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The Relationship between Emotion and Language Development amongst Infants and Toddlers at Differential Risk for Autism

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Abstract

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A defining feature for individuals with autism spectrum disorder (ASD) is social communication challenges, which can compromise the ability to form meaningful connections with others and their overall well-being. The present study examined the relationship between emotional expression and language development in children with ASD. Secondary data analysis of data drawn from a study at Marcus Autism Center was performed. The participants ($N = 345$) were infants and toddlers at differential risk for ASD with the following completed measures: the Autism Diagnostic Observation Schedule (ADOS), the Communication and Symbolic Behavior Scales (CSBS), and the Mullen Scales of Early Learning (Mullen). It was found that: risk status for ASD is associated with both emotional regulation and language development; there is a significant positive correlation between the range and appropriateness of emotional expression and language abilities; the interaction between the risk for ASD and emotional expression had a non-significant effect on language, but the interaction between ADOS classification and emotional expression had a significant effect on receptive and expressive language. Given the potential implications of this study's findings, further research is necessary to better understand the effects of emotional regulation on non-verbal communication.

Keywords: social communication challenges, emotional expression, language development, autism spectrum disorder, emotional regulation

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Introduction

Social skills are essential to developing a sense of autonomy, maintaining relationships, and overall well-being (McVey et al., 2016). Two skills essential to social development and often impaired in people with autism spectrum disorder (ASD)[1] are emotional regulation and language (Boucher, 2003; Samson et al., 2014). People with ASD endure many social hardships and may find it more difficult to overcome adversity when experiencing social communication challenges (LaGasse et al., 2017). The literature features studies describing the nature of impaired emotional and verbal expression in people with ASD and its influence on social development independently (Samson et al., 2014; Rapin & Dunn, 1997). However, little is known about how these vital processes impact *each other* in the developmental trajectories of young children with ASD. Discerning the relationship between emotional and verbal expression processes in children may help us understand how to establish a social-developmental context to foster a more typical social developmental trajectory. This knowledge would be especially informative for children with ASD and their caregivers, as expressing emotions appropriately may reduce challenges with communication. Many interventions are currently being used to improve people with ASD's quality of life (Centers for Disease Control and Prevention, 2022), but few consider the inter-relationship between emotional and verbal expression; I hope this study provides the information and context that will help clinicians develop and employ more effective, individualized interventions.

Emotional regulation may be crucial for optimal social competence and positive long-term developmental outcomes (Samson et al., 2014); in typically developing (TD) children,

[1] There is a debate in the field over whether person-first or identity-first terminology is proper to use. As someone who is not part of the Autism community, I am mindful of the need to be respectful and avoid any potential insensitivity. Therefore, I believe that using person-first language is the most considerate approach, and I will use it throughout this paper.

regulating emotions may be related to the production of socially appropriate responses to others and promotion of adaptive functioning (Samson et al., 2014). From current research emerges a consensus that people with ASD express emotions differently than their typically developing peers (Grabowski et al., 2019). This 'difference' is often characterized by a lack of emotion in the face (flat facial affect) or a struggle to moderate emotions in social contexts (emotional dysregulation, which encompasses both which emotions are expressed, and the length, intensity, and target of emotional expression). People with ASD may have difficulty expressing their emotions appropriately, contributing to miscommunication and occasionally more severe internalizing behaviors (which reflect one’s emotional/psychological state, e.g., social withdrawal) and externalizing behaviors (which manifest as outward projections that interfere with life functioning, e.g., impulsivity) (Samson et al., 2015). In TD children, we see more effective use of adaptive behaviors (e.g., socializing, avoiding danger, following societal norms), which enable a person to cope with their environment (Samson et al., 2015). However, emotional dysregulation appears to impair adaptive functioning in children with ASD. Maladaptive behaviors (e.g., slapping, head banging, running away) that interfere with daily functioning are highly prevalent and the most commonly recognized hurdle to the inclusion of children with ASD in social contexts (Grace et al., 2008, as cited in Fulton et al., 2014).

Impairments and delays in language are also thought to be causal factors for social deficits in children with ASD (Naigles, 2013). TD children learn to successfully convey information, intrinsic needs, and emotions to others by acquiring basic syntactical rules and diverse vocabulary (Schmidt & Paris, 1984). Children with ASD, however, may develop language skills more slowly and thus struggle to comprehend what others say; dysphasia (a disorder marked by speech and comprehension deficits) is a common comorbidity of ASD

(Rapin & Dunn, 1997). Beyond verbal speech, people with ASD may also struggle with nonverbal communication, such as hand gestures, eye contact, and facial expressions (U.S. Department of Health and Human Services, 2020).

Executive action systems (which constitute the prototype emotions) are preprogrammed by evolutionary mechanisms to rely on cognitive processing and appraisal (Tyng et al., 2017). Essentially, when confronted with emotionally stimulating situations (e.g., getting attacked by a predator), there are evolutionary adaptations, "programmed" behavioral routines, that serve as homeostatic mechanisms to ensure our safety and well-being (Tyng et al., 2017). Primary emotional processes anticipate survival demands and direct secondary learning and memory through associative learning, then communicate with higher-order cognitive functions to stimulate future planning (Tyng et al., 2017). With the knowledge that emotional expression and cognitive processing are interrelated, researchers might consider how providing support for emotional expression could play a role in cognitive development. Schroth et al. (2005) exemplify the connection between these variables in tying emotional expression to language, asserting that people's words evoke emotions and that we can articulate our emotions with words. From a developmental standpoint, this is supported by the fact that caregivers' responses to children's emotions lay a foundation for labeling emotions (U.S. Department of Health and Human Services, 2021). Emotional literacy is promoted by children's capacity to name their feelings, enabling them to reflect and talk with others about how they experience their surroundings (U.S. Department of Health and Human Services, 2021). However, science has often considered this to be the extent of the relationship between language and emotion (Lindquist et al., 2015). Numerous modern psychological theories contend that physical types of emotions are unrelated to linguistic or cognitive processing (Ekman & Cordaro, 2011; Panksepp, 2011; Shariff & Tracy, 2011; Fontaine et al., 2013, as cited in Lindquist et al., 2015). Nevertheless, new research suggests that language may play a more prominent role in emotions than previously thought. The Conceptual Act Theory (CAT) asserts that emotions transpire when physical interactions with others are meaningfully connected to experiences while cognitive and perceptual processing is occurring (Barrett, 2014); this theory suggests that language influences emotion by supporting the conceptual knowledge used to derive meaning from interactions with our environment and others (Lindquist et al., 2015). In essence, language is involved in emotion processing and expression, helping us draw significance from our sensory environment. This theory points to language's causal effect on emotions. However, empirical evidence suggests a bidirectional relationship. Tyng et al. (2017) established a relationship between emotion and cognitive processing. Jablonka et al. (2012), following a review of the evolution of language and emotion, respectively, concluded that in an evolutionary sense, emotional regulation may have precipitated the use of linguistic signs, and language may have further enhanced emotional perception. It appears that there is empirical evidence supporting a bidirectional relationship, and I will delve deeper into the relationship between emotional expression and language acquisition and production in this study.

Past research has mostly examined emotional expression and language in isolation. Research covering this relationship primarily investigates these variables in TD children and concentrates on language acquisition rather than vocabulary, grammar, and other essential elements of good communication. Study results in this area have also been contradictory, with some researchers suggesting positive relationships between positive emotional expression and the development of language (Dixon & Shore, 1997; Dixon & Smith, 2000; Kubicek et al., 2001; Matheny, 1989; Slomkowski et al., 1992, as cited in Kubicek & Emde, 2012) and others reporting a negative relationship in both positive and negative emotional expression and the acquisition of language (Karass & Braungart-Rieker, 2003, as cited in Kubicek & Emde, 2012). Thus, the relationship between emotional expression and language development has not been well-established and is predominantly concerned with TD children. It is necessary to examine this relationship in a broader group of children, as the findings would likely have considerable influence on the study of cognitive development and disability research. Kubicek and Emde (2012) propose that both emotion and language emerge in infancy and are related to a "child's transactions with their social environment." Examining and discovering a relationship between emotional expression and language may help clinicians lay the foundation for facilitating social development for children with ASD and provide a means of fostering social competence.

While few studies to date have examined the link between emotional expression and language development in individuals with ASD, a wealth of literature studies the abnormalities in these cognitive processes independently. Firstly, researchers contend that children with ASD exhibit poor emotional coordination (e.g., incongruent facial movements) and timing of affect during social interactions (Scambler et al. (2007), as cited in Nader-Grosboise & Mazzone (2014)). Children with ASD may appear less expressive than TD peers because of more frequent displays of flat facial affect and idiosyncratic expressions (Czapinski & Bryson, 2003; Hobson & Lee, 1998; Kasari et al., 1990; Loveland et al., 1994, as cited in Nader-Grosboise & Mazzone, 2014)). Observed deficiencies in language among children with ASD may include the following communication deficits: not responding when prompted, not recognizing gestures and language as tools used to influence others, and not using gestures to augment speech (Rapin & Dunn (1997)). Rapin & Dunn (1997) also suggest that children with ASD generally experience language delays and may lack the drive to communicate, stating that some people with ASD use language only when compelled, and others may be partially or completely nonverbal. This literature has offered an in-depth view of the two primary variables being analyzed in the current study – emotional expression and language development – and emphasizes the need for research that examines both emotion and language in children with ASD.

Children with ASD may present with difficulties in their social environment, including sustaining relationships, communicating with others, social transactions, and expressing appropriate behaviors (LaGasse, 2017). Impairments in social skills may have significant implications for children with ASD, compromising self-esteem, sense of independence, academic skills, and relations with family and friends (LaGasse, 2017). The current study is a secondary data analysis that builds on the original work of researchers at Marcus Autism Center (Klin, 2012; 2017) and examines two cognitive processes that play a considerable role in social performance. Advantages of this study include: a large sample being studied longitudinally, the use of established measures, and direct observation of children's behavior. I predicted that investigating the relationship between emotional expression and language development in children with ASD might help clinicians establish the social-developmental framework necessary to promote meaningful social growth. In alignment with this cogitation, I proposed the following hypotheses: 1) Children at elevated likelihood (EL) for ASD will have a more limited range of emotional expression and will score lower on all emotion clusters at 12 months than children with no familial risk. 2) At 24 months, children at EL for ASD will have lower levels of receptive and expressive language than children at lower likelihood (LL). 3) Range of emotional expression, appropriateness of emotional expression, and both receptive and expressive language abilities are positively correlated. 4) The risk for ASD moderates the relationship between language and emotion expression.

Methods

Participants

In the original study, 655 infants and toddlers were observed at 6, 12, 16, 24, and 36 months. Infants were recruited if they were at either EL or LL for ASD. Participants were classified as ‘EL’ if they had an older biological sibling with ASD, as confirmed by a diagnostic evaluation report signed by a licensed health professional. A clinical review of the evaluation reports and scores within the ASD range on the Social Responsiveness Scale and the Social Communication Questionnaire confirmed that EL participants had an older biological sibling with an ASD diagnosis. ‘LL’ participants had no familial history of ASD in first or second-degree relatives. The participant's age, gender, race, and living arrangements, as well as parental marital status, ethnicity, and race, were provided by parents in a self-report questionnaire. Families participating in the study were recruited through multiple sources, including Marcus Autism Center, Facebook posts, relationships with local obstetric practices, and word of mouth. Each child's caregiver provided written, informed consent before evaluation or data collection. The Institutional Review Board (IRB) of Emory University School of Medicine authorized all procedures involving human participants in this study.

Measures

The Mullen Scales of Early Learning (Mullen) is a standardized measure of development designed for children from 0 to 68 months (Mullen, 1995). It can be used to derive standard scores for the overall early learning composite, T-scores for subscales, percentile ranks, descriptive categories, and age equivalents for five developmental domains: visual reception, gross motor, fine motor, receptive language, and expressive language. This study specifically focused on the receptive and expressive language subscales from the Mullen. For individual scales, the mean T-score is 50, and the standard deviation is 10, and for the Early Learning Composite (which is an estimate of overall developmental functioning), the mean standard score is 100 with a standard deviation of 15. The scoring for each item can range from zero to five points, but most items are either a '0' or a '1', indicating a correct response. The scale items are presented in order of difficulty. This study uses age-equivalent scores to create a developmental quotient for each child by subtracting the age in months at assessment from the age-equivalent score. A positive value indicates that performance was above expectation; a negative score indicates performance below expectation.

The Communication and Symbolic Behavior Scales (CSBS) is a standardized play-based infant and toddler communication assessment (Wetherby & Prizant, 2002). The scale utilizes direct observation to assess a child's communication skills. The evaluation consists of 24 items organized into seven clusters corresponding to three composite domains (social, speech, and symbolic) and yields a total score. Composite standard scores are based on a mean of 10 and a standard deviation of 3, and the standard score for the total is based on a mean of 100 and a standard deviation of 15. While there are seven clusters, only four clusters are used in the present study: the emotion and eye gaze cluster (further referred to as the emotion cluster in this paper), the communication cluster, the gestures cluster, and the object use cluster. These four clusters were selected because each contains elements that play a role in emotional expression.

The emotion and eye gaze cluster has three items: gaze shifts (shifting gaze between a person and an object and back) that are important for measuring social referencing and shared positive affect states (laughter), and gaze/point following (a child's ability to follow someone's gaze and point). The communication cluster consists of four items that evaluate the frequency and function of communicative acts across different activities. A communicative act is a gesture, vocalization, or verbalization directed toward another individual and is often tied to emotion. The four items of the communication cluster include communication rate (frequency of communicative acts in each of the six activities), behavior regulation (requesting or protesting), social interaction (requesting a social routine, requesting comfort, calling, greeting, or showing off), and joint attention (directing caregiver and/or researcher's attention to an entity or event). The gestures cluster contains two items: conventional gestures (such as giving, pointing, and reaching) and contact (the child's hand touches a person or object), and distal gestures (a child's hand does not touch a person or object while making a gesture). The object use cluster employs a symbolic play probe to evaluate four items: inventory of action schemes (feeding or pouring), action schemes toward others (feeding caregiver with a spoon), sequences in action schemes (stir bowl, and then feed doll with a spoon), and stacks tower of blocks; this cluster measures relative interest in an object or activity and demonstrates a child engaging in play to express emotion.

The Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 2000) is a standardized evaluation of social interaction, communication, play skills, and restricted, repetitive behaviors diagnostic of ASD. Examiners select the appropriate module for children depending on their language ability and age. Children were administered Module 1, which quantifies ASD symptoms such as social communication skills (joint attention, eye contact, social overtures and responses, etc.) and restricted and repetitive behaviors (e.g., sensory seeking behaviors, repetitive play, atypical engagement with objects, etc.), which are relevant in making a diagnostic determination of ASD. Module 1 is specifically used for children who are minimally verbal to non-verbal, and Module 2 is for children with phrase speech. Children were administered Module 3 if they were verbally fluent, but this Module was less applicable to children participating in this study. The total algorithm scores were converted into a calibrated severity score (CSS) with a score range of 1 to 10, allowing us to ascertain symptom severity across modules and language ability. The 'Risk' and 'ADOS Classification' categories were used to assess the genetic risk of developing ASD and diagnostic determination for ASD, respectively.

Procedures

The data used in the present study were extracted from a large longitudinal study. In the study, researchers evaluated infants and toddlers at 6, 12, 16, 24, and 36 months using the CSBS, the Mullen, and the ADOS. All three evaluations were conducted over two days. Study visits began with the Mullen, which takes approximately 30-45 minutes, followed by the ADOS, which takes between 30 and 60 minutes. The CSBS was typically conducted on the second study visit day and took about 30 minutes. Infants were in a child-friendly assessment room with their caregiver during all three assessments. The Mullen and CSBS were conducted at a table with a child secured in a child safety seat, and the ADOS was executed with the child roaming and exploring the room.

Speech-language pathologists with expertise in infant development and ASD administered the CSBS in the original study. An author of the CSBS trained all speech-language pathologists to achieve a 90% reliability rate in administration and scoring. Over 30 months, training and reliability monitoring were conducted through biweekly meetings that included video reviews and discussion of administration and scoring issues. The Mullen was administered by licensed psychologists with expertise in infant development and ASD or doctoral psychology trainees under the supervision of licensed psychologists. The ADOS was administered by research reliable psychologists with ASD and infant development expertise. Psychologists and trainees were blind to the participant's risk status and the precise objectives of this study.

Statistical Methods

Data analyses were performed using Statistical Package for Social Sciences (SPSS). Demographic frequencies were calculated at 12 and 24 months. Not all children were assessed at exactly 12 and 24 months of age, therefore, I used age ranges. Twelve months was quantified as participants aged between 12-14 months. Twenty-four months was quantified as participants aged between 24-26 months. Independent samples *t*-tests were performed to ascertain the relationship between differences in emotion expression and language, respectively, between children classified as EL vs. LL for ASD. The emotion, communication, gestures, and object use clusters of the CSBS were used to measure emotional expression, and the receptive and expressive language subscales from the Mullen were used to quantify language for all measures. Pearson Product Moment correlations were performed to examine the relationship between the range and appropriateness of emotional expression and receptive and expressive language. Multiple linear regression with moderation was performed to ascertain whether the relationship between emotion and language varied by risk status. Risk status consisted of children who were either at EL or LL for ASD. Multiple linear regression with orthogonal contrasts was performed to investigate whether the relationship between emotional expression and language development differed by ADOS classification. ADOS classification included children who did not score on the ASD range (labeled ‘Non-spectrum’), children who exceeded the threshold for autism spectrum disorder (categorized as ‘Autism-spectrum’), and children who exceeded the threshold for autism (classified as 'Autism'). These designations were based on the Diagnostic and Statistical Manual, 4th Edition (DSM IV), which was applicable at the time of data collection for this study. The orthogonal contrasts were labeled as Contrast 1 (Non-spectrum vs. ASD and Autism) and Contrast 2 (ASD vs. Autism).

Results

Description of the Sample:

In our study's sample, the number of children available for analysis varied across times of measurement. Three-hundred and forty-five infants were observed at 12 months. The racial majority were White participants (73.3%), followed by Black or African American participants (13.0%). For participant gender at 12 months, most participants were male (59.7%). Of the 345 participants at 12 months, 46.1% were at EL for ASD. Of the 183 participants whose ADOS classification was reported at 12 months, 31.15% percent were classified as either 'Autism' or 'Autism-spectrum.' One hundred and seventy-four participants returned for assessment at 24 months. The racial majority were White participants (77.6%), followed by Black or African American participants (10.3%). For participant gender, the majority of participants were male (65.5%). Of the 174 participants at 24 months, 43.7% were at EL for ASD. Of the 136 participants whose ADOS classification was reported at 24 months, 30.15% were classified as either 'Autism' or 'Autism-spectrum.' I excluded participants who did not fall within the selected age ranges or had incomplete data on the main study variables. See Table 1 for further details on demographic variables.

Hypothesis One:

I hypothesized that children with EL for ASD would maintain a narrower range of emotional expression and score lower on the clusters assessing for emotional expression than children at LL risk. Separate independent samples *t*-tests were conducted on each cluster score representing elements of emotional expression at 12 months. There was a statistically significant difference in the standard scores of the emotion clusters for children at EL and LL for ASD; children at EL for ASD displayed, on average, lower emotional expression. For the emotion and eye gaze cluster, children at EL for ASD presented with, on average, lower emotion standard scores, $t(342.188) = 4.147$, $p = 0.000$, $d = .445$, 95% CI [.231, .658]. For the communication cluster, children at EL for ASD maintained, on average, lower communication standard scores, $t(344.777) = 5.008$, $p = 0.000$, $d = .533$, 95% CI [.318, .747]. For the gestures cluster, children at EL for ASD produced, on average, lower gestures standard scores, $t(337.846) = 3.883$, $p = 0.000$, $d = .418$, 95% CI [.204, .631]. For the object use cluster, children at EL for ASD exhibited, on average, lower object use standard scores, $t(344.665) = 3.556$, $p = 0.000$, $d = .380$, 95% CI [.167, .592]. See Table 2 for further details on the independent samples *t*-test conducted.

Hypothesis Two:

I hypothesized that children at EL for ASD would present with lower receptive and expressive language levels than children at LL risk. Separate independent samples *t*-tests were conducted to compare the receptive and expressive language in EL and LL groups at 24 months. There was a statistically significant difference in the standard scores of receptive and expressive language for children at EL and LL for ASD; children at EL for ASD had, on average, lower receptive and expressive language abilities. For receptive language, children at EL for ASD presented with, on average, lower receptive language skills, $t(207.269) = 5.056$, $p = .000$, $d = .671$, 95% CI [.407, .935]. For expressive language, children at EL for ASD maintained, on average, lower expressive language skills, $t(229.883) = 5.360$, $p = .000$, $d = .701$, 95% CI [.436, .965]. See Table 3 for further details on the independent samples *t*-test assessment.

Hypothesis Three:

I hypothesized a positive association between the range and appropriateness of emotional expression and receptive and expressive language abilities. I used Pearson Product-Moment correlations to assess the linear relationship between the range and appropriateness of emotional expression (at 12 months) and receptive and expressive language (at 24 months). There was a significant positive correlation between emotional expression and language abilities; lower standard scores for all four emotion clusters (representing the fundamental components of emotional expression) were correlated with lower developmental quotient scores for receptive and expressive language. For the emotion cluster, emotion standard scores were significantly positively correlated with developmental quotient scores for receptive ($r(234) = .262.$, $p = .000$) and expressive ($r(234) = .173$, $p = .004$) language at 24 months. For the communication cluster, communication standard scores were significantly positively correlated with developmental quotient scores for receptive ($r(234) = .357.$, $p = .000$) and expressive ($r(234) = .385$, $p = .000$) language at 24 months. For the gestures cluster, gestures standard scores were significantly positively correlated with developmental quotient scores for receptive ($r(234) = .343.$, $p = .000$) and expressive ($r(234) = .344$, $p = .000$) language at 24 months. For the object use cluster, object use standard scores were significantly positively correlated with developmental quotient scores for receptive ($r(234) = .273.$, $p = .000$) and expressive ($r(234) = .174$, $p = .004$) language at 24 months. See Table 4 for the Pearson Product-Moment correlation results.

Hypothesis Four:

Multiple regression analyses were used to estimate the total variance explained in receptive and expressive language by the set of emotion variables measured to control for potential multicollinearity between emotion variables. The emotion, communication, gestures, and object use clusters measured at 12 months explained 18.2% of the variance in receptive language measured at 24 months. Analyses were repeated for expressive language with emotion and eye gaze, communication, gestures, and object use clusters measured at 12 months, explaining 16.2% of the variance in expressive language measured at 24 months.

I hypothesized that the risk for ASD moderates the relationship between emotional expression and language development. I used multiple linear regression with moderation to examine the relationship between emotion and language by risk status. Risk status for ASD did not moderate the association between emotional expression and language; the interaction between risk for ASD and emotional expression was not associated with language development. The risk for ASD did not moderate the association between emotion standard scores at 12 months and developmental quotient scores for receptive ($F(3, 230) = 12.632$, $p < .000$; $\beta = .065$, $p < .802$) and expressive ($F(3, 230) = 10.587$, $p < .000$; $\beta = .094$, $p < .723$) language at 24 months. The risk for ASD did not moderate the association between communication standard scores at 12 months and developmental quotient scores for receptive ($F(3, 230) = 17.453$, $p < .000$; $\beta = .129$, $p < .517$) and expressive ($F(3, 230) = 20.067$, $p < .000$; $\beta = .004$, $p < .984$) language at 24 months. The risk for ASD did not moderate the association between gestures standard scores at 12 months and developmental quotient scores for receptive ($F(3, 230) = 17.726$, $p < .000$; $\beta = .263$, $p < .237$) and expressive ($F(3, 230) = 17.980$, $p < .000$; $\beta = .065$, $p < .769$) language at 24 months. The risk for ASD did not moderate the association between object use standard scores at 12 months and developmental quotient scores for receptive ($F(3, 230) = 14.062$, $p < .000$; $\beta = .108$, $p < .650$) and expressive ($F(3, 230) = 11.079$, $p < .000$; $\beta = .032$, $p < .895$) language at 24 months. See Table 5 for the coefficients of the multiple regression. See Table 6 for the R^2 and $R^2\Delta$ values of the multiple regression.

Exploratory Analyses:

The original study examined not only the risk status for ASD but also ADOS classification. To further elucidate the non-significant results of our moderation analysis, I examined whether the manifestation of symptoms (prompting 'Autism' or 'Autism-spectrum' diagnoses) moderated the relationship between emotional expression and language development. ADOS classification moderated the association between emotional expression and language; the interaction between ADOS classification and emotional expression was associated with language development. ADOS classification was measured across groups with two orthogonal contrasts: Contrast 1 (Non-spectrum vs. ASD and Autism) and Contrast 2 (ASD vs. Autism). ADOS classification moderated the association between emotion standard scores at 12 months and developmental quotient scores for receptive ($F(5, 157) = 21.102$, $p < .000$; Emotion and Contrast 1: $\beta = -.836$, $p < .005$; Emotion and Contrast 2: $\beta = -1.031$, $p < .001$) and expressive ($F(5, 157) = 8.441$, $p < .000$; Emotion and Contrast 1: $\beta = -.172$, $p < .608$; Emotion and Contrast 2: $\beta = -.640$, $p < .056$) language at 24 months. ADOS classification moderated the association between communication standard scores at 12 months and developmental quotient scores for receptive ($F(5, 157) = 19.830$, $p < .000$; Communication and Contrast 1: $\beta = -.645$, $p < .011$; Communication and Contrast 2: $\beta = -.218$, $p < .313$) and expressive ($F(5, 157) = 11.425$, $p < .000$; Communication and Contrast 1: $\beta = -.217$, $p < .432$; Communication and Contrast 2: $\beta = .207$, $p < .381$) language at 24 months. ADOS classification moderated the association between gestures standard scores at 12 months and developmental quotient scores for receptive ($F(5, 157) = 19.768$, $p < .000$; Gestures and Contrast 1: $\beta = -.457$, $p < .095$; Gestures and Contrast 2: $\beta = -.375$, $p < .127$) and expressive ($F(5, 157) = 9.842$, $p < .000$; Gestures and Contrast 1: $\beta = -.370$, $p < .225$; Gestures and Contrast 2: $\beta = .139$, $p < .611$) language at 24 months. ADOS classification moderated the association between object use standard scores at 12 months and developmental quotient scores for receptive ($F(5, 157) = 17.063$, $p < .000$; Object Use and Contrast 1: $\beta = .212$, $p < .407$; Object Use and Contrast 2: $\beta = -.534$, $p < .021$) and expressive ($F(5, 157) = 7.026$, $p < .000$; Object Use and Contrast 1: $\beta = .019$, $p < .946$; Object Use and Contrast 2: $\beta = -.197$, $p < .445$) language at 24 months. See Table 7 for the R^2 and $R^2\Delta$ values of the multiple regression. See Graphs 1-8 for a visual representation of the association between emotion and language for each ADOS classification.

Discussion

A primary goal of the present study was to establish a contextual framework highlighting the relation between emotional and linguistic expression with the potential to help children with ASD attain a more typical social development. Children with ASD may present with social communication challenges and have difficulty understanding conventional social norms, making it difficult to bond with others (like friends and family) (LaGasse et al., 2017). Socialization is vital to our human essence and development, helping us combat feelings of isolation, enhance our cognitive abilities, and enrich our sense of happiness and well-being (Williams, 2019). We conducted this study to determine the association between emotional regulation and language development in children with ASD—to expand our knowledge of the social domain and help these individuals improve their social competence. This insight may also provide developmental context to help clinicians generate more effective interventions for children with ASD. There are several key findings of the present research. First, children at EL of risk for ASD (children with an older biological sibling with an ASD diagnosis) exhibit a more limited range and appropriateness of emotional expression than children at LL of risk for ASD (children with no first or second-degree relatives with ASD diagnosis) at 12 and 24 months. These results are in accordance with our hypothesis. I predicted this outcome with the knowledge that behavioral symptoms of ASD appear early in development, usually between 12 to 18 months or earlier (U.S. Department of Health and Human Services, 2017), and that children at EL for ASD have a recurrence risk between 10-20% compared to the general population (Szatmari et al., 2016). Second, we obtained evidence that children at EL for ASD present with lower receptive and expressive language at 24 months. As previously stated, most symptoms of ASD become apparent between 12-18 months (U.S. Department of Health and Human Services, 2017), so we presumed that just like our first hypothesis, the risk for ASD would be associated with language abilities. Third, the range and appropriateness of emotional expression measured at 12 months significantly positively correlate with receptive and expressive language at 24 months; individuals whose emotional expression behaviors were more limited had less proficient language abilities, while individuals with emotional expression comparable to or exceeding normative development had more competent language skills. Based on evidence that there is a relationship between emotional and cognitive processing and that emotional regulation may have perpetuated the use of linguistic signs (Tyng et al., 2017; Jablonka et al., 2012), I hypothesized that emotional expression and language skills would be positively correlated, and the hypothesis was supported. Two other results from this study merit comment. The results of the multiple linear regression with moderation by risk status for ASD indicate that risk does not have a moderating effect on the relationship between emotional expression and language development. Though these findings are inconsistent with our proposed hypotheses, I am confident the lack of significance can be attributed to the fact that risk status in the original study was calculated based on the participant's genetic risk for ASD. Though a family history of ASD makes individuals more susceptible to developing ASD, the likelihood of recurrence in a younger male sibling with an older diagnosed female sibling was 16.7%, 12.9% in a younger male with an older diagnosed male sibling, 7.6% in a younger female sibling with an older diagnosed female sibling, and 4.2% in younger female siblings with an older diagnosed male sibling (Palmer et al., 2017). From these study results, we may infer that the likelihood of ASD recurrence among siblings of children diagnosed with ASD is not exceptionally high. It seems plausible that the interaction of risk status and emotional expression on language development did not produce significant outcomes because the risk for ASD does not signify that an individual will develop the disorder (and hence, acquire the symptoms). Next, the outcome of the multiple regression with moderation by ADOS classification reveals significance for all emotion clusters for receptive language. I have interpreted these findings to mean that the range and appropriateness of emotional expression in children with ASD is associated with their receptive language abilities. In other words, children diagnosed with ASD with a more limited repertoire of emotion regulation behaviors will have a less proficient understanding of language, and individuals with emotional expression similar to or exceeding typical development will demonstrate more competent language abilities.

The results of this study should be interpreted with numerous caveats in mind. The racial diversity of the sample may limit the generalizability of the findings. Racial demographics help us determine if our participants are a good representation of the racial makeup of society; these data were not consistently available in the present study. Comparing the U.S. Census from 2010 to 2020, it’s evident that the racial makeup of American society is changing, with the White population decreasing and the number of people of color increasing (United States Census Bureau, 2021). Considering that our participants were recruited in 2012 and 2017, it is possible that the racial demographics of our participants may not reflect those of the general population in the next years and decades. It is critical to study a diverse sample of participants so that researchers can make their work applicable to all and everyone is well-represented, but the participants may not be a good measure of the population moving forward due to the ever-changing racial composition of the United States. Another possible limitation is that this study was conducted before the COVID-19 pandemic. With masking policies and social distancing regulations constantly changing, our results may not apply to children tested today. These restrictions may pose challenges for children, who look to others for emotional cues to interpret their surroundings and regulate a response, a process called social referencing (Katz & Hadani, 2020). Moreover, the Columbia University Global Mental Health Programs (2020) contend that masks remove key information about facial features that make it especially challenging for children to read emotional signals, which can be unsettling, especially for children with ASD who have particular difficulty reading non-verbal cues.

Despite these limitations, the results suggest several theoretical and practical implications. The experiment provides new insight into the relationship between emotional expression and language development. Consistent with our hypotheses, children at EL risk for ASD are associated with emotional expression and language development at 12 and 24 months, respectively. The U.S. Department of Health and Human Services (2017) stresses that early detection and intervention of ASD greatly enhances developmental outcomes, but most children do not receive a diagnosis until after age three. The results provide evidence that earlier diagnosis may be possible, as impairments in emotional and linguistic expression (two symptoms of ASD) were identified at time points before the age of three. Thus, I have concluded that administering diagnostic tests as early as 12 months may provide children with ASD the best opportunity to succeed developmentally. Further, congruent with the proposed third hypothesis, there was a significant positive correlation between emotional expression and receptive and expressive language at 24 months. This illuminates a connection between emotional expression and linguistic development, contributing to a clearer understanding of their relationship. Though I cannot infer causation, Tyng et al. (2017) highlights the association between emotion and cognitive processes, and Jablonka et al. (2012) expand on this argument, positing a bidirectional relationship between emotional processes and language. The significant values from this correlation provide further evidence for this relationship. Contrary to the last set of findings, the moderating effect of ASD risk status on the relationship between emotional expression and language development has no significant outcomes. I have postulated that these non-significant outcomes are attributable to risk being an ineffective measure predicting the development of ASD and that study participants who presented with EL risk for ASD may be unaffected. However, suppose risk is an accurate measure of developing ASD. In that case, clinicians should consider if regulating this relationship would be meaningful or a complete waste of resources and time individuals with ASD could have spent receiving alternative forms of therapy. Lastly, the interaction of ADOS classification with emotional regulation on language abilities yields a significant result, suggesting that risk can be an erroneous measure of developing ASD and that efforts should focus on early identification and diagnosis of ASD. Overall, our research hypotheses are well-supported. The results of this study further the application of the existing social-developmental frameworks to individuals with ASD. This information could also benefit clinicians studying and devising new interventions targeting social challenges in individuals with ASD. Perhaps targeted interventions could help the autism community develop newfound social confidence and, accordingly, connect better with family and friends and boost mental and physical well-being.

Conclusion

While poor emotional regulation and language abilities are well-recognized symptoms of ASD, researchers have failed to effectively examine this relationship for any social-developmental context it may provide. This study established that the risk for ASD is associated with emotional expression and language development independently, there is a positive association between the range and appropriateness of emotional expression and receptive and expressive language abilities, the interaction between emotional expression and risk had a no significant effects on receptive language, and the interaction between ADOS classification and emotional expression had a significant effect on receptive and expressive language. Much work remains to be done before a full understanding of the extent of emotional regulation on language development can be established. Avenues for future research should include studying the effects of emotional regulation on both verbal and nonverbal communication, researching the effects of emotional expression on other cognitive processes, and examining the effects of emotional regulation on linguistic development with a subset of neurotypical children born after the onset of COVID-19. Although I was able to evaluate components of verbal communication (receptive and expressive language), I did not investigate how emotional expression may impact non-verbal language, which is often more powerful than verbal messaging (Bambaeeroo & Shokrpour, 2017). Studying the effects of emotional expression on language development was meaningful because these are two challenging areas for people with ASD. Nevertheless, Tyng et al. (2017) have described how emotional regulation is associated with cognitive processes, including many other cognitive processes besides language (e.g., perception, reasoning, attention). In future research, exploring how emotional expression impacts attention might be useful because attention-deficit/hyperactivity disorder (ADHD) is a common comorbidity in individuals with

Autism (van Steensel, Bögels, & de Bruin, 2013, as cited in Ridderinkhof et al., 2020); specifically, children with ASD may exhibit “impaired disengagement and orienting of attention, overly focused and narrow attention, and a decreased ability to filter distractors” (Allen & Courchesne, 2001; Keehn et al., 2016; Landry & Parker, 2013, as cited in Ridderinkhof et al., 2020). Finally, as discussed in our limitations section, children born during the pandemic may not display typical emotional and linguistic development. Mask and social distancing regulations can make it difficult for children to social reference (Katz & Hadani, 2020), which can be especially disconcerting for children who do not interpret non-verbal messaging as easily as neurotypical peers (Columbia University Global Mental Health Programs, 2020). These studies suggest that COVID-19 policies might interfere with emotional regulation and linguistic development, which furthers the necessity for research that analyzes how the pandemic has impacted the developmental trajectories of children with ASD.

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Appendices

Table 1

Study Demographics at 12 and 24 Month Evaluations

		12 Month Eval.		24 Month Eval.	
		N	Percent	*N*	Percent
Valid		345	100%	174	50.4%
Missing		0	0.0%	171	49.6%
Total		345	100%	345	100.0%
Race	Unreported	6	1.7%	2	1.1%
	Native American/Alaskan Native	1	.3%	1	.6%
	Asian	10	2.9%	5	2.8%
	Black or African American	45	13.0%	18	10.3%
	Hawaiian or Pacific Islander	1	.3%	0	0.0%
	Multiracial	28	8.1%	12	6.9%
	White	253	73.3%	135	77.6%
	Other	0	0.0%	1	.6%
Gender	Female	139	40.3%	60	34.5%
	Male	206	59.7%	114	65.5%
Risk	EL Risk	159	46.1%	76	43.7%
	LL Risk	186	53.9%	98	56.3%
ADOS Classification	Not Conducted	162	47%	38	21.8%
	Autism	32	9.3%	22	12.6%
	Autism-spectrum	25	7.2%	19	10.9%
	Non-spectrum	126	36.5%	95	56.3%

Table 2

Emotion Clusters v. Risk Status for ASD at 12 Months

	EL		*LL*					
	M	*SD*	*M*	*SD*	*df*	*t*	*p*	Cohen's *d*
Emotion Cluster Standard Score	10.32	2.430	11.43	2.565	342.188	4.147	.000	.445
Communication Cluster Standard Score	7.16	2.252	8.48	2.670	344.777	5.008	.000	.533
Gestures Cluster Standard Score	7.29	2.094	8.17	2.092	337.846	3.883	.000	.418
Object Use Cluster Standard Score	7.52	2.031	8.34	2.276	344.665	3.556	.000	.380

Table 3

Receptive and Expressive Language v. Risk Status for ASD at 24 Months

	EL		*LL*					
	M	*SD*	*M*	*SD*	*df*	*t*	*p*	Cohen's *d*
RL DevQ	-.0155	.06525	.0237	.05171	207.269	5.056	.000	.671
EL DevQ	-.0270	.06220	.0172	.06374	229.883	5.360	.000	.701

Table 4

Correlation of Emotion Clusters and Receptive and Expressive Language

		RL DevQ	EL DevQ
Emotion Cluster	Pearson Correlation	.262**	.173**
Communication Cluster	Pearson Correlation	.357**	.385**
Gesture Cluster	Pearson Correlation	.343**	.344**
Object Use Cluster	Pearson Correlation	.273**	.174**

Note. Pearson Product-Moment Correlation ($N = 234$)

**. Correlation is significant at the 0.01 level.

Table 5

Coefficients of the Multiple Regression with Moderation by Risk Status for ASD

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
Emotion Cluster * Risk	RL DevQ	.001	.003	.065	.251	.802	-.005	.006
	EL DevQ	.001	.003	.094	.355	.723	-.005	.007
Communication Cluster * Risk	RL DevQ	.002	.003	.129	.650	.517	-.004	.008
	EL DevQ	6.664E-5	.003	.004	.020	.984	-.006	.007
Gestures Cluster * Risk	RL DevQ	.004	.003	.263	1.185	.237	-.003	.011
	EL DevQ	.001	.004	.065	.294	.769	-.006	.008
Object Use Cluster * Risk	RL DevQ	.002	.004	.108	.455	.650	-.005	.009
	EL DevQ	.001	.004	.032	.132	.895	-.007	.008

Table 6

R^2 and $R^2\Delta$ Values of the Multiple Regression with Moderation by Risk Status for ASD

		R^2	$R^2\Delta$
Emotion Cluster * Risk	RL DevQ	.141	.000
	EL DevQ	.121	.000
Communication Cluster * Risk	RL DevQ	.185	.001
	EL DevQ	.207	.000
Gestures Cluster * Risk	RL DevQ	.188	.005
	EL DevQ	.190	.000
Object Use Cluster * Risk	RL DevQ	.155	.001
	EL DevQ	.126	.000

Note. R^2 values for total regression model. $R^2\Delta$ represents contribution of interactions with contrasts.

Table 7

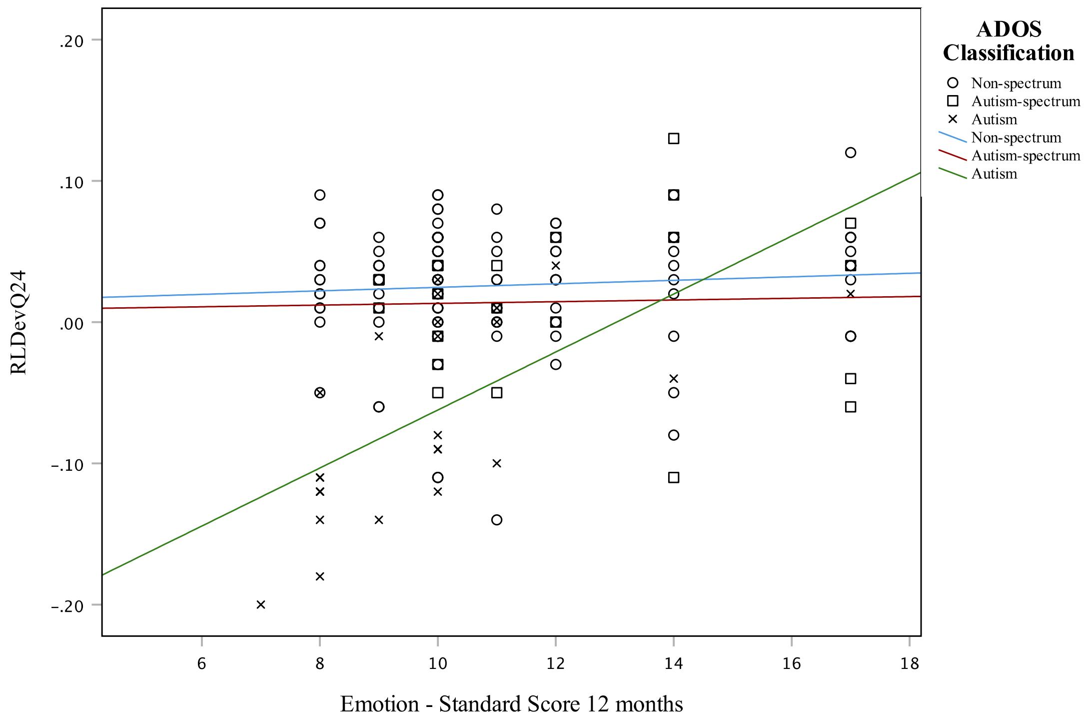
R^2 and $R^2\Delta$ Values of the Multiple Regression with Moderation by ADOS Classification

		R^2	$R^2\Delta$
Emotion Cluster * ADOS Classification	RL DevQ	.402	.068
	EL DevQ	.212	.019
Communication Cluster * ADOS Classification	RL DevQ	.387	.029
	EL DevQ	.267	.007
Gestures Cluster * ADOS Classification	RL DevQ	.386	.027
	EL DevQ	.239	.007
Object Use Cluster * ADOS Classification	RL DevQ	.352	.024
	EL DevQ	.183	.003

Note. R^2 values for total regression model. $R^2\Delta$ represents contribution of interactions with contrasts.

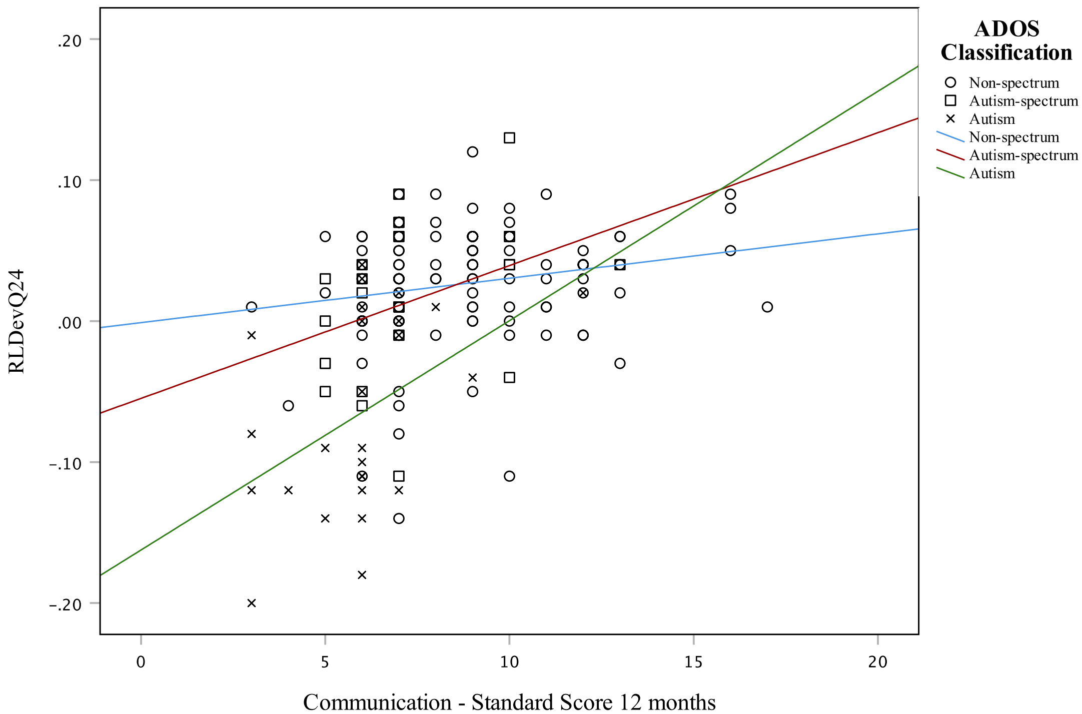
Graph 1

Multiple Regression with Moderation by ADOS Classification



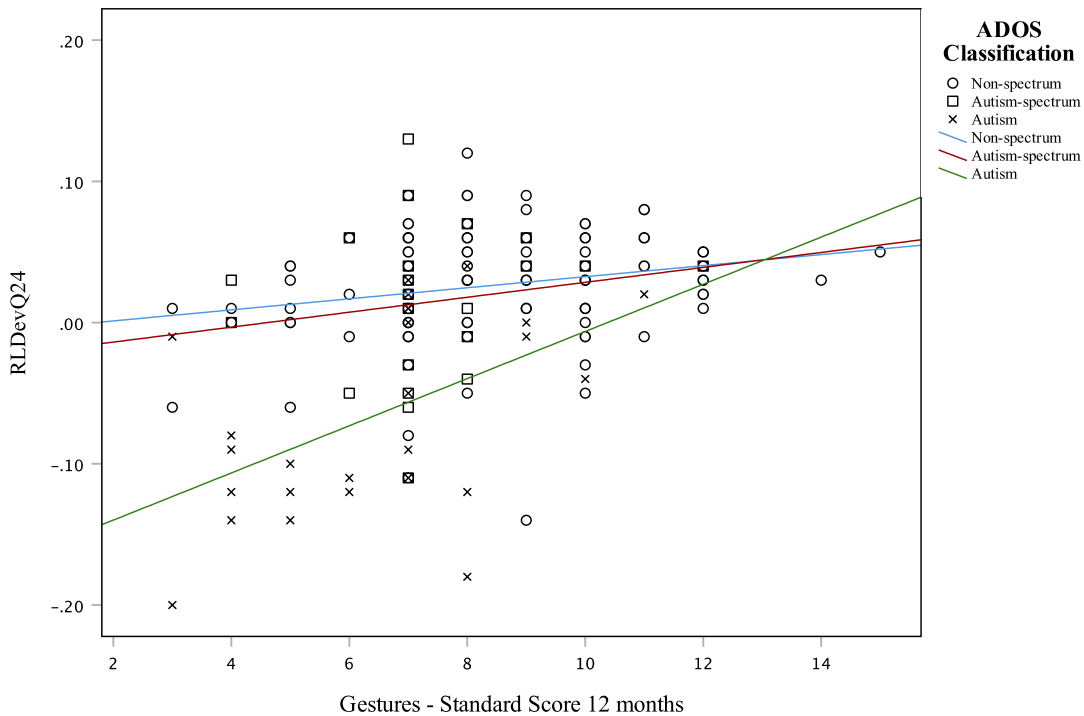
Graph 2

Multiple Regression with Moderation by ADOS Classification



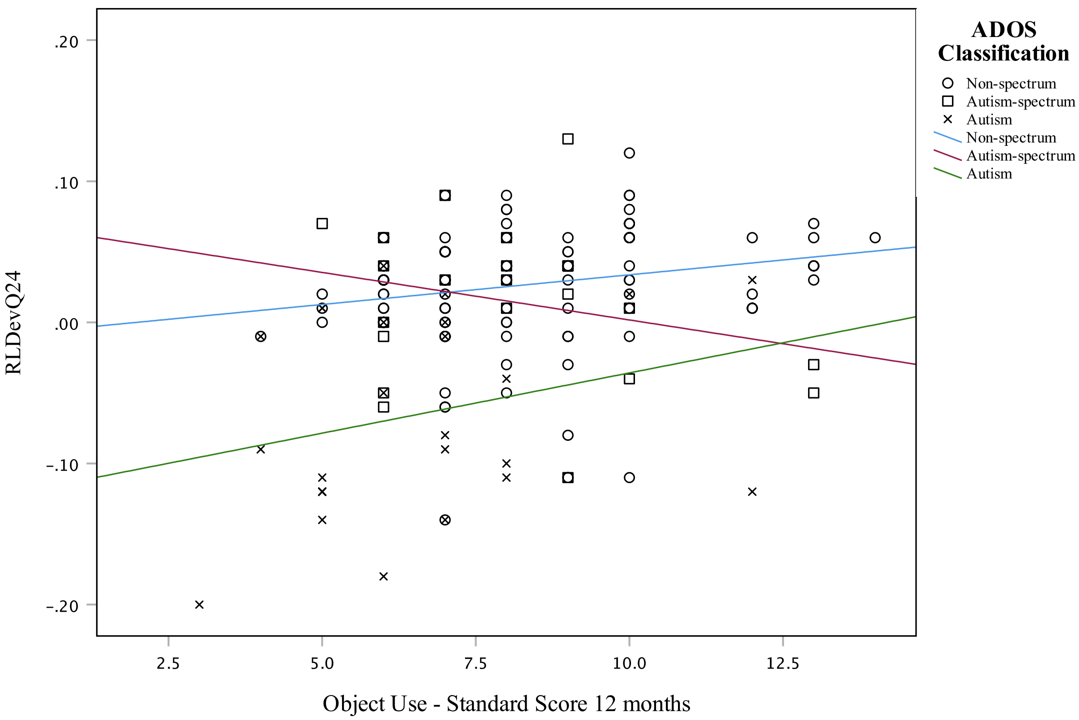
Graph 3

Multiple Regression with Moderation by ADOS Classification



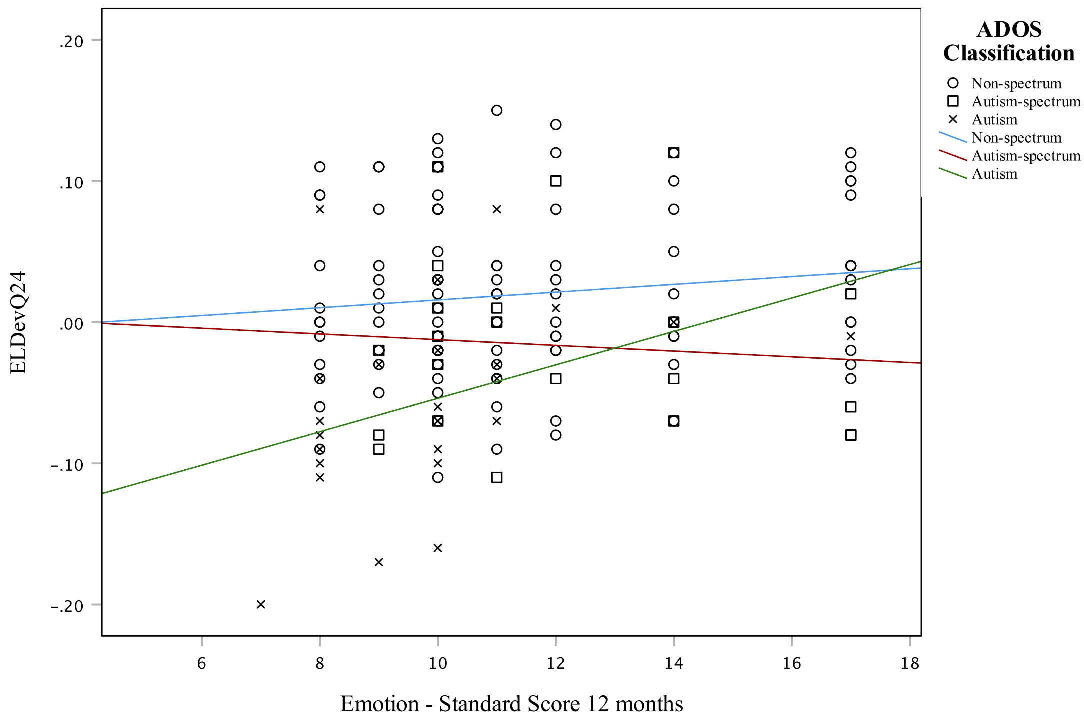
Graph 4

Multiple Regression with Moderation by ADOS Classification



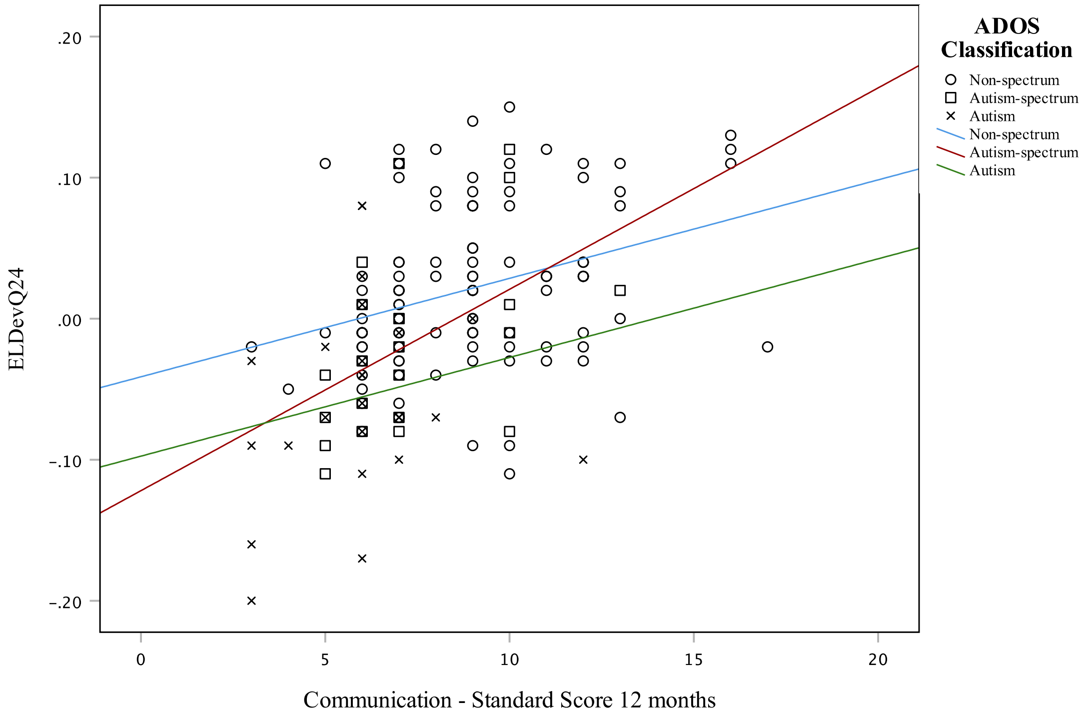
Graph 5

Multiple Regression with Moderation by ADOS Classification



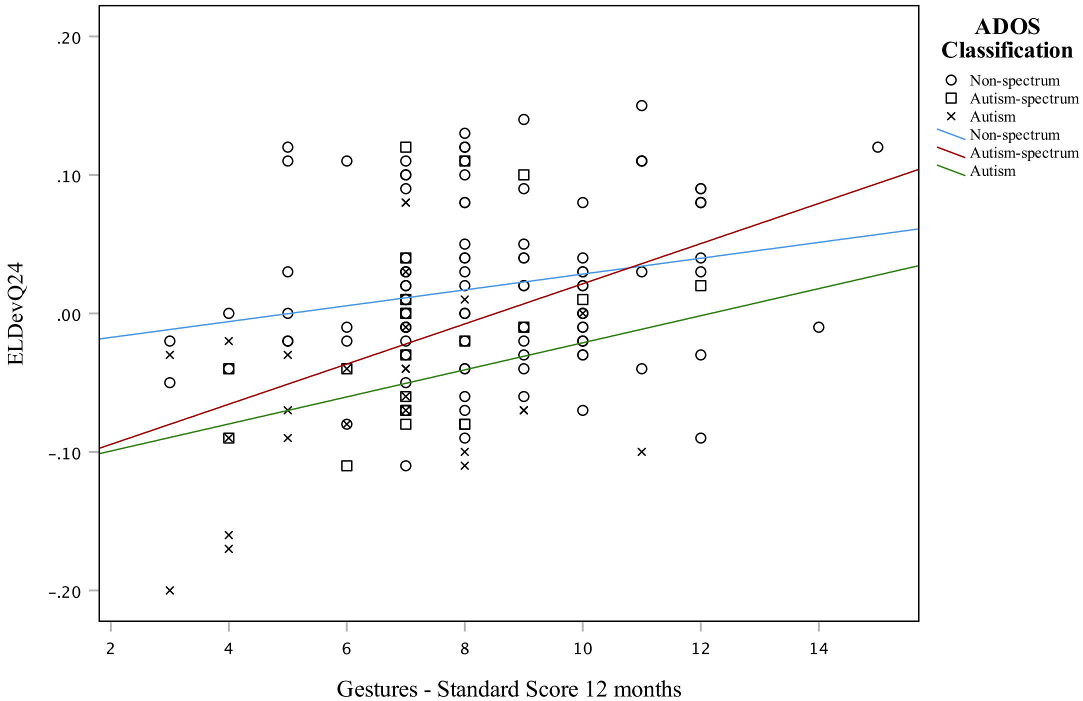
Graph 6

Multiple Regression with Moderation by ADOS Classification



Graph 7

Multiple Regression with Moderation by ADOS Classification



Graph 8

Multiple Regression with Moderation by ADOS Classification