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Social and language regression: characteristics of children with autism spectrum disorder in a community-based sample

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Abstract

This study investigated the prevalence, and the developmental, behavior and emotional outcomes of 675 preschoolers with ASD with or without a history of regression, who participated in the Study to Explore Early Development (SEED). The SEED project is a cross-sectional case-control study that collected data between 2007 and 2011. Children's history of regression, adaptive skills, and behavior problems were assessed using the Autism Diagnostic Interview-Revised (ADI-R), the Vineland Adaptive Behavior Scales-Second Edition (Vineland-2), and the Child Behavior Checklist (CBCL), respectively; and children's developmental levels were assessed using the Mullen Scales of Learning (MSEL). Findings from this study indicated that 26% of children experienced social and language regression, and of those with regression, 76% had regained lost skills upon completion of the study. Compared to children without a history of regression, children with social regression demonstrated increased internalizing problems and decreased fine motor skills, and children with language regression demonstrated poorer language skills. Also, children with language and social regression displayed poorer adaptive communication skills than children without regression. Children who experienced regression in one area of development demonstrated better outcomes than those who experience regression in multiple areas. To conclude, children with regression are at risk for poorer outcomes during their preschool years.

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Ethics approval and consent to participate This study was approved by a university institutional review board.

Informed Consent Informed consent was obtained for all the recruited participants. Legal representatives (i.e., parents/caregivers) gave consent for child participation.

Competing interests The authors declared no conflicts of interest. The authors alone are responsible for the content and the writing of the article.

Keywords

Language and social regression; Preschoolers with autism; Outcomes

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by difficulties in social-communication and the presence of repetitive and restricted behaviors or interests (American Psychiatric Association, APA, 2013). Approximately 1 in 44 children have ASD, and 20–90% of parents of children with ASD report developmental regression in the first few years of life (Barger, Campbell, & McDonough, 2013; Maenner, et al., 2018, Ozonoff, Williams, & Landa, 2005). Developmental regression is broadly defined as a deterioration of previously acquired skills, such as loss of spoken words or social responsiveness (e.g., social smile; Stefanatos, 2008; Taylor el al., 2002). Language regression in particular appears to be related to ASD in that children with ASD tend to experience language regression more than children with other developmental problems (Baird et al., 2008; Hansen et al., 2008; Maestro et al., 2005; Rogers, 2004; Siperstein, & Volkmar, 2004; Wiggins, Rice, & Baio, 2009). In fact, children who show language regression in the first few years of life are *almost always* diagnosed with ASD after loss of skills (Lord, Shulman, & DiLavore, 2004; Shinnar et al., 2001). For example, Lord and colleagues (2004) documented that 81.25% of children with language regression were subsequently diagnosed with Autism Disorder/Pervasive Developmental Disorder (18.75% of children with a language regression were later diagnosed with developmental delays only).

On average, children with ASD with developmental regression tend to lose skills between 18 and 24 months of age and most regain some of those skills between 3 and 5 years of age (Barger et al., 2013). For instance, 75% of parents reported that children regained some language skills (Golbert et al., 2003). Most children with ASD who lose skills had developmental delays before the regression, such as delayed motor milestones (Wiggins et al., 2019). When compared to children who did not regress, those who did regress had poorer outcomes even after recovery of skills (Boterberg, Van Coster, & Roeyers, 2019; Parr et al., 2011). For instance, children who experienced developmental regression were subsequently found to have more adaptive, behavioral, and cognitive delays than those who did not experience developmental regression. They also continued to show more difficulties with language abilities, social skills, eye contact, and response to name than children who never lost skills (Osterling, Dawson, & Munson, 2002; Palomo et al., 2006; Richler et al., 2006).

Overall, current research suggests that regression may be one pathway to exacerbation of ASD symptoms and those who regress may have different trajectories, prognoses, and service needs than children with ASD who do not regress. Nonetheless, few studies examined whether preschool children with ASD and a history of regression also are more likely to experience other behavioral or emotional difficulties than their peers without such history (Boterberg et al., 2019). This is important given that children with ASD are often described as experiencing increased internalizing and externalizing problems when compared to their peers (Hartley & Sikora, 2009; Hartley et al., 2008; Pandolfi et al.,

2009; Tseng et al., 2011). Children with ASD are often reported to lose language skills or both language and social skills (Luyster et al., 2005); however, previous research has not reported whether there is an association between type of regression (i.e., language regression only, social regression only, or both language and social regression) and later outcomes in young children with ASD. Learning about the association between developmental regression and later outcomes in children with ASD is likely to inform intervention planning for this population. To increase our knowledge and understanding of developmental regression in ASD, this study had several goals:

1. To report the occurrence of parent-reported regression, including type of regression, in a large case-control sample of preschool children with ASD.
2. To report how many children with ASD and regression regained skills, as an overall group and by different types of regression.
3. To examine differences in adaptive skills, behavior problems, and developmental functioning in children with ASD and different types of regression.
4. To investigate adjusted associations between adaptive, behavioral, and developmental deficits and type of regression in children with ASD.

Method

Study Design and Participants

We used data from the first phase of the Study to Explore Early Development (SEED), a multi-site, community-based sample, case-control study that includes children with ASD, children with other developmental delays or disabilities (DD), and children recruited from the general population (*this study only included children with ASD*). Participants were enrolled from six sites located in California, Colorado, Georgia, Maryland, North Carolina, and Pennsylvania between 2007 and 2011. Children who qualified for the study met the following criteria: (1) were born between 2003 and 2006, enrolled between the ages of 24 and 68 months, and completed their SEED developmental assessment between the ages of 30 and 68 months; (2) lived with a caregiver (who was their parent or legal guardian and had cared for them since birth or since 6 months of age); (3) lived in a current residence in one of the six specific catchment areas; (4) had a parent or legal guardian who spoke English (English or Spanish or both for the California and Colorado samples); and (5) did not have disabilities that would prevent an in-person assessment of the child (e.g., uncorrected hearing or vision impairment).

Children potentially eligible for the ASD and DD groups were identified through local hospitals, Regional Centers, schools, and other agencies that provide services to children with ASD and DD and their families. Children from the general population were identified through random sampling of birth certificate records at each site. After explaining the study's goals and procedures to child's caregivers, a written consent, which was approved by the university's Institutional Review Board (IRB), was obtained from all caregivers. All children were screened for ASD symptoms upon enrollment. Those who had a score of 11 or greater on the Social Communication Questionnaire (SCQ), or a previous ASD diagnosis, underwent a developmental assessment using the Mullen Scales of Early Learning

(Mullen et al., 1995) and an autism assessment using the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000). In addition, a parent or legal guardian completed the Autism Diagnostic Interview–Revised (ADI-R; Lord et al., 1994), Child Behavior Checklist-Preschool (CBCL; Achenbach and Rescorla, 2000), and Vineland Adaptive Behavior Scales, Second Edition (VAPBS-2; Sparrow et al., 2005). In SEED, children were classified as ASD if they met ASD criteria on the ADOS and one of four criteria on the ADI-R. Details on the SEED final classification algorithm and SEED methodology have been described previously (Schendel et al., 2012; Wiggins et al., 2015). Children in this analysis were limited to those who met SEED criteria for ASD and had complete data for both language and social regression items on the ADI-R.

Data Collection Instruments

After qualifying for the study, the caregivers were given options in how they wanted to complete the study measures, which were not given in any particular order: (1) sometimes, the Autism Diagnostic Interview-Revised was administered before the Mullen Scales of Early Learning; (2) other times, the Mullen Scales of Early Learning was administered before the Autism Diagnostic-Interview Revised, (3) in rare occasions, parents wanted to complete all measures in one day, and they were administered simultaneously when two caregivers accompanied the child the study visit.

Autism Diagnostic Interview-Revised—The Autism Diagnostic Interview-Revised (ADI-R) is a parent interview designed to obtain information about social and communication functioning, and presence of repetitive behaviors and restrictive interests, in order to classify children as ASD or non-ASD (Le Couter, & Lord, Rutter, 2003; Lord et al., 2004; Rutter et al., 2003). The ADI-R considers a child to have experienced regression if they have not demonstrated skills for at least three months that were previously established and used daily for at least three months. In order to meet the language regression threshold, the child must have used at least five different words (other than mama and dada) daily for at least three months. For example, if a parent reported that her child lost words in the second year of life, the interviewer would clarify that the child had at least five words used daily before coding language regression.

In addition to assessing the presence or absence of regression, the ADI-R measures whether the child regained lost skills (parents are asked the duration of the loss). Thus, developmental regression or lack thereof was operationally defined as no regression, language only regression, social only regression, and both language and social regression based on two ADI-R questions: question number 11 (language regression) and question number 25 (social regression). Children with a score of “0” (indicating no regression reported) on questions 11 *and* 25 were assigned to the “no regression” group. Children with a score of “1” (indicating regression was reported by the respondent) on question 11 and “0” on question 25 were assigned to the “language only regression” group. Children with a score or “1” (possible) or “2” (definitely) on question 25 and “0” on question 11 were assigned to the “social only regression group.” Children with a score of “1” on question 11 and “1” or “2” on question 25 were assigned to the “language and social regression” group. Finally, parents were asked how long the loss lasted (question #19); thus, two groups were

identified: children who had regained the lost skills, and those who had not been gained lost skills.

Autism Diagnostic Observation Schedule—The Autism Diagnostic Observation Schedule (ADOS) was administered to all participants to confirm ASD classification and assess current ASD symptom severity (Lord et al., 1999, 2000). The ADOS is a play-based assessment that lasts approximately 45 min. During this assessment, the child is presented with a variety of activities that are designed to elicit social and communication behaviors. A calibrated severity score (CSS) was developed to measure ASD symptom severity on a 10-point scale with higher scores representing a more severe presentation of ASD symptoms (Gotham, Pickles, & Lord, 2009).

Caregiver Interview—The caregiver interview is a SEED-developed instrument to ascertain exposures and health status of child's mother before, during, and shortly after her pregnancy, and the developmental history of the child. Demographic information was also collected during the caregiver interview. Data relevant to this analysis include questions on child sex, maternal age, maternal education, and maternal race/ethnicity.

Child Behavior Checklist—The Child Behavior Checklist-Preschool for children ages 1 ½ to 5 years of age (CBCL) is a screening tool that assesses child internalizing and externalizing behavior problems (Achenbach et al., 2000). The CBCL is composed of 99 statements about their child, and caregivers respond to each statement by selecting from a 0 to 2 scale (0 = *Not True*, 1 = *Somewhat or Sometimes True*, 2 = *Very True or Often True*). Internalizing behavior problems are emotional reactivity, anxious/depressed, somatic complaints, and withdrawn behavior. Externalizing behavior problems are attention problems and aggressive behavior. While t-scores between 65 and 69 indicate that some behavior/emotional problems might be developing and need to be monitored, t-scores of 70 or higher indicate clinically significant malfunctioning that likely require treatment or intervention.

Mullen Scales of Early Learning—The Mullen Scales of Early Learning (MSEL) were used to evaluate the children's developmental functioning. The MSEL is an individually administered measure of developmental functioning for young children from birth through 68 months. The MSEL assesses a child's current functioning in visual reception, fine motor, expressive language, and receptive language domains. Standardized t-scores are provided for each domain and have a mean of 50 points and standard deviation of 10 points. Scores of less than 30 points represent very low developmental functioning. Child's chronological age at the time the MSEL was administered is reported in this study (Mullen, 1995).

The Vineland Adaptive Behavior Scales-Second Edition—The Vineland Adaptive Behavior Scales, Second Edition (VABS-2) was administered to parents to assess child's adaptive functioning (Sparrow et al., 2005). Adaptive behaviors are daily skills that children use in their environment and provide a measure of an individual's degree of independence in meeting the demands of everyday life. The VABS-2 measures adaptive behaviors in four domains: communication, daily living, motor, and socialization skills. All VABS-2 domain

scores have a mean of 100 points and standard deviation of 15 points. Scores of less than 85 points represent below average adaptive skills.

Statistical Analyses

Child and parent characteristics for each regression group (i.e., no regression, language only regression, social only regression, and language and social regression) were reported for the following: child ASD severity, child age, child sex, maternal age, maternal education, and maternal race/ethnicity. ANOVA and chi-square analyses assessed differences in these characteristics between study groups. Descriptive statistics were reported to define the occurrence of regression overall and by regression type. Descriptive statistics were also reported to define how many children who experienced each type of regression, overall and by regression type, who eventually regained skills.

ANOVA analyses were conducted to assess between-group differences in child adaptive skills, behavior problems, and developmental functioning. A Bonferroni correction was applied to account for multiple comparisons and assess differences between specific study groups ($p \leq 0.01$). Outcomes that showed statistically significant differences between regression types were dichotomized as follows: CBCL behavior problems indicated by domain scores of 60 or more points, MSEL very low developmental functioning indicated by domain scores less than 30 points, and VABS-2 below average adaptive skills indicated by domain scores less than 85 points. Given that children with ASD have difficulties participating in standardized assessments, the MSEL was dichotomized using 2 standard deviations; and because children with ASD tend to score poorly on behavior and emotional functioning measures, the CBCL was dichotomized with a cut-off that is likely to indicate impairment or more severe presentation. Adjusted logistic regression analyses determined the odds of experiencing an adaptive, behavioral, or developmental deficit given regression type in early childhood (e.g., language only regression) when compared to no regression. Maternal age and maternal race/ethnicity were included as confounders since there were statistically significant differences in these variables based on regression status.

Results

A total of 707 children met SEED ASD criteria after a comprehensive in-person evaluation and, of those, 675 had a parent answer questions regarding language and social regression on the ADI-R and were included in our sample. There were 499 (73.9%) children who did not experience developmental regression and 176 (26.1%) who experienced either language or social regression. Of those 176, 60 (34.1%) experienced language only regression, 59 (33.5%) social only regression, and 57 (32.4%) language and social regression. Child and parent characteristics are presented in Table 1.

The average age of the child at the time of language loss was 21.4 months and the average age at the time of social loss was 20.5 months. Most children who lost skills eventually regained skills (76.4%). The proportion of children who regained skills differed by regression type: compared to the 61.4% of children with social only regression, 81.7% of children with language only regression regained skills ($\chi^2 = 5.93$, $p = 0.01$), and 86.0% of children with both language and social regression regained skills ($\chi^2 = 8.87$, $p = 0.003$).

Adaptive Skills, Behavior Problems, and Developmental Functioning

Differences in adaptive skills, behavior problems, and developmental functioning based on regression type are presented in Table 2; Fig. 1. There were no differences in VABS-2 daily living, motor, or social skills based on regression type. There were differences in VABS-2 communication skills; post-hoc analyses found that this difference was limited to the comparison between the no regression group and language and social regression group. Specifically, the no regression group had higher adaptive communication scores (M = 78.0) than the language and social regression group (M = 70.4).

There were no differences in CBCL externalizing problems between regression types. There were differences in CBCL internalizing problems between the no regression group and social only regression group. Specifically, the no regression group had fewer internalizing behavior problems (M = 59.5) than the social only regression group (M = 61.2).

There were no differences in MSEL visual reception skills based on regression type. ANOVA and post-hoc analyses found that expressive language abilities differed between the no regression and language only regression groups (M = 30.2 and 24.9, respectively), fine motor abilities differed between the no regression and social only regression groups (M = 31.0 and 29.2, respectively), and receptive language abilities differed between the no regression and language only regression groups (M = 31.3 and 26.0, respectively).

Associations Between Regression Type and Child Outcomes

Logistic regression analyses assessed whether type of regression in early childhood was associated with current adaptive, behavioral, or developmental deficits in the child, after adjusting for maternal age and race/ethnicity (Table 3). Compared to children with no regression, children who experienced language only regression had 1.94 odds of having below average adaptive communication, 2.10 odds of having very low expressive language, 2.04 odds of having very low fine motor skills, and 2.38 odds of having very low receptive language skills than children who did not experience regression. Children who experienced social only regression had 3.29 odds of experiencing internalizing behavior problems, 1.95 odds of having very low fine motor skills, and 2.05 odds of having very low receptive language skills than those who did not experience regression. Children with language and social regression had 2.21 odds of having below average adaptive communication, 1.93 odds of having internalizing behavior problems, and 1.87 odds of having very low expressive language than those who did not experience regression.

Discussion

Consistent with previous research, we found that 26.1% of preschool children with ASD enrolled in a large community-based study were reported to have experienced developmental regression based on ADI-R criteria. Among those who experienced developmental regression, 34.1% regressed in language skills, 33.5% regressed in social skills, and 32.4% regressed in both language and social skills. On average, children with ASD who regress do so before two years of age, which gives parents and providers a sense of when to increase monitoring of the child to ensure continued advancement of skill development.

Most children in our study with ASD and regression regained skills, which also is similar to reports from other studies where children often regained their skills before the age of 5 years (Goldberg et al., 2003).

Preschool children who regressed had poorer developmental skills than those who did not regress in adaptive communication, internalizing behavior problems, receptive/expressive language abilities, and fine motor abilities; these differences were between children with no regression and a specific regression type. Moreover, children with specific regression types had higher odds of experiencing current adaptive, behavioral, and developmental deficits than children who did not experience regression. These results can be used to inform parents and providers about the proportion and characteristics of children with ASD who experience a loss of skills and how regression is related to preschool outcomes and can inform intervention planning.

Similar to previous findings, most preschool children with ASD were not reported to lose previously acquired skills in our study (Baird et al., 2008; Hansen et al., 2008). However, caregivers reported that slightly more than a quarter of children with ASD do experience language regression, social regression, or both. This rate is similar to population samples that reported 25% prevalence rate of regression (e.g., Barger et al., 2013; Pickles et al., 2022), and within the range reported in previous reports (e.g., between 15 and 41%; Hansen et al., 2008). Diverse reports of the occurrence of regression between studies could be due to different study designs, ascertainment procedures, participant characteristics such as age, and data collection methods (Goldberg et al., 2008; Yirmiya & Charman, 2010).

These results also show that preschool children with ASD tend to experience more adaptive, behavioral, and/or developmental deficits than children with ASD who did not regress. One way in which our study expands upon previous research is by clarifying how differences in child outcomes between children with ASD who regressed versus those who did not regress are influenced by the type of regression. There were no differences between children who lost language only skills, social only skills, and both language and social skills. However, there were differences between children with no regression and language only, social only, or language and social regression. Children with language only regression had fewer expressive and receptive language abilities than children with no regression. Children with social only regression had more internalizing behavior problems and fewer fine motor abilities than children with no regression. Children with both language and social regression had fewer adaptive communication skills than children with no regression. These results suggest that, although all children with regression need support in multiple areas, those with language only regression may need more support with use and understanding of spoken words, social only regression with emotional regulation and fine motor skills, and language and social regression with independent use of language used in daily life.

The abovementioned findings were bolstered by analyses that showed children with various types of regression not only differed but had had two to three times the odds of having current adaptive, behavioral, or developmental deficits than children without regression. Most notable was the finding that children with social only regression had 3.29 odds of experiencing internalizing behavior problems than children who did not experience

regression. This finding coupled with the fact that children with social only regression were less likely than others to regain skills highlights the association between social regression in the first few years and continued emotional problems as children age. Also, young children with ASD typically show more internalizing problems regardless of regression status, and these problems tend to be stable over time (Vallencourt et al., 2017; Wiggins et al., 2015). Although the clinical significance of these findings need to be examined in school age children with ASD, developmental regression may represent another risk factor for internalizing problems, and children with ASD and social regression may therefore be particularly vulnerable to symptoms of anxiety and depression that warrant heightened screening and intervention efforts.

Limitations, Strengths, and Conclusions

This study has several limitations. First, our definition of regression was based on parent report data using a very specific definition of regression (i.e., children had to have at least 5 meaningful words before loss of skills to code language regression and loss had to persist for at least 3 months to code any regression) instead of observational data (Werner & Dawson, 2005). Second, the definition of both language and social regression was broad and did not assess specific skills lost in these domains. Third, the sample in this study was composed of preschool children, and it has been documented that children continue to gain skills even after age 5; therefore, this study may underestimate the number of children who eventually regain skills (Goldberg et al., 2003; Pickles et al., 2022). A recent study reported that children with ASD with a history of language regression continued to show delays in expressive language skills only when compared to those without language regression; however, these effects were reduced when accounting for motor and cognitive abilities (Pickles et al., 2022). Notably, that study did not examine children with a history of social regression. Fourth, sex differences or current versus past regression status could not be examined due to small numbers of girls when stratified by regression type. Finally, it is important to note that these study participants were diagnosed with ASD before the current DMS-5 was published in 2013; thus, it is possible that regression prevalence is different in children who met the DSM-IV criteria versus the DSM-5 criteria.

Despite those limitations, this study has numerous strengths in study design and analysis. This sample is comprised of a community-ascertained group of children from multiple geographic areas, and children in this study also show a wide range of abilities. The age range of preschool participants spanned a time when parents might be more apt to remember details about developmental regression than with school-aged children (Goldberg et al., 2003). Children were classified with ASD with a consistent case definition based on gold standard diagnostic instruments. Finally, we were able to examine the influence of regression type on differences in child outcomes and the association with current adaptive, behavioral, and developmental deficits.

To conclude, these findings suggest that slightly more than a quarter of preschool children with ASD lose skills in the first few years of life and, although most regain lost skills by age 5, those with a history of regression have poorer outcomes than those without a history of regression in the preschool years. Children with language only regression, social

only regression, or language and social regression may need different types of support that can guide developmental monitoring and intervention planning. Currently, we are beginning to understand the sequelae of language regression beyond preschool years (Pickles et al., 2022), and future research is needed to assess differences in adaptive, behavioral, emotional, and academic outcomes by regression type at different stages of development to provide children with the supports they may need.

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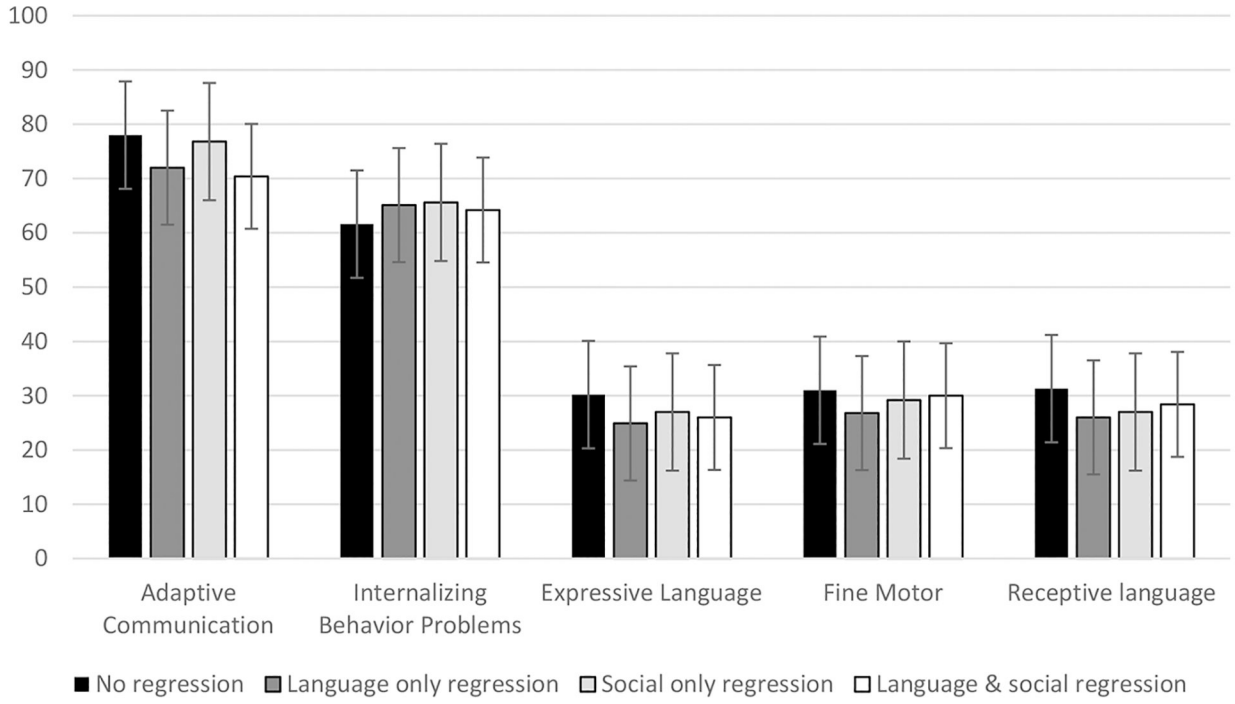

Fig. 1.

Adaptive, Behavioral, and Developmental Functioning Among Preschool Children with Autism Spectrum Disorder by Regression Status*†

*The whiskers represent the 95% confidence interval

†4Significant differences in adaptive communication were between the no regression and language + social regression groups; internalizing behavior problems between the no regression and social only regression groups; expressive language between the no regression and language only regression groups, fine motor between the no regression and social only regression groups; and receptive language between the no regression and language only regression groups

Table 1

Child and Parent Characteristics Among Preschool Children with Autism Spectrum Disorder Stratified by Regression Status

	No Regression (n=499)	Language Only Regression (n=60)	Social Only Regression (n=59)	Language & Social Regression (n=57)
Child				
Autism severity score	7.15 (Range: 4–10)	7.08 (Range: 4–10)	7.53 (Range: 5–10)	7.21 (Range: 4–10)
Child age	59.7 months (SD=6.63)† N (%)	58.2 (SD=7.85)† N (%)	58.7 months (SD=6.44)† N (%)	59.1 months (SD=6.77)† N (%)
Child sex				
Female	88 (17.6%)	10 (16.7%)	10 (16.9%)	13 (22.8%)
Male	411 (82.4)	50 (83.3%)	49 (83.1%)	44 (77.2%)
Mother				
	N (%)	N (%)	N (%)	N (%)
Maternal age‡				
29 years or younger	47 (9.2%)	7 (11.7%)	4 (6.8%)	3 (5.3%)
30–34 years	109 (21.8%)	28 (46.7%)	16 (27.1%)	20 (35.1%)
35–39 years	173 (34.7%)	12 (20.0%)	24 (40.7%)	15 (26.3%)
40 years or older	170 (34.1%)	13 (21.7%)	15 (25.4%)	19 (33.3%)
Maternal education‡				
Less than high school	24 (4.8%)	5 (8.3%)	2 (3.4%)	4 (7.14%)
High school	52 (10.4%)	7 (11.7%)	7 (11.9%)	8 (14.29%)
Associate degree/some college	162 (32.5%)	20 (33.3%)	15 (25.4%)	14 (25.00%)
College or advanced degree	261 (52.3%)	28 (46.7%)	35 (59.3%)	31 (54.4%)
Maternal race and ethnicity‡				
Non-Hispanic White	273 (54.7%)	24 (40.0%)	39 (66.1%)	29 (50.9%)
Non-Hispanic Black	106 (21.2%)	15 (25.0%)	6 (10.2%)	6 (10.5%)
Non-Hispanic Other	54 (10.8%)	8 (13.3%)	6 (10.2%)	8 (14.0%)
Hispanic	55 (11.0%)	12 (20.0%)	8 (13.6%)	13 (22.8%)
Missing race/ethnicity	11 (2.2%)	1 (1.7%)	/	1 (1.8%)

†SD=Standard Deviation;

‡there were no statistically significant between group differences in autism severity score, child age, child sex, maternal education; there were statistically significant between group differences in maternal race and ethnicity (χ^2=21.3; p=0.04) and maternal age (χ^2=28.6; p=0.02); data with less than five individuals per cell were suppressed in these analyses

Table 2

Adaptive, Behavioral, and Developmental Functioning Among Preschool Children with Autism Spectrum Disorder Stratified by Regression Status[†]

	No Regression (n=499)	Language & Social Regression (n=60)	Social Only Regression (n = 59)	Language & Social Regression (n = 57)	F	*p*
Adaptive Skills						
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
Communication	78.0 (18.4)	72.0 (15.1)	76.8 (18.4)	70.4 (18.1)	4.41	< .01
Daily living	75.0 (15.7)	72.0 (14.1)	72.8 (15.1)	70.9 (16.4)	1.80	0.14
Motor	80.3 (14.2)	76.9 (12.0)	81.2 (15.1)	79.3 (14.5)	1.20	0.31
Socialization	73.3 (13.7)	69.6 (11.6)	73.1 (13.9)	69.2 (13.0)	2.53	0.06
Behavior Problems						
Externalizing problems	59.5 (11.2)	63.0 (9.88)	61.8 (12.3)	61.2 (12.9)	2.12	0.09
Internalizing problems	61.6 (9.65)	65.1 (9.19)	65.6 (7.74)	64.2 (10.3)	5.08	< .01
Developmental Functioning						
Expressive language	30.2 (11.9)	24.9 (8.31)	27.0 (9.18)	26.0 (1.03)	6.30	< .01
Fine motor	31.0 (12.4)	26.8 (10.1)	29.2 (12.7)	30.0 (12.1)	4.51	< .01
Receptive language	31.3 (13.5)	26.0 (10.5)	27.0 (11.3)	28.4 (13.3)	4.79	< .01
Visual reception	31.3 (13.5)	30.0 (13.3)	33.5 (14.9)	32.7 (17.1)	2.25	0.08

[†]Adaptive skills measured with the Vineland Adaptive Behavior Scales – Second edition (higher standard scores indicate more adaptive abilities); behavior problems were measured with the Child Behavior Checklist (higher scores indicate more behavioral concerns); developmental skills were measured with the Mullen Scales of Early Learning (higher scores indicate more developmental abilities)

Table 3

Type of regression as a predictor of adaptive, behavioral, or developmental deficits in the child (no regression group as the referent category).[†]

	Average Adaptive Communication	Below Average Adaptive Communication	aOR (95% CI)[1]	p
	N (%)	N (%)		
No regression	187 (37.6%)	310 (62.4%)	1.00	REF
Language only regression	14 (23.7%)	45 (76.3%)	1.94 (1.03,3.63)	0.04
Social only regression	22 (37.3%)	37 (62.7%)	1.01 (0.58,1.77)	0.96
Language & social regression	12 (21.4%)	44 (78.6%)	2.21 (1.14,4.30)	0.02
	No Internalizing Behavior Problems	**Internalizing Behavior Problems**		
	N (%)	N (%)		
No regression	183 (39.2%)	284 (60.8%)	1.00	REF
Language only regression	14 (26.4%)	39 (73.6%)	1.79 (0.95,3.40)	0.07
Social only regression	9 (16.4%)	46 (83.6%)	3.29 (1.57,6.89)	< 0.01
Language & social regression	13 (25.0%)	39 (75.0%)	1.93 (1.00,3.72)	0.05
	Average to Below Average Expressive Language	**Very Low Expressive Language**		
	N (%)	N (%)		
No regression	203 (41.2%)	290 (58.8%)	1.00	REF
Language only regression	15 (25.0%)	45 (75.0%)	2.10 (1.14,3.87)	0.02
Social only regression	20 (34.5%)	38 (65.5%)	1.33 (0.75,2.35)	0.33
Language & social regression	15 (27.3%)	40 (72.7%)	1.87 (1.00,3.47)	0.05
	Average to Below Average Fine Motor Skills	**Very Low Fine Motor Skills**		
	N (%)	N (%)		
No regression	221 (44.6%)	274 (55.4%)	1.00	REF
Language only regression	17 (28.3%)	43 (71.7%)	2.04 (1.13,3.68)	0.02
Social only regression	17 (29.3%)	41 (70.7%)	1.95 (1.08,3.52)	0.03
Language & social regression	19 (34.5%)	36 (65.5%)	1.53 (0.85,2.74)	0.15
	Average to Below Average Receptive Language	**Very Low Receptive Language**		
	N (%)	N (%)		
No regression	205 (41.7%)	287 (58.3%)	1.00	REF
Language only regression	14 (23.3%)	46 (76.7%)	2.38 (1.26,4.38)	< 0.01
Social only regression	15 (25.9%)	43 (74.1%)	2.05 (1.11,3.78)	0.02
Language & social regression	16 (29.1%)	39 (70.9%)	1.74 (0.95,3.20)	0.07

[†]Of the 675 children in the sample, 4 were missing data on adaptive communication, 48 were missing data on internalizing behavior problems, 9 were missing data on expressive language skills, 7 were missing data on fine motor skills, and 10 were missing data on receptive language skills

[‡]Adjusted odds ratio (aOR): Maternal age and maternal race/ethnicity were included as confounders since there were statistically significant differences in these variables based on regression status