either direct or averted eye gaze direction. There were a total of sixteen pictures presented individually on print-out sheets of paper, where there were two faces (one male and one female) in each emotion with direct and averted gaze direction. There were a total of four pictures for each emotion condition. An experimenter read the words aloud and children gave verbal responses. Scores could range from 0 to 16.

Theory of Mind Tasks. The children's version of the reading the mind in the eyes (RMTE) task was used as a measure of advanced theory of mind abilities in this study (Baron-Cohen et al., 2001). During this task, children matched words or phrases depicting mental states (i.e. shy, worried, not believing, or kind) to pictures of the eye regions of faces. Each item had one picture of the eye regions of a face with four words around the eyes. Children were read the words from the page and asked which word matched the thoughts or emotions of the person in the picture. There were a total of twenty-eight items, with possible scores from 0 to 28.

The strange stories mental states task was also used to measure advanced theory of mind performance based on a subset of six of the mentalizing stories from O'Hare et al. (2009). The mentalizing stories measure included understanding of lies, persuasion, deception, and others. This version of the strange stories mental states task relies on norms from over 100 children, along with explicit scoring procedures with lists of acceptable mental state answers for coding responses. For the strange stories mental states stories, children were read a short paragraph and then asked questions such as "is it true what Peter said?" and "why does he say that?" which required the child to respond about the person being deceptive, trying to lie, "ignorance of her real intentions", etc. A total of six stories were chosen (lie, white lie, misunderstanding, contrary emotions, appearance/reality, and forget). Each story was worth up to 3 points (one point for "is it true?" and 2 points for justification), for a total possible score of 0 to 18.

Syntax. The Syntax Construction subtest of the *CASL* was used in this study (Carrow-Woolfolk, 1999). The syntax construction test asked children to complete sentences using imitation of a sentence presented by the experimenter, targeting a specific syntactic form for each item, and focusing on the use of syntax rules. Raw scores were used to calculate standardized scores and age-equivalence scores for this measure.

Social Responsiveness Scale. One parent for each child completed the Social Responsiveness Scale (SRS), which is a measure of autism social symptom severity and social skills (Constantino, 2002). This measure was used to confirm the diagnosis of autism, and to ensure that there were differences in autism symptom severity between the autism and typically developing groups. The SRS had sixty-five items, rated on a 4-point (0 to 3) scale, where the parent rated the child's behavior over the last six months. This measure sampled a range of social abilities, allowing this measure to be used as a quantitative measure of overall social functioning for both groups of children. High scores were reflective of low social functioning and more autistic symptoms.

Verbal and Nonverbal Intelligence. The Kaufman Brief Intelligence Test, 2nd edition (KBIT2) was used to measure verbal and nonverbal intelligence. The verbal intelligence score was a composite of two tasks, verbal knowledge and riddles (Kaufman & Kaufman, 2004). The verbal knowledge sub-test measured receptive vocabulary. In this task, the experimenter asked the child to point to the picture that matched what they said (ie. "point to gift"), where there were six possible picture choices. The riddles task measured verbal comprehension, reasoning, and vocabulary knowledge. During the riddles task, the experimenter read questions such as "What is something shiny and hard that people wear on their finger?" and the child was asked to respond using only one word (ie. "Ring"). The raw scores could range from 1 to 60 for verbal knowledge, and 1 to 48 for riddles. Verbal IQ standard scores and age equivalence scores were computed using the sum of the two sub-test raw scores.

The nonverbal intelligence score consisted of the matrices sub-test. This test presented visual stimuli (either meaningful objects or abstract designs). The participants were presented with at least five multiple-response options and were asked to choose which picture goes best with the target stimuli picture or matrices of pictures (2x2 or 3x3). The stimuli increased in complexity and abstractness over the course of the measure. Raw scores could range from 1 to 46, and the raw scores were used to compute standard scores. Nonverbal intelligence was used only as a descriptive variable and was not included in the results of this study.

Procedures

During this study, the parent signed the consent form for their child, completed a parent questionnaire, and completed the SRS about their child. The parents reported diagnosis and age in the questionnaire. All of the children completed the basic emotion task, the RMTE task, the strange stories mental states task, CASL syntax, verbal, and nonverbal intelligence tests. Each measure was read aloud to the child and they were asked to respond verbally. Since some of the autistic children had language impairments, the measures only needed verbal responses. The entire battery of tests took about an hour for the child to complete.

Results

Basic Emotion Recognition

Emotion recognition scores were higher in children with typical development than in those with autism spectrum disorders. There was a significant difference between the ASD group and the TD group in the overall basic emotion task scores and two of the specific emotions (happy and scared). The means, standard deviations, *t*-tests, and *p*-values for each emotion in the basic emotion task and the total basic emotion task score are presented in Table 2. There was a significant difference between the ASD and TD groups in the overall scores on the basic emotion task, $t(48) = 2.84$, $p < .01$. There was also a significant difference between the two groups for two of the four basic emotions, where typically developing children performed better than children with autism for both emotions happy expressions, $t(48) = 2.55$, $p < .05$, and scared expressions, $t(48) = 2.15$, $p < .05$. There were no significant differences in sad and angry emotions between the two groups ($p < .8$, $p < .2$), suggesting that the differences in overall scores were driven primarily by the differences for happy and scared emotions.

Table 2: Means and standard deviations for each emotion in the basic emotion task (max. 4) and the total basic emotion task (max. 16) scores for the autism spectrum disorder (ASD) and typical developing (TD) groups.

	ASD	TD	*t*	*p*
Angry	3.46 (1.41)	3.79 (0.51)	1.31	0.198
Happy	1.42 (0.88)	2.13 (1.03)	2.55	0.014*
Sad	2.00 (1.06)	2.08 (0.93)	0.29	0.774
Scared	2.88 (1.19)	3.50 (0.78)	2.15	0.037*
Total Score	9.75 (2.42)	11.50 (1.79)	2.84	0.007**

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

Predictors of Emotion Recognition: Age and Diagnosis

Age relates to basic emotion processing. To assess the relationship between age, diagnosis, and basic emotion scores, a linear regression was used and the result is shown in Table

3. The analysis shows that age, diagnosis, and their interaction accounts for about 34% percent of the total variance ($R^2 = 0.34$) in basic emotion scores. Diagnosis had a significant effect on basic emotion scores in this model, $\beta = 2.01$, $p < .01$. Age had a significant effect on basic emotion scores, where older children had higher basic emotion scores than younger children, $\beta = 1.41$, $p < .01$. The interaction of age and diagnosis had a significant effect on basic emotion scores, $\beta = 1.67$, $p < .01$. To determine the nature of the interaction between age and basic emotion scores, one-tailed correlations were conducted. In the ASD group, age was significantly correlated with the basic emotion task scores, $r(24) = .587$, $p < .001$. Age was not significantly correlated with the basic emotion task scores in the TD group, $r(24) = -.042$, $p < .5$.

Table 3: Regression analysis for age, diagnosis, and their interaction for predicting basic emotion scores.

Variable	β
Diagnosis	2.01**
Age	1.41**
Age x Diagnosis	1.67**

$R^2 = 0.34$, $p < .05$*, $p < .01$**

Predictors of Emotion Recognition: Theory of Mind and Diagnosis

Theory of mind, as measured by the reading the mind in the eyes task, relates to basic emotion processing. To assess the relationship between RMTE, diagnosis, and basic emotion scores, a linear regression was used and the result is shown in Table 4. The analysis shows that

RMTE, diagnosis, and their interaction accounts for about 34% percent of the total variance ($R^2 = 0.34$) in basic emotion scores. Diagnosis had a significant effect on basic emotion scores in this model, $\beta = 1.14$, $p < .05$. RMTE had a significant effect on basic emotion scores, where children with higher RMTE scores also had higher basic emotion scores, $\beta = 1.10$, $p < .05$. The interaction of RMTE and diagnosis did not have a significant effect on basic emotion scores, $\beta = 1.16$, $p < .1$. To more closely examine performance of the two groups individually, one-tailed correlations were conducted for each group. In the ASD group, RMTE was significantly correlated with the basic emotion task scores, where children scoring higher on the RMTE also scored higher on basic face processing $r(24) = .540$, $p < .01$. RMTE was not significantly correlated with the basic emotion task scores in the TD group, though there is a trend for children with higher RMTE scores to have higher basic emotion scores, $r(24) = .320$, $p < .1$.

Table 4: Regression analysis for reading the mind in the eyes task, diagnosis, and their interaction for predicting basic emotion scores.

Variable	β
Diagnosis	1.14*
RMTE	1.10*
RMTE x Diagnosis	1.16

$R^2 = 0.34$, $p < .05$*, $p < .01$**

Theory of mind, as measured by the strange stories mental states task, relates to basic emotion processing also. To assess the relationship between strange stories mental states scores, diagnosis, and basic emotion scores, a linear regression was used and the result is shown in Table 5. The analysis shows that the strange stories mental states, diagnosis, and their interaction accounts for about 36% percent of the variance (R^2 = 0.36) in basic emotion scores. Diagnosis had a significant effect on basic emotion scores in this model, $\beta = 1.09$, $p < .01$. The strange stories mental states task had a significant effect on basic emotion scores, where children scoring higher on the strange stories mental states task also had higher basic emotion scores, $\beta = 1.27$, $p < .01$. The interaction of the strange stories mental states task and diagnosis did have a significant effect on basic emotion scores, $\beta = 1.49$, $p < .05$. To determine the nature of the interaction between the strange stories mental states and basic emotion scores, one-tailed correlations were conducted. In the ASD group, the strange stories mental states task was significantly correlated with the basic emotion task scores, $r(24) = .611$, $p < .01$. The strange stories mental states task was not significantly correlated with the basic emotion task scores in the TD group, $r(24) = -.48$, $p < .5$.

Table 5: Regression analysis for strange stories mental states task, diagnosis, and their interaction for predicting basic emotion scores.

Variable	β
Diagnosis	1.09**
Strange Stories Mental States	1.26**
Strange Stories Mental States x Diagnosis	1.49*

$R^2 = 0.36$, $p < .05$*, $p < .01$**

Predictors of Emotion Recognition: Language Measures and Diagnosis

Syntax standardized scores do not relate to basic emotion processing. To assess the relationship between syntax standard scores, diagnosis, and basic emotion scores, a linear regression was used. The analysis shows that syntax standardized scores, diagnosis, and their interaction accounts for about 17% percent of the variance ($R^2 = 0.17$) in basic emotion scores. Diagnosis did not have a significant effect on basic emotion scores in this model, $\beta = 1.49$, $p < .2$. Syntax standard scores did not have a significant effect on basic emotion scores, $\beta = 0.49$, $p < .4$. The interaction of age and diagnosis did not have a significant effect on basic emotion scores, $\beta = 1.43$, $p < .4$.

Age equivalence syntax scores do relate to basic emotion processing. To assess the relationship between syntax age equivalence scores, diagnosis, and basic emotion scores, a linear regression was used and the result is shown in Table 6. The analysis shows that age equivalence syntax scores, diagnosis, and their interaction accounts for about 27% percent of the variance ($R^2 = 0.27$) in basic emotion scores. Diagnosis had a significant effect on basic emotion scores in this model, $\beta = 1.30$, $p < .01$. Syntax age equivalence scores had a significant effect on basic emotion scores, where children with older age equivalence scores had higher basic emotion scores, $\beta = 1.03$, $p < .05$. The interaction of syntax age equivalence scores and diagnosis had a significant effect on basic emotion scores, $\beta = 1.36$, $p < .05$. To determine the nature of the interaction between syntax age equivalence scores and basic emotion scores, one-tailed correlations were conducted. In the ASD group, syntax age equivalence scores were significantly correlated with the basic emotion task scores, $r(24) = .540$, $p < .05$. Syntax age equivalence scores were not significantly correlated with the basic emotion task scores in the TD group, $r(24) = -.152$, $p < .3$.

Table 6: Regression analysis for syntax age equivalence, diagnosis, and their interaction for predicting basic emotion scores.

Variable	β
Diagnosis	1.30**
Syntax Age Equivalence	1.03*
Syntax Age Equivalence x Diagnosis	1.36*

$R^2 = 0.27$ $p < .05$*, $p < .01$**

Verbal IQ standardized scores do not relate to basic emotion processing. To assess the relationship between verbal IQ standard scores, diagnosis, and basic emotion scores, a linear regression was used. The analysis shows that verbal IQ scores, diagnosis, and their interaction accounts for about 20% percent of the variance ($R^2 = 0.20$) in basic emotion scores. Diagnosis did not have a significant effect on basic emotion scores in this model, $\beta = 1.59$, $p < .3$. Verbal IQ standard scores did not have a significant effect on basic emotion scores, $\beta = 0.73$, $p < .2$. The interaction of verbal IQ standard scores and diagnosis did not have a significant effect on basic emotion scores, $\beta = 2.40$ $p < .2$.

Age equivalence verbal IQ scores do relate to basic emotion processing. To assess the relationship between verbal IQ age equivalence scores, diagnosis, and basic emotion scores, a linear regression was used and the result is shown in Table 7. The analysis shows that age equivalence verbal IQ, diagnosis, and their interaction accounts for about 27% percent of the variance ($R^2 = 0.27$) in basic emotion scores. Diagnosis had a significant effect on basic emotion scores in this model, $\beta = 1.22$, $p < .05$. Verbal IQ age equivalence scores had a significant effect on basic emotion scores where children with higher verbal IQ age equivalence scores had higher basic emotion scores, $\beta = 0.95$, $p < .05$. The interaction of verbal IQ age equivalence scores and diagnosis did not have a significant effect on basic emotion scores, $\beta = 1.13$, $p < .1$. To more closely examine performance of the two groups individually, one-tailed correlations were conducted for each group. In the ASD group, verbal IQ age equivalence scores were significantly correlated with the basic emotion task scores, where children with higher verbal IQ age equivalence scores also scored higher on basic face processing $r(24) = .455$, $p < .05$. Verbal IQ age equivalence was not significantly correlated with the basic emotion task scores in the TD group, though there is a trend for children with higher verbal IQ age equivalence scores to have higher basic emotion scores, $r(24) = .094$, $p < .4$.

Table 7: Regression analysis for verbal IQ age equivalence, diagnosis, and their interaction for predicting basic emotion scores.

Variable	β
Diagnosis	1.22*
Verbal IQ Age Equivalence	.948*
Verbal IQ Age Equivalence x Diagnosis	1.13

$R^2 = 0.27$, $p < .05$*, $p < .01$**

Discussion

Differences in Basic Emotion Recognition

One key objective of this study was to analyze the recognition of four basic emotions in typical developing children and children with ASD when only the eye regions of faces were presented. The expected result was that the ASD group would not perform as well as the typical developing group on the basic emotion recognition measure. In line with the prediction, the ASD group scored lower than the TD group for the overall basic emotion task. When breaking down the task by specific emotion, happy and scared were the only emotions in which the ASD group scored significantly lower. This means that the overall significant difference is probably being driven by the difference in these two emotions.

One potential explanation for the significantly lower scores in happy and scared is that happy and scared may be emotions that are more difficult for those with autism to recognize, especially when viewing only the eye regions of faces. Those with ASD have been found to perform better on items with only the mouth region, while they showed significant difficulty when presented with the only the eye region of the face (Joseph & Tanaka, 2003). Since positive emotions are focused especially near the mouth in the lower regions of the face, it may be more difficult for individuals with ASD to interpret happy from only the eye region of face (Dimberg & Peterson, 2000). In contrast, negative emotions are focused in the upper region of the face, however past research has shown that fearful or scared expressions were some of the most difficult for individuals with autism to recognize, even when presenting full faces (Wallace et al., 2008). Although negative emotion cues are found in the eye region of the face, the difficulties that those with ASD have with eye gaze may explain why negative emotions, such as scared, are still quite challenging for these individuals to identify.

Age Effects on Basic Emotion Scores

One set of clues to interpreting the results is that the two groups differed in terms of age effects. There is a clear and significant age effect on the basic emotion scores in the ASD group. This basic emotion task was very significantly related to age, with individuals with ASD showing improvement on the task with age, where older children performed significantly better than the younger children in this sample. However, the basic emotion scores were not found to have a significant relationship with age in the TD group, with most of the typical developing children performing well overall on the task. Mostow et al. (2002) previously found that older children exhibit better emotion knowledge and recognition skills, supported by the theory that emotion perception develops in a particular sequence as children get older. This does not explain why there were no significant relationships in the present study, but this issue is addressed in the next section. One relevant observation on the methods is that the Mostow et al. (2002) study included stories about recognizing basic emotions from social situations and social behaviors (in addition to recognizing emotions expressed on the face) in their measure of basic emotion knowledge, whereas the current study only included recognizing basic emotions from pictures.

Language, Theory of Mind, and Relationship to Basic Emotion

Another key study objective was to determine whether the theory of mind and language measures would show a clear and positive relationship with the children's basic emotion skills. Results confirmed that each language measure and each theory of mind measure was positively and significantly related to basic emotion scores in the ASD group, but that none of the same measures correlated to emotion scores in the TD group.

The lack of significant relationship between TD basic emotion scores and language measures might be explained in part by developmental timing differences between TD and ASD individuals, even though the two groups were matched on mean age and age range. Most of the TD children used in this study may have all already gone through the major developmental milestones in recognizing basic emotions, so their emotion skills may no longer be related to their levels of language ability, theory of mind (perspective-taking), or age. On the other hand, the ASD group clearly lags behind the TD children for the basic emotions of happy and scared. Accordingly, as the processes of acquiring and refining basic emotions is still active for most of these children with ASD, it makes sense that when their language skills and theory of mind skills are relatively high, these skills serve as a type of facilitator for the emotional domain. Possible ways in which such facilitation could occur are discussed in detail below.

At the theoretical level within the dynamic systems model, it has been argued that disparate language levels and theory of mind levels will dynamically interact with knowledge structures, information-processing capacities, and ongoing social processes to determine how much learning of new emotional structures occurs both in informal conversational episodes and in direct teaching episodes (Bornstein & Tamis-LeMonda, 1989; Campione & Brown, 1987; Elman et al., 1996; Ladd et al., 1999; Nelson, 2000; Nelson & Arkenberg, 2008; Nelson et al., 2004; Pianta, 2001; Thelen & Smith, 1994, 2006). In line with such theoretical framings, the present study shows, for the 5 to 12 year-old children with autism spectrum disorders, substantial positive relationships to emotion recognition for both language skills and theory of mind skills.

Limitations

One limitation of this study was the small sample size for each group. Although the sample size was large enough to find significant correlations and interactions among variables for the group with autism, the study could have been stronger if there were more participants, especially if there are more subtle relationships among the variables for this age range in typical development. Having a few outliers could significantly alter the results of the study because there were a modest number of participants, though an examination of the data suggested that outliers were unlikely to be driving the current study results. This may be another explanation as to why there were no significant findings in the TD group of children. If there were a larger group of children, this may make the significant findings stronger and allow other relationships to show significant differences. At the same time, it should be noted that in the prior literature comparing ASD children and TD children, it is not uncommon to have group sizes as small or smaller than the two groups of 24 examined in the present study.

Another limitation of this study was that there were very few items in the basic emotion task. Since this measure was embedded in a larger ongoing study examining language abilities in children with autism, the basic emotion task was kept short to help prevent attention difficulties in the children with autism from affecting task performance. There were only sixteen items in the current measure, which means there were only four individual items for each of the four emotions. It is possible that if one or two of the items were particularly hard, this could alter the overall task results as well as the results for each individual emotion. Joseph & Tanaka (2003) used three sessions with twenty-four trials in each, which was seventy-two total items. The larger number of items may have increased the reliability of the task because one or two especially difficult items would probably not affect the overall results.

Although the ages of the groups did not significantly differ, another limitation was that the groups were matched only on chronological age. The results may have been stronger if the participants had been matched on both chronological and mental age. Joseph & Tanaka (2003) used a group of typical developing children that were matched on age, verbal IQ, and nonverbal

IQ, which makes the results stronger knowing that the children were of both similar chronological and mental age.

Future Studies

One area for future study would be to try to have two typical developing controls for each member of the ASD group or matching each ASD group participant to one typical developing control on both age and nonverbal IQ. This would strengthen the results of the study because it would allow analyses to be done in comparison to children who are of similar age and those who are of similar mental age. Building on the Joseph & Tanaka (2003) and Mostow et al. (2002) studies, conducting a study similar to the present one with a larger number of overall participants, more basic emotion task items, and controls matched on both age and nonverbal IQ would make a stronger overall study.

Looking to future research and intervention possibilities, as viewed from a dynamic systems perspective, effective engagement and teaching of individual children with ASD in social-perspective-taking (including theory of mind) skills and emotion recognition would be likely to benefit from some tailored adjustments of the language of teaching to the children's disparate language levels.

Summary

In line with prediction, the autism spectrum disorder (ASD) group scored lower than the typically developing (TD) group in recognition of basic emotions. This study further found that language abilities and theory of mind are both positively correlated with basic emotion recognition skills in children with autism spectrum disorders. This pattern of relationship is a significant extension of prior work on factors affecting progress by children with autism spectrum disorders in their understanding of others' emotions. The outcomes also confirmed the need for further research in this area to determine if there are other factors that may be related to basic emotion recognition and processing and to more fully determine the reasons that children with autism spectrum disorders are delayed in their emotion recognition compared to typical developing children.

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Experience and Volunteer Activities

HIV Counselor - University Park, PA: September 2011 - Present
Student Interventionist - University Health Services (UHS), Penn State University
- Trained and certified as an HIV Counselor by the PA Department of Health
- Performed pre-test and post-test counseling for students undergoing HIV testing
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Peer Health Educator - University Park, PA: January 2011 - Present
HealthWorks - University Health Services (UHS), Penn State University
- Engaged in student health promotion outreach as a peer health educator
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Therapeutic Staff Support Aide - Elwyn, PA: July - Aug. 2010 and 2011
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