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Child and family characteristics associated with verbal communication difficulties in adolescents with autism and other developmental disabilities

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Abstract

Background: Verbal communication difficulties are associated with a range of adolescent and adult outcomes in individuals with autism spectrum disorder (ASD). Yet there is limited information about contextual factors associated with verbal communication difficulties beyond early childhood, and how youth with ASD compare to youth with other developmental disabilities (DD).

Aims: The current study examined verbal communication difficulties among adolescents with ASD and other DD, and child and family characteristics associated with these difficulties in later in life.

Methods and procedures: Children were classified as ASD or other DD between 2 and 5 years old. Caregivers of these same children reported verbal communication difficulties between 12 and 16 years old. Chi square tests examined group differences in adolescent verbal communication difficulties; Poisson regression examined child and family characteristics associated with adolescent verbal communication difficulties.

Outcomes and results: Adolescents with ASD had significantly more verbal communication difficulties (47.4 %) than adolescents with other DD (14.6 %). Factors that predicted verbal

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ridd.2024.104879.

communication difficulties in adolescents with ASD and other DD were expressive language abilities and internalizing symptoms in early childhood, having a mother of non-Hispanic Black compared to White race, and having a mother with some college compared to an advanced degree.

Conclusions and implications: Almost half of adolescents with ASD had verbal communication difficulties, which was significantly higher than those with other DD. Early childhood and socio-demographic factors like race, education, and insurance were associated with verbal language outcomes. These factors may be useful in identifying and supporting those most likely to benefit from targeted communication services.

What this paper adds?: Verbal communication difficulties are common among adolescents with autism. Early childhood and socio-demographic characteristics like race and education are associated with these difficulties. These findings could help better identify and support adolescents with communication difficulties.

Keywords

Autism; Communication; Language; Adolescence; Verbal

1. Introduction

Autism spectrum disorder (ASD) is primarily characterized by difficulties with social communication and interaction, and patterns of restricted and repetitive behaviors or interests. Delayed or impaired expressive language is another common feature of ASD and one of the most frequent concerns expressed by parents of children with ASD prior to receiving a formal diagnosis (DesChamps et al., 2020; Franchini et al., 2018; Richards et al., 2016). Although much prior work has focused on verbal language acquisition in young children with ASD, less is known about the verbal language abilities of adolescents with ASD. Addressing this gap is particularly important considering early expressive language abilities are associated with a range of subsequent outcomes in adolescents and adults with ASD, including behavior, education, employment, independent living, and social relationships (Magiati et al., 2014). Thus, the current study sought to understand early child and family characteristics associated with verbal communication difficulties later in life.

1.1. Predictors of verbal language outcomes in ASD

Previous investigations have identified several early childhood characteristics associated with verbal language acquisition in children with ASD. However, cognitive ability, baseline language skills, and ASD symptomatology are arguably the most common (Anderson et al., 2014; Bal et al., 2020; Brignell et al., 2018; Ellis Weismer & Kover, 2015; Lombardo et al., 2015; Smith et al., 2015; Thurm et al., 2015; Wodka et al., 2013; Yoder et al., 2015). In contrast, few studies have investigated the contribution of contextual factors (e.g., family socio-demographics) on later language development in adolescents and adults with ASD (Girolamo et al., 2023). In one study, Maltman et al. (2021) found that parental education, parental race/ethnicity, and family income differentiated children with ASD who eventually acquired verbal fluency in adolescence or adulthood from those who remained minimally verbal. Yet, there are no identified studies that examine these and other contextual factors

on verbal communication development in adolescence, or compare whether adolescents with ASD have more verbal communication difficulties than adolescents with other DD.

1.2. Purpose of current study

The primary objectives of the current study were to fill gaps in the research literature by a) describing verbal communication difficulties among adolescents with ASD and other non-ASD developmental disabilities (DD) and b) identify child and family socio-demographic characteristics that predict verbal communication difficulties in adolescence. Following this, a secondary objective was to examine child and family characteristics that account for differences in verbal communication outcomes among a subset of adolescents with a language delay of 12 months or more in early childhood

2. Methods

2.1. Sample and procedures

This analysis included 508 caregivers (i.e., parent or grandparent) of adolescents, age 12–16 years, who originally participated in the Study to Explore Early Development (SEED) when they were 2–5 years old. For the current study, caregivers of these adolescents completed a longitudinal follow-up survey to gather information on the health and development of SEED children in adolescence (i.e., SEED Teen). To participate in SEED Teen, caregivers had to meet the following eligibility criteria: a) caregiver consented to future follow-up during original SEED, and b) their child received a final classification of ASD, other DD, or population comparison during their original participation in SEED.¹ For the purposes of the current analysis, only caregivers of children who received a final classification of ASD or other DD were included. Children classified as ASD were those who completed a comprehensive developmental evaluation and met diagnostic cutoff scores for ASD on the Autism Diagnostic Observation Schedule (ADOS) and Autism Diagnostic Interview Revised (ADI-R) or met ASD criteria on the ADOS and one of the following three criteria on the Autism Diagnostic Interview Revised (ADI-R): 1) met the social domain cutoff and was within two points of the communication domain cutoff, 2) met the communication domain cutoff and was within two points of the social domain cutoff, or 3) met the social domain cutoff and had at least two points on the behavioral domain.² Children assigned to the DD group were those identified from education or clinic sources that served children with developmental disabilities and completed a limited developmental evaluation because ASD risk was not indicated on the Social Communication Questionnaire (i.e., SCQ score < 11), or completed the comprehensive developmental evaluation but did not meet SEED study criteria for ASD on the ADOS or ADI-R. The most common parent-reported diagnoses for children in the DD group were speech-language delay (57.3 %), developmental delay

¹Children in SEED were classified as ASD, other DD, or no DD at the time of the study based on ascertainment source and results of an in-person developmental evaluation. Methodological details of how assignments to the ASD, other DD, and no DD study groups were made are described elsewhere (Schendel et al., 2012; Wiggins et al., 2015)

²At the time of the initial SEED study, the diagnostic algorithm used in the ADOS and ADI-R was based the Diagnostic and Statistical Manual of Mental Disorders – 4th edition (DSM-4) definition of ASD which included autistic disorder, Asperger disorder, childhood disintegrative disorder (CDD), Rett syndrome, and pervasive developmental disorder- not otherwise specified (PDD-NOS) American Psychiatric Association, (1994). *Diagnostic and statistical manual of mental disorders* (4 ed.). American Psychiatric Publishing, Inc., Association, A. P. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.) (4th ed.). American Psychiatric Association.

(34.8 %), sensory integration disorder (13.9 %), and motor delay (13.6 %). For a detailed description of the methods used to assign SEED children to the ASD or DD group see Wiggins et al., (2015a), (2015b).

Overall, 1119 caregivers of adolescents originally assigned to the ASD or DD group in SEED met eligibility criteria for the SEED Teen study. Of these, 96 % were invited to participate (n=1077), 62 % of those invited were enrolled (n=673), and 82 % of those enrolled completed a follow-up survey (n=554).³ Compared to the those who did not participate in SEED Teen, participants in the current sample included a higher proportion of non-Hispanic White mothers (71 % vs. 57 %, $p < 0.001$), a higher proportion of mothers with a college or advanced degree (70 % vs. 49 %, $p < 0.001$), and a higher proportion of families with household incomes more than 400 % above the federal poverty level (41 % vs. 33 %, $p < 0.001$).⁴ Additionally, average scores from the Mullen Scales of Early Learning (MSEL) indicated that the adolescents in the current sample had slightly higher expressive and receptive age-equivalent scores at 2–5 years old compared those who did not participate in SEED Teen (46.8 vs. 43.9 months, $p = 0.004$; 49.1 vs. 46.1 months, $p = 0.004$, respectively). Excluding those with missing socio-demographic (n=46) or phenotypic data (n=23) resulted in a final analytic sample of 485 participants (ASD: N=180, 37.1 %; DD: N=305, 62.9 %). Of these participants, 221 (ASD: N=127, 57.5 %; DD: N=94, 42.5 %) had an expressive language delay of 12 months or more in early childhood and were included in the supplementary analyses examining child and family factors that characterize those with persistent verbal communication difficulties in adolescence.

2.2. Measures

2.2.1. Early language abilities—The adolescents included in the current study were administered the Mullen Scales of Early Learning (MSEL; Mullen, 1995) to assess early learning abilities during their original participation in SEED at age 2–5 years. The MSEL is validated for children from birth to 68 months of age. Research reliable clinicians administered scales for four developmental domains: Expressive Language, Receptive Language, Visual Reception, and Fine Motor (Schendel et al., 2012). Receptive and Expressive Language age equivalent scores (RLAE and ELAE, respectively) were expressed as the average age expected (in months) for an observed level of raw test performance (Mullen, 1995). Delays in expressive language were assessed by subtracting ELAE scores from chronological age at the time of the assessment (i.e., chronological age at assessment – ELAE score). Adolescents who exhibited an expressive language delay of 12 months or more in early childhood were included in the supplemental analyses.

2.2.2. Early ASD symptoms—During the original SEED study, caregivers completed the Social Communication Questionnaire (SCQ; Rutter et al., 2003), a 40-item caregiver-reported questionnaire used as a screening instrument for ASD risk. For the current study, total scores from the SCQ were used to assess the association between ASD symptom

³Comparisons between the ASD and DD group indicated no significant differences in the percentage who enrolled (59 % vs. 65 %, $p = 0.81$) or the percentage who completed the SEED Teen data collection protocol (81 % vs. 83 %, $p = 0.52$).

⁴The demographic data used for these comparisons were collected during the original SEED study.

severity and verbal communication outcomes in adolescents with ASD and DD. Higher SCQ scores indicate greater ASD symptom severity.

2.2.3. Early emotional & behavioral functioning—The Child Behavior Checklist (CBCL) is a standardized caregiver-report questionnaire designed to assess emotional and behavioral functioning (Achenbach & Edelbrock, 1991; Achenbach, 1992). Caregivers completed the CBCL during their child’s original participation in SEED. The CBCL includes both an externalizing and internalizing subscale. The externalizing subscale includes items related to aggressive and oppositional behaviors, while the internalizing subscale includes items related to anxiety, depression, emotional reactivity, social withdrawal, and somatic complaints. For both scales, higher scores indicate greater problems, with a normalized T-score ≥ 65 recommended as a clinically meaningful threshold (Achenbach, 2001).

2.2.4. Adolescent health and development survey—Caregivers enrolled in the follow-up study were asked to complete a 117-item survey with questions related to their adolescent’s current health, mental health, service needs and utilization, functioning, and social activities and relationships. These survey topics were chosen by review of the literature and input from ASD advocates. Nearly all questions (97 %) included in this survey were selected from existing national surveys or surveillance systems, like the National Health Interview Survey (CDC-National Center for Health Statistics, 2021), National Survey of Children’s Health (NSCH, 2021) and National Longitudinal Transition Study-2 (NLTS2; National Center for Special Education Research, n.d.). Questions were chosen from existing surveys and systems because these questions have been extensively tested in pilot and field studies and were developed by experts who had experience with the topics under investigation.

Verbal Outcome.: For the current analysis, our primary outcome focused on one question regarding the child’s current level of verbal communication that was adapted from the National Longitudinal Transition Study-2 (NLTS2) parent interview(NCSER, n.d)⁵ and has been examined in previous reports (Anderson et al., 2014). Specifically, parents were asked, “Does this child use verbal communication, such as words or noises, to communicate with people?” and provided with the following response options: a) “Verbally communicates using words easily”, b) “Verbally communicates using words with a little trouble”, c) “Verbally communicates using words with a lot of trouble”, d) “Verbally communicates with noises”, e) “Does not verbally communicate”. Preliminary analyses showed that a relatively small percentage of caregivers reported that their child verbally communicated with some difficulty (e.g., child verbally communicated with a little trouble, a lot of trouble, with noises, or not at all). Therefore, these responses were collapsed into a single category of “Verbally communicates with difficulty” and a two-level categorical variable was created (i.e., Verbally communicates easily vs. Verbally communicates with difficulty) and used as the primary dependent variable in the regression analyses.

⁵NLTS2 instruments are available at www.nlts2.org

As a sensitivity analysis, we examined caregiver-reported diagnosis of current speech-language disorder (SLD) or current use of speech or language therapy (SLT) as other potential indicators of verbal communication difficulties in adolescence. A current diagnosis of SLD was assessed by asking caregivers, “*Has a doctor or other healthcare provider ever told you that this child has speech-language disorder?*”. If the caregiver answered yes, they were asked “*Does this child currently have speech-language disorder?*” This question aligns with the National Survey of Children’s Health (NCSH, 2021). Current use of SLT was assessed by asking caregivers “*Has this child ever received speech or language therapy, or communication services?*”. If the caregiver answered yes, they were asked, “*Has this child received the services or support during the past 12 months?*”. This question aligns was adapted from the NLTS-2 parent interview. A response of yes to either question was used to identify adolescents who either had a current SLD diagnosis or received SLT in the past 12 months.

2.3. Analyses

Descriptive statistics (number and percentage) were calculated for socio-demographic characteristics and adolescent verbal communication outcomes. Chi-square tests of independence were used to compare the distributions by study group. Measures of central tendency (mean and standard deviation) were calculated for early childhood characteristics and Student’s T-tests were used to compare characteristic means by study group.

Following these between-group comparisons, separate regression analyses were conducted on the total sample and within each study group (ASD vs.DD). The first regression model examined the association between early phenotypic characteristics and verbal communication difficulties in adolescence. For this model, MSEL expressive language age-equivalent scores (ELAE), MSEL receptive language age-equivalent scores (RLAE), CBCL internalizing standard scores (t-scores), CBCL externalizing standard scores (t-scores), and SCQ total scores were included as the primary phenotypic predictors. Following this, a second regression model examined the unique contribution of socio-demographic characteristics on adolescent verbal communication difficulties after adjusting for the phenotypic variables included in the first model. For this model, ELAE, RLAE, CBCL internalizing, CBCL externalizing, and SCQ scores were included as covariates, and maternal age at follow-up, maternal race/ethnicity, maternal education level, maternal primary language, adolescent sex, household income as a percentage of the federal poverty level (FPL), and insurance type were included as the primary socio-demographic predictors.

For all models, a modified Poisson regression with robust error variance was used to estimate prevalence ratios and 95 % confidence intervals for each predictor (Zou, 2004). Each model satisfied the assumptions of Poisson regression (e.g., primary verbal outcome treated as count data and followed a Poisson distribution, observations were independent, variance equaled the mean,⁶ and linearity). To assess for potential multicollinearity, a Variance Inflation Factor (VIF) was calculated for each predictor in the regression models. All analyses were completed in SAS Version 8.3.

⁶Robust standard errors for the parameter estimates were used to control for mild violation of the distribution assumption that the variance equals the mean.

3. Results

Approximately 98 % of caregivers who completed the follow-up survey were mothers, therefore the term ‘mother’ is used hereafter and should be considered synonymous with ‘caregiver’. Socio-demographic characteristics of the sample are shown in Table 1 and early childhood characteristics and adolescent verbal communication outcomes are shown in Table 2. Adolescents in the ASD group, compared to adolescents in the DD group, were more likely to have some degree of difficulty with verbal communication (i.e., verbally communicated with a little trouble, a lot of trouble, or with noises/not at all) (47.4 % vs. 14.6 %, respectively) and a current diagnosis of SLD (43.8 % vs. 22.5 %; Table 2).

3.1. Early childhood characteristics

Inspection of the VIF values indicated expressive (MSEL ELAE) and receptive language (MSEL RLAE) exceeded the threshold of 10 and were highly correlated ($r = 0.93$, $p < 0.0001$). Given the evident multicollinearity between these two predictors and results that indicated receptive language was not a significant predictor of verbal communication difficulties in neither the first or second regression model (aPR = 1.00, 95 % CI = 0.98 – 1.02, $p = 0.79$ and aPR = 1.00, 95 % CI = 0.98 – 1.02, $p = 0.75$, respectively), receptive language was removed from both regression models and adjusted prevalence ratios and 95 % confidence intervals were re-estimated. After removal of receptive language scores from the regression models, the VIF values of each predictor were well below the recommended threshold of 10 (all VIF's < 1.9). Results from the two regression models after excluding receptive language are described below.

Results of the first Poisson regression model (Table 3) found that lower early childhood MSEL expressive language age equivalent (ELAE) scores were associated with a higher likelihood of adolescent verbal communication difficulties in the combined sample (aPR=0.96, 95 % CI = 0.95 – 0.97) and within the ASD and DD samples (aPR = 0.96, 95 % CI = 0.95 – 0.97 and aPR = 0.95, 95 % CI = 0.93 – 0.96, respectively). In contrast, early internalizing symptoms (CBCL internalizing T-scores), were marginally associated with an increased likelihood of reporting verbal communication difficulties in the combined sample and ASD sample (aPR = 1.02, 95 % CI = 1.00 – 1.04 and aPR = 1.02, 95 % CI = 1.00 – 1.05, respectively), however this association was not statistically significant in the DD sample. The remaining early childhood variables included in the model (i.e., CBCL externalizing scores, and total SCQ scores) were not significant predictors of verbal communication difficulties in the combined sample or the ASD and DD samples.

3.2. Family socio-demographic characteristics

Results of the second Poisson regression model indicated that early expressive language and internalizing symptoms were significantly associated with adolescent verbal communication difficulties after adjusting for socio-demographic predictors in the combined sample and in the ASD sample (Table 4). Significant associations with early externalizing symptoms were also observed within each study group, but these associations differed in nature. Within the ASD sample, higher internalizing symptoms decreased the likelihood of reporting verbal communication difficulties (aPR = 0.98, 95 % CI = 0.96 – 1.00), while in the DD sample,

higher externalizing symptoms increased the likelihood of verbal communication difficulties (aPR = 1.04, 95 % CI = 1.01 – 1.07).

Several socio-demographic predictors were also associated with adolescent verbal communication difficulties. First, non-Hispanic Black mothers were more likely than non-Hispanic White mothers to report that their adolescent had verbal communication difficulties in the combined sample (aPR = 1.38, 95 % CI = 1.02 – 1.87), but not in the ASD or DD samples. Second, mothers with some college or a technical or vocational degree were more likely to report that their adolescent had verbal communication difficulties compared to mothers with an advanced degree in the combined sample (aPR=1.70, 95 % CI = 1.17 – 2.48) and in the ASD sample (aPR = 1.67, 95 % CI = 1.13 – 2.47), but not in the DD sample. A similar, but marginally significant, association in the combined sample and DD sample indicated mothers with a bachelor's degree were more likely to report verbal communication difficulties than mothers with advanced degrees (aPR = 1.36, 95 % CI = 0.96 – 1.93 and aPR = 1.83, 95 % CI = 0.90 – 3.72). Third, female adolescents in the DD sample were more likely to have verbal communication difficulties compared to male adolescents (aPR = 1.89, 95 % CI = 1.14 – 3.12), however this was not a significant association in the combined or ASD sample. Finally, there was a marginally significant association of health insurance in the combined sample indicating that adolescents covered under both public and private insurance were more likely to have verbal communication difficulties compared to adolescents with only private health insurance in the combined sample (aPR = 1.38, 95 % CI = 0.98 – 1.95).⁷ A similar association was observed in the ASD and DD samples, but these were not statistically significant.

3.3. Sensitivity analyses

Sensitivity analyses were conducted to assess the association of early child and family socio-demographic characteristics with other potential indicators of speech or language difficulties. Namely, whether the adolescent had a current diagnosis of SLD or received SLT in the past 12 months. For these analyses, the same two regression models described above were used, however the primary outcome was current SLD or SLT instead of reported verbal communication difficulties. Results from the first regression model are reported Table S2 and show that early expressive language was the only predictor significantly associated with a current SLD or SLT in the combined sample (aPR = 0.97, 95 % CI = 0.96 – 0.97) and in the ASD and DD samples (aPR = 0.98, 95 % CI = 0.97 – 0.99 and aPR = 0.95, 95 % CI = 0.94 – 0.96). Higher SCQ scores were also associated with verbal communication difficulties in the ASD sample (aPR = 1.03, 95 % CI = 1.01 – 1.05). These associations remained after adjusting for socio-demographic variables in the second regression model (Table S3).

Results from the second regression model showed that non-Hispanic Black mothers were more likely than non-Hispanic White mothers to report current SLD or SLT in the combined sample and in adolescents with ASD (Table S3, aPR = 1.30, 95 % CI = 1.03 – 1.64 and

⁷Given that the inclusion of adolescents with a current diagnosis of SLD in the DD group could potentially confound the observed associations, this same analysis was repeated after excluding adolescents in the DD group with a current diagnosis of SLD. Results from this analysis revealed the exact same pattern of results as reported above.

aPR = 1.48, 95 % CI = 1.14 – 1.93, respectively). Additionally, adolescents covered under both public and private insurance were more likely to have a current SLD diagnosis or receive SLT compared to those with only private health insurance in the combined sample and adolescents with ASD (aPR = 1.61, 95 % CI = 1.27 – 2.06 and aPR = 1.66, 95 % CI = 1.29 – 2.15, respectively). None of these associations were significant in the other DD group, and maternal education was not significantly associated with current SLD or SLT in the combined sample or either study group.

3.4. Verbal language delay in early childhood

Of the 508 adolescents from the current sample, 221 (43.5 %) exhibited a language delay of 12 months or more in early childhood with approximately 58 % (n=125) and 42 % (n=90) from the ASD and DD groups, respectively (Table S4). Within this subsample, 49.8 % (n=110) had no difficulty verbally communicating in adolescence (i.e., verbally communicates using words easily), and 50.2 % (n=111) had persistent difficulties in verbal communication in adolescence (i.e., verbally communicates with difficulty). However, the majority of those with persistent difficulties were reported to have only a little trouble with verbal communication (55 %, n=60).

Compared to those without verbal communication difficulties, those with persistent difficulties were more likely to be covered under public insurance (38.7 % vs. 30.9 %) or both public and private insurance (19.8 % vs. 10.0 %) and more likely to be from the ASD group relative to the DD group (68.5 % vs. 31.5 %, respectively). Adolescents with persistent difficulties in verbal communication were also characterized by greater delays in expressive and receptive language, greater internalizing and externalizing symptoms, and greater ASD symptom severity (SCQ scores) in early childhood (Table S4).

4. Discussion

Prior research on verbal language development in ASD has largely focused on verbal language acquisition that occurs up to age 5 years, but much less is known about verbal language outcomes beyond early childhood (Brignell et al., 2018). As such, the current study represents one of only a few longitudinal studies of ASD to examine the association of early childhood and family socio-demographic characteristics on verbal communication difficulties in adolescence. Overall, our findings showed that adolescents with ASD were significantly more likely than adolescents with other DD to have verbal communication difficulties, and that early expressive language was a robust predictor of adolescent communication difficulties in the combined sample and within the ASD and DD samples despite the communication outcome utilized (i.e., maternal report of verbal difficulties vs. current SLD/SLT). However, early childhood internalizing and externalizing symptoms were differentially associated with communication outcomes depending on adjustment for socio-demographic predictors and whether maternal report of verbal difficulties or current SLD or SLT was used as the outcome in regression analyses. These findings highlight the importance of implementing SLT focused on expressive language development for children with ASD symptoms as early as possible or perhaps when expressive language concerns are first noted by parents to providers (Richards et al., 2016). Continued monitoring of

internalizing and externalizing problems, and their relationship with language development, may also help identify children with ASD or DD who could benefit from targeted communication services.

Several socio-demographic factors were also differentially associated with verbal communication difficulties depending on study group and the communication outcome utilized. First, maternal education was associated with adolescent verbal communication difficulties in the combined sample and in adolescents with ASD when maternal report of verbal difficulties was used as the outcome. These findings are consistent with previous research (Grandgeorge et al., 2009; Maltman et al., 2021; Morales et al., 2024; Vernon-Feagans et al., 2020). Maternal responsivity and language input has been shown to partially mediate the association between maternal education and later child language abilities in both clinical and population-based samples (Hudson et al., 2015; Vernon-Feagans et al., 2020), thus interventions that target these factors in mothers with lower education may help increase verbal language development in children with ASD.

Maternal non-Hispanic Black race was associated with adolescent verbal communication difficulties in the combined sample when maternal report was used as the outcome and in both the combined and ASD sample when current SLD or SLT was used as the outcome. Previous research has found that non-Hispanic Black mothers are just as responsive and verbally expressive with their children within the same education levels. This suggests that the intersection between maternal education and race/ethnicity could be considered when interpreting these results, however larger research studies that actively strive for better representation of racial and ethnic minorities are needed to disentangle the complex relationships between these contextual factors and verbal language development in ASD (Girolamo et al., 2023).

Results from our sensitivity analysis showed that adolescents with both private and public health insurance coverage were more likely to have verbal communication difficulties compared to adolescents with only private health insurance in the combined sample and adolescents with ASD when current SLD or SLT was used as the primary outcome. To our knowledge, this study is the first to provide evidence of an association between the type of health insurance and verbal communication outcomes among adolescents with and without ASD. While causality cannot be assessed, an understanding of the accessibility, affordability, and utilization of services that target verbal language acquisition for adolescents with public and private insurance will be the focus of future investigations involving these data.

Finally, findings from our supplemental analysis of a subset of adolescents from the ASD and DD groups with expressive language delay in early childhood indicated that nearly half had no reported difficulties in verbal communication by the time they reached adolescence. However, the majority (55 %) of adolescents with persistent verbal communication difficulties were reported to have only minor difficulty communicating (i.e., verbally communicates using words with a little trouble). These findings add to emerging evidence suggesting that some individuals with ASD with limited verbal communication in early childhood may acquire greater verbal language fluency as they mature (Maltman et al., 2021; Wodka et al., 2013).

4.1. Limitations

The current study is subject to several limitations. First, reliance on mothers to report verbal communication difficulties rather than standardized speech and language assessments possibly introduced some degree of error in the classification of verbal ability in this sample of adolescents with ASD and DD. Second, comparisons between those that did and did not participate indicated that the racial and ethnic distribution of the current sample is not representative of the larger SEED sample. Thus, the current findings – especially those regarding race and ethnicity – may be under-estimated and should be interpreted with caution. Third, our modeling methods assumed linearity between the phenotypic variables and the examined verbal outcome, which could obscure meaningful cut-points or thresholds that confer the greatest risk for verbal communication difficulties in adolescence. However, visual inspection of the predicted probability of verbal communication difficulties by MSEL, CBCL, and SCQ scores suggested these associations were largely linear in nature and well above the acceptable area under the curve (AUC) threshold of 0.5 (AUC's = 0.70 – 0.85). Additionally, overall model fit did not significantly improve when quadratic terms for the phenotypic predictors were included in the model. Fourth, although follow-up analysis that excluded adolescents with a current diagnosis of SLD from the DD group revealed the same pattern of results, findings may be difficult to generalize to the larger DD population given the heterogeneity of the DD group included in the current study. Finally, although careful consideration was given to selecting potential predictors of verbal language outcomes based on existing literature, our relatively small sample size necessitated we restrict our investigation to a smaller subset of variables. Thus, other potential variables not examined, such as the type or number of services received, may contribute to verbal language outcomes in adolescents with ASD and DD.

This study also has several strengths. First, participants included in this study were part of a multi-site longitudinal study of adolescents with ASD and other DD who completed an in-depth developmental evaluation when they were 2–5 years old as part of their original participation in SEED. Second, the survey question used to assess verbal communication in adolescence was adapted from a large national survey of students in special education (i.e., NLTS2 parent survey) and subjected to a pretesting protocol during the design process (SRI International, 2000). Moreover, follow-up tests revealed that mothers who reported that their child had some degree of difficulty with verbal communication were also more likely to report a current diagnosis of SLD (68.6 %) than mothers who reported no verbal communication difficulties (16.4 %). This finding suggests that the verbal difficulties reported by mothers in this study are likely real and observable difficulties, particularly for those with SLD who likely received this diagnosis based on clinical observation of persistent difficulties in the acquisition or use of language (APA, 2013). Additionally, results from our sensitivity analyses indicated similar associations between early expressive language in the combined sample and adolescents with ASD when SLD was used as the outcome instead of maternal report of verbal language difficulties. This suggests that the findings presented herein are relatively robust and consistent across two different language outcomes.

5. Conclusions

Findings from this study showed that verbal communication difficulties are more prevalent among adolescents with ASD relative to adolescents with other DD. Subsequent analyses indicated that early expressive language and maternal race/ethnicity were robust predictors of adolescent communication difficulties in the combined sample of adolescents with ASD and other DD. Other contextual factors such as maternal education and type of health insurance were independent predictors of verbal communication difficulties depending on study group and communication outcome analyzed. These findings emphasize the importance of both individual and contextual factors on verbal language acquisition in ASD and other DD and highlight the need for early speech and language therapy in children with ASD symptoms. Such interventions that target mothers from under-served populations may also help improve verbal language outcomes in individuals with and without ASD across the lifespan.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Data availability

The authors do not have permission to share data.

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Table 1

Socio-demographic characteristics of mothers and their adolescent children in the autism spectrum disorder (ASD) and the developmental disability (DD) groups, Study to Explore Early Development, Preliminary Follow-up Study – Four Sites, United States, 2018–2020.

<i>Adolescent & Maternal Characteristics</i>	ASD (n=192) n (%)	DD (n=316) n (%)	p-value
Maternal age at birth ^a – <i>Mean (SD)</i>	31.5 (5.2)	32.4 (5.6)	0.0593
Maternal age at follow-up ^b – <i>Mean (SD)</i>	46.2 (5.2)	47.1 (5.6)	0.0659
Child age during SEED Teen ^b – <i>Mean (SD)</i>	14.2 (0.6)	14.2 (0.6)	0.9109
Maternal race-ethnicity ^a			
Non-Hispanic White	116 (60.4 %)	226 (71.5 %)	0.0545
Non-Hispanic Black	48 (25.0 %)	63 (19.9 %)	
Non-Hispanic Other	18 (9.4%)	17 (5.4 %)	
Hispanic	10 (5.2 %)	10 (3.2 %)	
Maternal education ^b			
≤ High School Diploma	13 (6.8 %)	25 (7.9 %)	0.5305
Some College/Technical or Vocational Degree	43 (22.4 %)	55 (17.4 %)	
Bachelor's Degree	72 (37.5%)	119 (37.7 %)	
Advanced Degree	64 (33.3 %)	117 (37.0 %)	
Primary language spoken in home ^a			
English	180 (93.8 %)	309 (97.8 %)	0.0201
Other	12 (6.3 %)	7 (2.2 %)	
Adolescent's sex ^a			
Female	38 (19.8 %)	108 (34.2 %)	0.0005
Male	154 (80.2 %)	208 (65.8 %)	
Mother born outside United States ^a	30 (15.6 %)	26 (8.2 %)	0.0098
Household Income as Percentage of Federal Poverty Level ^b			
≤100%	23 (12.0 %)	27 (8.5 %)	0.4273
101 – 200%	31 (16.2 %)	42 (13.3 %)	
201 – 300%	56 (29.2 %)	103 (32.6%)	
≥ 301 %	82 (42.7 %)	144 (45.6 %)	
Adolescent's Health Insurance ^b			
Private only	105 (54.7 %)	219 (69.3 %)	0.0008
Public only	53 (27.6 %)	71 (22.5 %)	
Both Public & Private	34 (17.7 %)	26 (8.2 %)	
Study site ^a			
GA	62 (32.3 %)	101 (32.0 %)	0.1507
MD	40 (20.8 %)	48 (15.2 %)	
NC	50 (26.0 %)	109 (34.5 %)	
PA	40 (20.8 %)	58 (18.4 %)	

Abbreviations: ASD = autism spectrum disorder; DD = developmental disabilities; SD = standard deviation; SEED = Study to Explore Early Development

[¶]Socio-demographic data missing for 46 participants (ASD = 16; DD = 30)

^aCollected during SEED 1.

^bCollected during SEED Teen, adolescents without health insurance were excluded from analysis.

Table 2

Early child and adolescent characteristics among children in the autism spectrum disorder (ASD) and the developmental disability (DD) groups, Study to Explore Early Development, Preliminary Follow-up Study – Four Sites, United States, 2018–2020.

	ASD (n=192)	DD (n=316)	
<i>Early child characteristics</i>	Mean (SD)	Mean (SD)	<i>p-value</i>
Mullen Scales of Early Learning (MSEL) ^a			
Expressive Language (age-equivalent)	36.9 (18.1)	53.0 (14.0)	<0.0001
Receptive Language (age-equivalent)	39.5 (18.9)	55.1 (13.1)	<0.0001
Child Behavior Checklist (CBCL) ^b			
Internalizing (T-scores)	61.2 (10.1)	49.6 (11.8)	<0.0001
Externalizing (T-scores)	59.0 (11.6)	48.6 (12.2)	<0.0001
Total Score (T-scores)	61.7 (11.7)	49.2 (12.2)	<0.0001
Social Communication Questionnaire (SCQ) ^c			
Total Score	16.9 (6.1)	6.6 (5.2)	<0.0001
<i>Adolescent characteristics</i>	<i>n (%)</i>	<i>n (%)</i>	<i>p-value</i>
Verbally communicates...			
using words easily	101 (52.6%)	270 (85.4%)	<0.0001
using words with a little trouble	49 (25.5 %)	32 (10.1%)	
using words with a lot of trouble	18 (9.4%)	— ^d	
with noises or not at all	24 (12.5 %)	— ^d	
Current diagnosis of SLD	84 (43.8%)	71 (22.5 %)	<0.0001
Current use of SLT	107 (55.7%)	66 (20.9 %)	<0.0001

Abbreviations: ASD = autism spectrum disorder; DD = developmental disabilities; SD = standard deviation; SLD = speech/language disorder; SLT = speech or language therapy

^aMissing MSEL data from 3 participants from ASD group

^bMissing CBCL data from 17 participants (ASD = 8, DD = 9)

^cMissing SCQ data from 3 participants (ASD = 1, DD = 2)

^dCounts suppressed because of small cell size

Table 3

Poisson regression with early childhood characteristics as predictors of verbal communication difficulties in adolescent children in the autism spectrum disorder (ASD) and the developmental disabilities (DD) groups (N = 485), Study to Explore Early Development, Preliminary Follow-up Study – Four Sites, United States, 2018–2020.

	Verbally communicates with difficulty vs. Verbally communicates easily^a					
	Combined Sample (N = 485)^d		ASD Group (n = 180)^d		DD Group (n=305)^d	
	aPR^b (95 % CI)	p-value	aPR^b (95% CI)	p-value	aPR^b (95 % CI)	p-value
MSEL Expressive Language (Age Equivalent Scores) ^c	0.96 (0.95, 0.97)	<0.0001	0.96 (0.95, 0.97)	<0.0001	0.95 (0.93, 0.96)	<0.0001
CBCL Internalizing (T-scores) ^c	1.02 (1.00, 1.04)	0.0162	1.02 (1.00, 1.04)	0.0658	1.02 (0.99, 1.06)	0.1824
CBCL Externalizing (T-scores) ^c	1.00 (0.98, 1.01)	0.7487	0.98 (0.97, 1.00)	0.0797	1.03 (1.00, 1.05)	0.0791
SCQ total score ^c	1.02 (0.99, 1.04)	0.1646	1.02 (0.99, 1.04)	0.2248	1.00 (0.96, 1.05)	0.9369

Abbreviations: aPR = adjusted prevalence ratio; CI = Confidence Interval; ASD = autism spectrum disorder; DD = developmental disabilities; MSEL = Mullen Scales of Early Learning; CBCL = Child Behavior Checklist; SCQ = Social Communication Questionnaire; *Ref.* = Reference Group

^aAdolescents with verbal communication difficulties were those whose mother indicated that their adolescent child verbally communicated with a little trouble, a lot of trouble, with noises, or not at all.

^bPrevalence ratios adjusted for all variables included in the table above.

^cMSEL, CBCL, and SCQ scores were measured during the initial SEED study when the child was 2–5 years old.

^d23 participants (ASD = 12; DD = 11) with missing data on the MSEL, CBCL, or SCQ.

Table 4

Poisson regression with early childhood and socio-demographic characteristics as predictors of verbal communication difficulties in adolescent children in the autism spectrum disorder (ASD) and the developmental disabilities (DD) groups (N = 485), Study to Explore Early Development, Preliminary Follow-up Study – Four Sites, United States, 2018–2020.

	Verbally communicates with difficulty vs. Verbally communicates easily^b					
	Combined Sample (n = 485)^e		ASD Group (n = 180)^e		DD Group (n=305)^e	
	aPR^c (95 % CI)	p-value	aPR^c (95% CI)	p-value	aPR^c (95 % CI)	p-value
<i>Early childhood variables</i>						
MSEL Expressive Language (Age Equivalent Scores) ^d	0.96 (0.95, 0.97)	<0.0001	0.97 (0.95, 0.98)	<0.0001	0.95 (0.93, 0.96)	<0.0001
CBCL Internalizing (T-scores) ^d	1.02 (1.00, 1.04)	0.0201	1.03 (1.01, 1.05)	0.0154	1.03 (0.99, 1.06)	0.1367
CBCL Externalizing (T-scores) ^d	1.00 (0.98, 1.02)	0.8597	0.98 (0.96, 1.00)	0.0188	1.04 (1.01, 1.07)	0.0084
SCQ total score ^d	1.02 (0.99, 1.04)	0.1861	1.02 (0.99, 1.05)	0.1713	1.02 (0.96, 1.07)	0.5457
<i>Socio-demographic variables</i>						
Maternal age at follow-up	1.01 (0.99, 1.04)	0.3502	1.00 (0.97, 1.02)	0.7721	1.01 (0.97, 1.06)	0.5896
Maternal race-ethnicity						
Non-Hispanic White (<i>Ref.</i>)	-	-	-	-	-	-
Non-Hispanic Black	1.38 (1.02, 1.87)	0.0343	1.25 (0.90, 1.72)	0.1804	1.22 (0.62, 2.38)	0.5671
Non-Hispanic Other	1.34 (0.78, 2.32)	0.2873	1.33 (0.71, 2.47)	0.3730	0.79 (0.19, 3.22)	0.7431
Hispanic	0.93 (0.47, 1.83)	0.8327	0.81 (0.35, 1.88)	0.6310	0.93 (0.42, 2.04)	0.8529
Maternal education						
≤ High School Diploma	0.90 (0.42, 1.93)	0.7925	0.65 (0.19, 2.21)	0.4874	0.86 (0.20, 3.62)	0.8372
Some College/Technical or Vocational Degree	1.70 (1.17, 2.48)	0.0059	1.67 (1.13, 2.47)	0.0097	1.45 (0.60, 3.52)	0.4105
Bachelor's Degree	1.36 (0.96, 1.93)	0.0821	1.20 (0.85, 1.71)	0.3055	1.83 (0.90, 3.72)	0.0944
Advanced Degree (<i>Ref.</i>)	-	-	-	-	-	-
Maternal Language						
English (<i>Ref.</i>)	-	-	-	-	-	-
Other	0.84 (0.47, 1.53)	0.5768	0.65 (0.3, 1.37)	0.2533	<i>a</i>	<i>a</i>
Adolescent's sex						
Female	1.21 (0.90, 1.61)	0.2080	1.03 (0.74, 1.42)	0.8821	1.89 (1.14, 3.12)	0.0137
Male (<i>Ref.</i>)	-	-	-	-	-	-
Household Income as Percentage of FPL						
≤100%	0.71 (0.43, 1.16)	0.1749	0.60 (0.37, 0.96)	0.0345	1.24 (0.35, 4.44)	0.7406
101 – 200%	0.99 (0.60, 1.62)	0.9657	0.90 (0.57, 1.42)	0.6459	1.58 (0.48, 5.23)	0.4567
201 – 300%	0.84 (0.54, 1.30)	0.4346	0.71 (0.46, 1.11)	0.1320	1.39 (0.54, 3.62)	0.4940
≥ 301 % (<i>Ref.</i>)	-	-	-	-	-	-
Adolescent's Health Insurance						
Private only (<i>Ref.</i>)	-	-	-	-	-	-
Public only	0.80 (0.54, 1.18)	0.2615	0.78 (0.54, 1.14)	0.2072	1.06 (0.48, 2.35)	0.8873

	Verbally communicates with difficulty vs. Verbally communicates easily^b					
	Combined Sample (n = 485)^e		ASD Group (n = 180)^e		DD Group (n=305)^e	
	aPR^c (95 % CI)	p-value	aPR^c (95% CI)	p-value	aPR^c (95 % CI)	p-value
Both Public & Private	1.38 (0.98, 1.95)	0.0647	1.32 (0.94, 1.84)	0.1089	1.51 (0.69, 3.27)	0.3008

Abbreviations: aPR = adjusted prevalence ratio; CI = Confidence Interval; ASD = autism spectrum disorder; DD = developmental disabilities; MSEL = Mullen Scales of Early Learning; CBCL = Child Behavior Checklist; SCQ = Social Communication Questionnaire; *Ref.* = Reference Group

^aVariable was excluded from model due to small cell size (n < 10)

^bAdolescents with verbal communication difficulties were those whose mother indicated that their adolescent child verbally communicated with a little trouble, a lot of trouble, with noises, or not at all.

^cPrevalence ratios adjusted for all variables included in the table above.

^dMSEL, CBCL, and SCQ scores were measured during the initial SEED study when the child was 2–5 years old.

^e23 participants (ASD = 12; DD = 11) with missing data on the MSEL, CBCL, or SCQ.