Journal of Autism and Developmental Disorders (2018) 48:3282–3295
https://doi.org/10.1007/s10803-018-3565-2

ORIGINAL PAPER

Patterns and Predictors of Language Development from 4 to 7 Years in Verbal Children With and Without Autism Spectrum Disorder

Amanda Brignell[1,2] · Katrina Williams[1,2,3] · Kim Jachno[2] · Margot Prior[1] · Sheena Reilly[4] · Angela T. Morgan[1,2]

Published online: 28 April 2018

Abstract
This study used a prospective community-based sample to describe patterns and predictors of language development from 4 to 7 years in verbal children (IQ ≥ 70) with autism spectrum disorder (ASD; n = 26–27). Children with typical language (TD; n = 858–861) and language impairment (LI; n = 119) were used for comparison. Children with ASD and LI had similar mean language scores that were lower on average than children with TD. Similar proportions across all groups had declining, increasing and stable patterns. Language progressed at a similar rate for all groups, with progress influenced by IQ and language ability at 4 years rather than social communication skills or diagnosis of ASD. These findings inform advice for parents about language prognosis in ASD.

Keywords Autism spectrum disorder · Language · Outcomes · Communication · Development · Follow-up · Longitudinal · Growth · Predictors · Trajectory · Language impairment · Typical development

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that affects more than one in 70 individuals (Centers for Disease Control and Prevention 2014). Social communication difficulties and restricted, repetitive behaviours are defining features of ASD (American Psychiatric Association 2013). Structural language skills (including use of grammar, syntax and phonology) in children with ASD vary widely. Some children with ASD never develop the ability to speak while others demonstrate superior language ability (Tager-Flusberg et al. 2011, 1990). In addition, children with ASD may show atypical language presentation such as regression in communication skills in the first few years of life (see Barger et al. 2013 for a review) and persistent or unusual repetitive, stereotyped language (Tager-Flusberg et al. 2011). Several studies have reported children with ASD to have stronger expressive relative to receptive language ability (e.g., Ellis Weismer and Kover 2015; Pickles et al. 2014), however other studies have not found this to be the case (Kwok et al. 2015). It has been argued that the apparent receptive-expressive discrepancy may relate to the use of standardized language tests (Tek et al. 2014; Wittke et al. 2017). For example, standardised tests may not fully capture the child's language ability because children with ASD do not always respond well to structured testing due to attention and motivation difficulties (Condouris et al. 2003). Verbal skills in childhood play an important role in predicting long-term outcomes in children with ASD in wellbeing, adaptive functioning and mental health (Billstedt et al. 2011; Gillespie-Lynch et al. 2012; Howlin and Moss 2012; Howlin et al. 2013).

Children with ASD have differing trajectories of language development, which include loss of skills, plateau, improvement and acceleration (Anderson et al. 2007; Ellis Weismer and Kover 2015; Kjelgaard and Tager-Flusberg 2001; Tager-Flusberg et al. 1990). Children with ASD and stronger verbal ability have been reported to have trajectories comparable to those with typically developing language on most measures

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10803-018-3565-2) contains supplementary material, which is available to authorized users.

✉ Amanda Brignell
amanda.brignell@mcri.edu.au

1 University of Melbourne, Melbourne, VIC, Australia

2 Murdoch Childrens Research Institute, Melbourne, VIC, Australia

3 Royal Children's Hospital, Melbourne, VIC, Australia

4 Menzies Health Institute Queensland, Griffith University, Southport, QLD, Australia

while children with low verbal skills have made slower progress (Tager-Flusberg et al. 1990; Tek et al. 2014;). Substantial variability in communication trajectories has also been reported in the first few years of life in ASD (Brignell et al. 2016; Landa et al. 2013; Lombardo et al. 2015) with more stable and predictable patterns of development reported from 6 to 19 years (Pickles et al. 2014).

Variability in trajectories seen in ASD may not be unique to the condition. Studies of language growth in children with specific language impairment, have also reported greater variability in trajectories before 6 years and relative consistency from 6 years of age onwards (Conti-Ramsden et al. 2012; Law et al. 2008). Variability has also been found in population studies of children under 8 years (McKean et al. 2016; Taylor et al. 2013) and in children under 9 years with non-spectrum developmental disabilities (Anderson et al. 2007). However, clearly-defined comparison groups within the same cohort are needed to test whether this pattern of language trajectory is indeed unique to ASD.

Language trajectories may differ according to the severity of the child's language problems and the time period being studied (Tek et al. 2014; Toth et al. 2006). Studies of children with ASD have examined a range of factors that may impact on later language outcome, focusing both on environmental (e.g., parent interaction style, socio-economic status and intervention; Ellis Weismer and Kover 2015; McDuffie and Yoder 2010; Siller et al. 2013) and child factors (e.g., play, gesture, joint attention, imitation, IQ, language ability, gender and ASD symptoms; Baghdadli et al. 2012; Ellis Weismer and Kover 2015; Luyster et al. 2007; Toth et al. 2006). Nonverbal IQ is the most consistently reported significant predictor of later language outcome (Thurm et al. 2015; Wodka et al. 2013). Earlier language ability has also been found to be important (Ellis Weismer and Kover 2015; Turner et al. 2006). There have been inconsistent findings around the importance of ASD symptoms in predicting language outcomes. Severity of ASD symptoms are reported as significant by some studies (Baghdadli et al. 2012; Ellis Weismer and Kover 2015; Magiati et al. 2011). One study that grouped children into categories of no words/single words, phrase or fluent speech based on ADOS module found severity of ASD symptoms was a stronger predictor than non-verbal IQ for the age at which children acquired speech (Wodka et al. 2013). By contrast, others have noted social ability is less important after factors such as nonverbal IQ are taken into account (Sigman and McGovern 2005; Thurm et al. 2015).

Despite an increase in the number of studies that have investigated patterns and predictors of language outcome in ASD, clinicians are still unable to provide timely, accurate prognostic information about language outcomes to parents based on their child's individual skill profile. Policy makers and service providers also require information about communication outcomes to inform decisions regarding allocation of resources and services. The aims of this study were to (a) examine individual patterns of receptive and expressive language development in children with ASD from 4 to 7 years; (b) compare the proportions of children with ASD who had declining, stable and accelerating patterns of language development between 4 and 5 and 7 years to children with typical development (TD) and language impairment (LI); (c) compare mean language development for children with ASD over time to children with LI and TD; (d) investigate whether children with ASD have relative weakness in receptive compared to expressive language (e) investigate predictors of language outcomes from 4 to 7 years, in a representative community sample.

Methods

Participants

Participants were drawn from the Early Language in Victoria Study (ELVS), a longitudinal, community-based study of language development in children (n = 1910). Participants were recruited from 6 of 31 local government areas around metropolitan Melbourne to represent a range of social economic advantage and disadvantage. Exclusion criteria were known developmental delay (e.g., Down syndrome), cerebral palsy or other serious medical conditions when the child was 8 months, and if parents had inadequate English to complete questionnaires (see Reilly et al. 2006, 2007 for further details). Several subgroups were selected from the ELVS for comparison. Communication growth from 1 to 2 years for these same groups have been reported in a prior publication (Brignell et al. 2016).

Ethical approval was obtained from the Royal Children's Hospital (#23018) and La Trobe University, Human Ethics Committee (#03-32). All parents provided written, informed consent.

Measures

Demographic details were collected when participants were aged 8–12 months. *The Clinical Evaluation of Language Fundamentals-Preschool-Second Edition* (CELF-P2; Wiig et al. 2006) was administered to participants at 4 years and the *Clinical Evaluation of Language Fundamentals-Fourth Edition* (CELF-4; Semel et al. 2003) at 5 and 7 years. This comprehensive standardised tool measures receptive and expressive language. Language domains including morphology (grammar), syntax (sentence structure), semantics (word meanings) and vocabulary were assessed and included for both plotting change over time and as the outcome measures for the regression analysis. Trained psychology graduates and speech pathologists administered the direct language assessments. Receptive and expressive index standard scores from the CELF-4 were used.

The Kaufman Brief Intelligence Test-2 (KBIT-2; Kaufman and Kaufman 2004) and *Wechsler Abbreviated Scale of Intelligence* (WASI; Wechsler 1999) were administered at 4 and 7 years, respectively. Standard scores were used from each tool. *The Pediatric Quality of Life Inventory 4.0*: parent report form (PedsQL; Varni et al. 2001) and the *Strengths and Difficulties Questionnaire* (SDQ; Goodman 1997) were completed by parents when participants were aged 4 years. A critical review of studies that used tools to assess quality of life in children with ASD found the PedsQL was the most frequently used quality of life tool for children with ASD. It was also the only tool where both reliability and validity had been established for children with ASD. Significant differences were found in social functioning scores between individuals with ASD and chronic health conditions and individuals with ASD and healthy individuals (i.e. no chronic condition) (Ikeda et al. 2014). Several studies have reported on the performance of children with ASD on the SDQ (e.g. Iizuka et al. 2010; Russell et al. 2013). These studies found children with ASD had more difficulties than those without ASD (and children with other co-morbidities) in the peer problems and prosocial behaviour subscales.

Identification of Subgroups

Identification of Participants with Autism Spectrum Disorder

From 4 years of age parents were asked if their child had received a diagnosis of ASD. Following parent report a psychologist (MP), experienced in the diagnosis of ASD, conducted a telephone interview to verify the diagnosis and collect information on: type of diagnosis, age of diagnosis, comorbidities and where the diagnosis was made, who made the diagnosis and some general questions about schooling and progress. The psychologist did not use an autism diagnostic tool during this interview. Forty four children were reported to have ASD, yielding an estimated prevalence between 2.3–3.0% with denominators representing those participants who remained in the study at 7 years ($n = 1438$) and those who were originally enrolled in the study ($n = 1910$). The prevalence of ASD in the ELVS cohort at 7 years is consistent with another population-based Australian study (the Longitudinal Study of Australian Children) that reported a parent-reported estimated ASD prevalence of 2.5% at 7 years and 2.4–3.9% at 10 years of age (May et al. 2017; Randall et al. 2015). Similar estimates have also been reported in several international studies ranging from 2.2 to 2.6% (Kim et al. 2011; Waugh 2016; Zablotsky et al. 2013). The majority of children ($n = 41/44$; 93%) received a diagnosis of ASD from a multidisciplinary team with at least two professionals (typically paediatrician, psychologist, speech pathologist). The remaining children ($n = 3$) were diagnosed by a paediatrician. Families of children with ASD also completed the *Social Communication Questionnaire* (SCQ; Rutter et al. 2003) at 7 years of age. Mean scores on the SCQ for the children with ASD in this study were 13.3 (SD 4.08; range 5–20). Mean SCQ scores were lower than might be expected for children diagnosed with ASD in this study indicating milder ASD symptoms. This may be related to the sample being community-based compared with clinically-derived samples. The SCQ is a parent reported measure of ASD symptoms and is not equivalent to a comprehensive diagnostic assessment that takes into account multiple assessment tools, informants and child behaviour in different environments. Forty-four children in the sample were diagnosed with ASD but in the present study only those children who had completed the CELF at 4 or 5 and 7 years ($n = 26$–27) were included in the analysis.

Identification of Language Impaired and Typical Language Development

Children were allocated to the language impaired (LI) and typical language (TD) groups based on their performance on the CELF and the WASI. Group allocation was conducted at 7 years. Children in the LI group had a WASI score ≥ 70 and a CELF score at two time points (7 years and 4 or 5 years) ≥ 1.25 standard deviations below the mean on either the receptive and/or expressive index. For the TD group children were required to have a WASI standard score ≥ 85 and a CELF score at 7 years and 4 or 5 years of ≤ 1.25 standard deviations below the mean on both the receptive and expressive index. Children were excluded from these groups if they had ASD. These criteria for group assignment were based on previous literature (Reilly et al. 2014; Tomblin et al. 1996). Children were only included in the current study if their language skills were measured on the CELF at 4 or 5 and 7 years. This produced 119 children in the LI group and 861 children in the TD group. Seventeen children with ASD were excluded from the analyses because they did not complete the language assessment at two time points. Reasons for missing data included: withdrew from the ELVS ($n = 4$), verbal ability too limited to complete CELF ($n = 3$), unable to schedule ($n = 3$), child non-compliant to testing ($n = 4$) and parents too busy with other interventions to schedule assessment ($n = 3$). We tested whether there were differences between the characteristics of these 17 children and those with ASD who were included in the study. There were no significant differences ($p > 0.05$) for the eight demographic factors (gender, number of children at home, English main language spoken at home, married/defacto, socio-economic advantage, maternal age at birth, primary caregiver completed high school and CDI total language score at 2 years). However, mean scores on early language and IQ measures were lower for the children with ASD who were not included in the analysis (see Supplementary Table A for detail).

Predictor Measures for Whole Sample

Nine predictors were used in this study. Baseline receptive and expressive language ability was based on a child's standard score at 4 or 5 years on the CELF-P or the CELF-4. Standard scores from the receptive and expressive index were used. Social communication skills were measured using the social functioning subscale from the PedsQL and peer relationship problems and prosocial behaviour subscales from the SDQ. Autism was assigned as described above. Nonverbal IQ was measured using the KBIT-2 matrices subtest. Standard scores were used. The ELVS sample at 7 years is skewed toward families who are more socioeconomically advantaged (McKean et al. 2015) thus Socio-Economic Indexes for Areas (SEIFA) quintiles were used based on the Australian Bureau of Statistics reference. We were not able to assess intervention as a predictor of outcome because data were not consistently collected at each wave on intervention.

Statistical Analysis

All analyses were conducted using Stata version 13.1. Individual patterns of language growth from 4 to 7 years were plotted for the children with ASD. The proportions of children with ASD who had declining, increasing and stable patterns were compared to children with LI and TD using the Chi square statistic. Various methods for studying language and developmental trajectories are available (e.g., Landa et al. 2012; Venker et al. 2014), however, the small sample size of children with ASD in the current study limited the range and complexity of language development analyses that could be conducted. We defined declining and increasing patterns as more than one standard deviation change (±15 points) in standard scores between 4 and 7 years on the CELF. A one standard deviation change is denoted as a clinically meaningful change in the CELF test manual and is consistent with cut points used in at least one previous study examining language trajectories (e.g., Snowling et al. 2016). Data were also analysed using the Generalised Estimating Equations (GEE) method for fitting the marginal models. An exchangeable correlation structure was used and robust standard errors, which take the dependence of the multiple responses from each participant, were taken into account. The mean change in language from 4 to 7 years for each group was plotted for these models. To assess whether a diagnosis of ASD predicted a greater gap between receptive and expressive language at 4 and 7 years of age we used linear regression with an autism diagnosis as the explanatory variable and the difference between CELF scores at 4 and 7 years as the outcome variable. Cohen's d effect sizes are reported to indicate the strength of the differences in receptive-expressive language gap between children with and without ASD.

We also used linear regression to analyse predictors of language outcome. Predictors were included in the model if they were found to be significant univariate predictors of CELF-4 standard scores. Multicollinearity between the social communication measures (i.e. subscales of the SDQ, PedsQL) was assessed to prioritise the measures. A variance inflation factor of 1.2 indicated low correlation so all three social communication measures were kept in the model. Finally, to assess whether social communication may influence language outcomes differentially by group we conducted bivariate linear regression analyses. We included each social communication measure separately for each group for each language outcome. We then added IQ to the regression model to test whether social communication remained a significant predictor of language receptive or expressive outcome.

Results

Participant characteristics are described in Table 1. There was no evidence of a difference ($p > 0.05$) between any of the three groups (ASD, LI, TD) in number of indigenous children, families where English was the main language spoken at home and maternal age at birth. A higher proportion of children with ASD were male compared to the other groups (ASD vs TD: χ^2 17.05, $p < 0.001$; ASD vs LI χ^2 6.61, $p = 0.01$). Children with LI were more likely to have a greater number of children living in the home ($t = 3.0$, $p < 0.001$) with parents who had not completed high school (χ^2 11.02, $p < 0.001$) and who were not married/defacto (χ^2 11.88, $p = 0.001$) compared to the TD group. The LI group was more socially disadvantaged than both the TD ($t = 2.25$, $p = 0.02$) and ASD ($t = 6.95$, $p < 0.001$) groups. Mean IQ was 99.71 (SD 14.35) for children with ASD included in the analysis with no child having a non-verbal IQ < 70. Children with TD had significantly higher non-verbal IQs than children with ASD ($t = 3.01$, $p < 0.001$) and children with ASD had significantly higher nonverbal IQ than children with language impairment ($t = 2.74$, $p = 0.007$). Children with ASD had significantly higher scores on social measures (SDQ pro-social, $t = 2.09$, $p = 0.037$; PedsQL social, $t = 2.12$, $p = 0.0345$; and SDQ peer problems, $t = 3.36$; $p = 0.0008$) indicating they had greater social difficulties. Children with LI had significantly higher scores than those with TD on the

Table 1 Participant characteristics

	ASD (n = 27)	LI (n = 110)	TD (n = 887)	TD versus ASD	LI versus ASD	LI versus TD
Male, %	85	60	45	$\chi^2 = 17.05$ $p < 0.001$*	$\chi^2 = 6.61$ $p = 0.010$*	$\chi^2 = 8.08$ $p = 0.004$*
Number of children at home, mean (SD; range)	1.8 (0.7; 1–3)	2.0 (1.0; 1–5)	1.7 (0.8; 1–5)	t = −0.67 p = 0.750	t = 1.01 p = 0.158	t = 3.0 p < 0.001*
English main language spoken at home (%)	100	95.8	97.7	$\chi^2 = 0.64$ $p = 0.423$	$\chi^2 = 1.48$ $p = 0.223$	$\chi^2 = 1.17$ $p = 0.278$
Indigenous (%)	0	0	0.24	$\chi^2 = 0.06$ $p = 0.805$	–	$\chi^2 = 0.28$ $p = 0.600$
Married or defacto (%)	96.3	90.8	97.1	$\chi^2 = 0.06$ $p = 0.808$	$\chi^2 = 0.90$ $p = 0.344$	$\chi^2 = 11.88$ $p = 0.001$*
SEIFA score, mean (SD; range)	1025.15 (61.41; 855.5-1090.1)	1012.4 (68.1; 834.4-1107.6)	1046.7 (51.8; 834.4–1147.0)	t = 2.25 p = 0.02*	t = −0.96 p = 0.341	t = −6.95 p < 0.001*
Maternal age at birth, mean (SD; range)	33 (5.1; 23–45)	32.4 (4.2; 19–44)	31.9 (4.9; 19–43)	t=-0.70 p = 0.485	t=-1.06 p = 0.291	t=-1.24 p = 0.215
Primary caregiver completed high school (year 12) (%)	74.1	63.6	81.7	$\chi^2 = 2.12$ $p = 0.347$	$\chi^2 = 2.01$ $p = 0.366$	$\chi^2 = 21.71$ $p < 0.001$*
Child nonverbal IQ, mean (SD; range)	99.6 (14.6, 74–132)	93.2 (10.0; 76–126)	107.9 (14.1; 85–147)	t = 3.01 p = 0.003*	t=-2.74 p = 0.007*	t=-11.02 p < 0.001*
Child core language mean (SD; range)	91.3 (15.2; 63–120)	81.9 (9.5; 53–106)	105.8 (10.8; 65–153)	t = 6.68 p < 0.001*	t=-4.33 p < 0.001*	t=-26.04 p < 0.001*
SDQ pro-social mean (SD; range)[a]	6.8 (2.6; 2.5–10)	7.3 (1.7; 3–10)	7.5 (1.8; 1.3–10)	t = 2.09 p = 0.037*	t = 1.27 p = 0.206	t = 1.35 p = 0.178
PedsQL- social mean (SD; range)	83.8 (16.1; 45–100)	85.8 (14.5; 44–100)	88.7 (11.4; 45–100)	t = 2.12 p = 0.0345*	t = 0.62 p = 0.5377	t = 2.46 p = 0.014*
SDQ peer problems mean (SD; range)[b]	2.2 (1.9; 0–6)	1.9 (1.7; 0–8)	1.2 (1.4; 0–7)	t = 3.36 p = 0.0008*	t = 0.72 p = = 0.473	t = 4.78 p < 0.001*

*Significant at the $p < 0.05$ level, SD = standard deviation, χ^2 = Pearson's chi-squared test, t = test statistic for t-test, *SEIFA* Socio-Economic Indexes for Areas, Non-verbal IQ was measured using the WAIS matrices. Core language was measured by the CELF-4 at 7 years. Social measures (SDQ and PedsQL) were collected at 4 years

[a]Lower score in this subscale indicates more difficulties in this domain

[b]Higher score in this domain indicates more difficulties in this domain

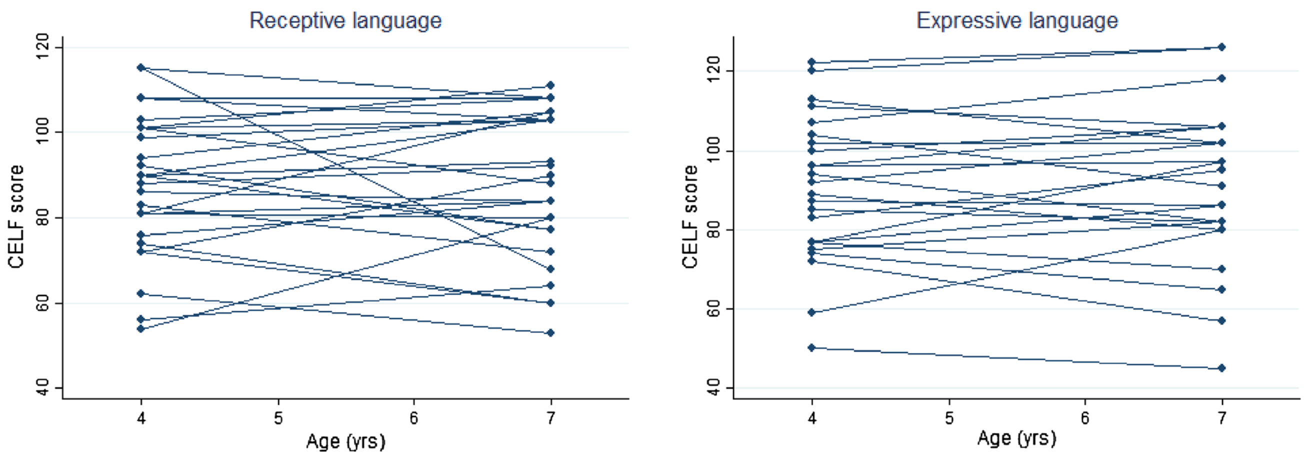
PedsQL social (t = 2.46, p = 0.014) and SDQ peer problems (t = 4.78, p = 0.001) measures.

Individual Change in Language Development for Children with ASD

Changes in language development for individual children with ASD (n = 26–27) are shown in Fig. 1. Three main patterns: declining, accelerating and stable were found for receptive and expressive language in children with ASD from 4 to 7 years. The majority of children with ASD had stable patterns with scores, remaining within one SD of their previous standard score from 4 to 7 years. Three children with ASD could not be tested on the CELF at all three time points due to limited language abilities. One child was minimally verbal (≤ 10 words) at 4 years and continued to have limited receptive and expressive language at 7 years. Another child was verbal but did not have adequate language to complete testing at 4 and 7 years. The third child could only use a limited number of phrases and communicated primarily using sign at 4 and 5 years. This child was verbal by 7 years and able to complete the CELF-4.

Patterns of Language Development

Language development patterns were defined using changes in standard scores for children who were able to complete the CELF (n = 27). Three children who attended assessments at required ages but were not able to complete the CELF are described separately and are not included in the sample of 27. Overall there were no significant differences between the three groups (ASD, LI, TD) in the proportions of children who demonstrated declining, stable and accelerating patterns in receptive



Note. One child in Fig. 1 demonstrated a steep decline in his receptive language ability with very low scores on two of three subtests in the receptive language index at 7 years. His score on the third receptive language subtest was age appropriate. We completed sensitivity analyses by removing this child's scores from the analyses and the overall summary findings remained the same

Fig. 1 Individual patterns of language development from 4 to 7 years of children with ASD (n = 26–27). Standard scores on the CELF are presented

language (χ^2 4.0932; p = 0.394) and expressive language (χ^2 5.9358; p = 0.204) (Table 2). Eighty-one and eighty-five percent of children with ASD had relatively stable standard scores in receptive and expressive language respectively from 4 to 7 years. Eight and eleven percent of children had increasing and 7 and 8% declining patterns, in receptive and expressive language respectively.

Mean Course of Language Development for Each Group

Receptive Language

The estimated mean standard scores for the LI group were 24.6 units lower than the TD group across the three waves of data collection (p < 0.001; 95% CI −26.1, −23.1). The estimated mean standard scores for the ASD group were

Table 2 Patterns of development (decline, maintain and accelerate) for children with ASD, LI and TD

Receptive language	ASD n = 27	LI n = 119	TD n = 861
Baseline mean (SD), range	87.9 (16.5) 54–115	81.3 (10.3) 50–105	102.9 (11.6) 64–132
Follow up mean (SD), range	87.5 (17.1) 53–111	73.2 (10.9) 45–100	99.4 (9.4) 82–125
Decline n (%)	2 (7)	24 (20)	147 (17)
Maintain n (%)	22 (81)	90 (76)	665 (77)
Accelerate n (%)	3 (11)	5 (4)	49 (6)
Expressive language	n = 26	n = 119	n = 858
Baseline mean (SD), range	89.3 (17.9) 50–122	81.3 (10.3) 50–105	105.6 (11.7) 72–140
Follow up mean (SD), range	89.7 (20.4) 45–126	78.3 (11.7) 45–110	103.3 (10.0) 82–136
Decline n (%)	2 (8)	17 (14)	84 (10)
Maintain n (%)	22 (85)	94 (79)	742 (86)
Accelerate n (%)	2 (8)	8 (7)	32 (4)

A declining or accelerating pattern of development was defined using criteria of ±1 standard deviation difference between standard scores at 4 and 7 years (i.e. change of ±15 standard score points)

18.0 units lower than the TD group across the three waves of data collection (p < 0.001; 95% CI − 23.2, − 12.7). There was a small effect of gender in the whole cohort (ASD, LI and TD) with girls having a mean standard score 1.6 units higher than boys (p = 0.005; 95% CI 0.5, 2.8). There was no evidence of effect modification by gender on language grouping (i.e. ASD, LI, TD).

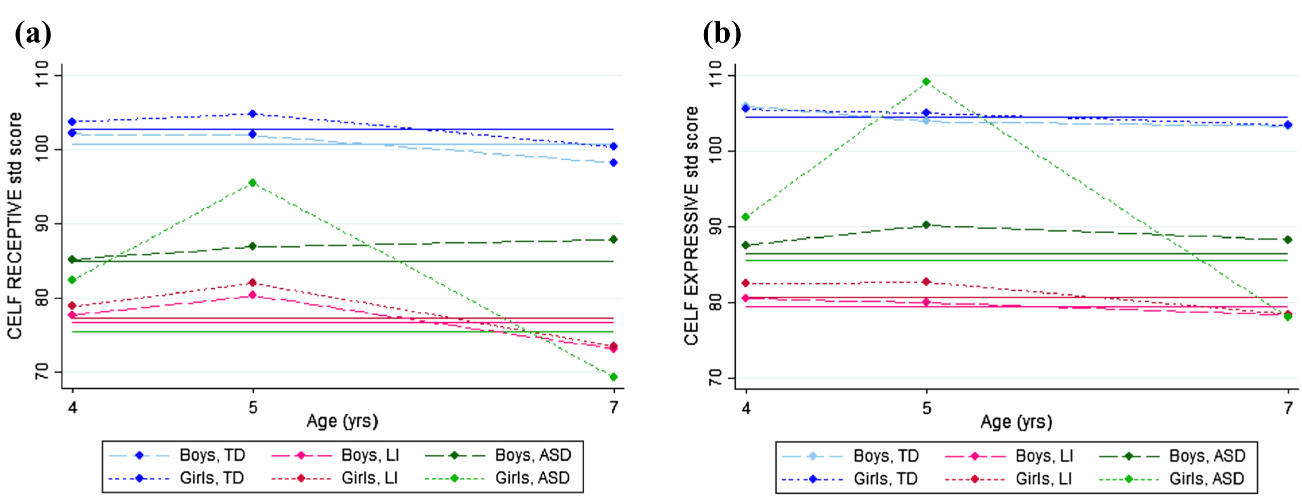
Expressive Language

Estimated mean standard scores were 24.4 units lower for the LI than the TD group across the three waves of data collection (p < 0.001; 95% CI − 26.1, − 22.6). Estimated mean standard scores were 18.1 units lower for the ASD than the TD group across the three waves of data collection (p < 0.001; 95% CI − 24.0, − 12.2). There was no evidence of an effect of gender on the mean standard scores for the whole cohort nor was there any evidence of an interaction between gender and grouping.

Mean patterns of development from 4 to 7 years for children with ASD, LI and TD are presented in Fig. 2a, b. While language ability varied between the three groups, the slopes of change over time in each group were generally flat, indicating the development of language was generally at a comparable rate. Exceptions to this were girls with ASD who demonstrated variable patterns of growth and the LI group who demonstrated a decrease of approximately 7 standard score points from 5 to 7 years in expressive language. Of note, girls with ASD achieved lowest scores of all three groups in receptive language. In order to assess whether using standard scores may have masked variability in language development we compared language development using standard scores to raw scores. Patterns of development for raw scores were similar to those for standard score, with children with LI and ASD having lower mean scores but tracking in parallel to children with TD.

Receptive-Expressive Language Profiles for ASD and non-ASD

There was a wide range of receptive/expressive difference scores (i.e. CELF receptive index standard score minus CELF expressive index standard score) observed in children with and without ASD at 4 years (− 30 to 36), 5 years (− 43 to 43) and 7 years (− 35 to 51). There was no evidence that having a diagnosis of ASD predicted greater receptive-expressive difference scores at 4 years (ASD n = 30, non-ASD n = 1530 at 4 years), 5 years (ASD n = 23, non-ASD n = 959) or 7 years of age (ASD n = 30, non-ASD n = 1174). Children with ASD aged 4 years had on average a 0.45 unit lower difference between expressive and receptive language than children without ASD (95% CI -3.1, 4.0; p = 0.81, *d* = 0.05). At 5 years children with ASD had on average a mean difference 2.0 units higher than children without ASD (95% CI − 2.9, 6.8; p = 0.43, *d* = − 0.17) and at 7 years children with ASD had on average a mean difference 1.7 units lower than children without ASD (95% CI − 5.8, 2.3; p = 0.40, *d* = 0.15). See Fig. 3.



Note. Solid line is the smoothed mean from 4 to 7 years and dashed lines show actual mean scores at 4, 5 and 7 years. LI and TD groups were pre-defined by the authors based on inclusion/exclusion criteria (see "Participants" section). For standard scores, a declining trajectory indicates progress at a slower rate but this does not necessarily indicate a loss of skills

Fig. 2 Mean language trajectories (CELF standard scores) for male and female subgroups of children with ASD, TD, LI in receptive language (**a**) and expressive language (**b**)

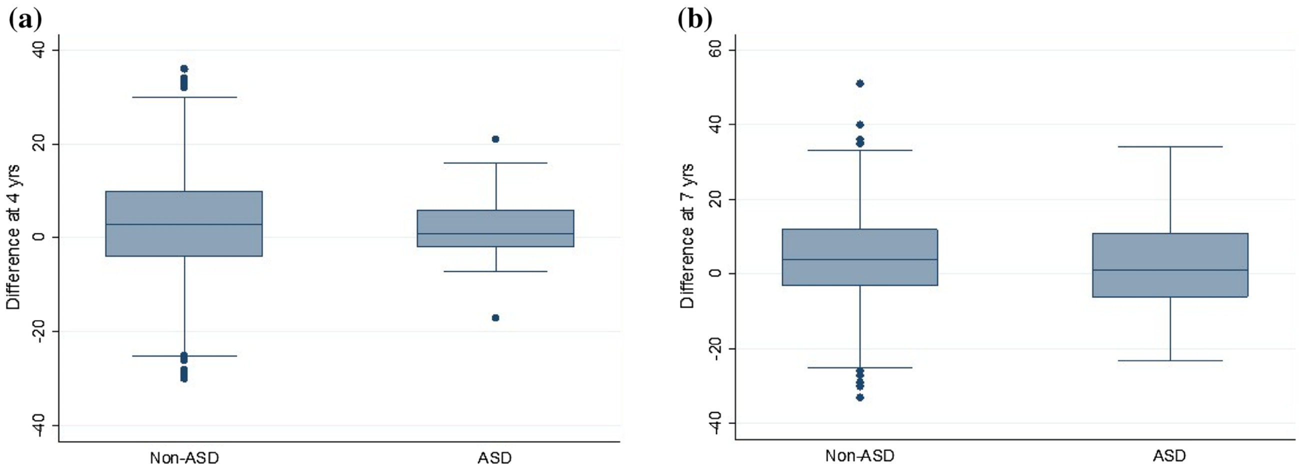


Fig. 3 Distribution of the receptive-expressive difference scores for non-ASD (n = 1204–1560) and ASD (n = 30) children at 4 (**a**) and 7 years (**b**)

Predictors of Receptive and Expressive Language Outcomes at 7 Years for Whole Sample

Five of nine predictors examined using multivariate analysis made a statistically significant independent contribution to variance in receptive language outcome. These included receptive ($B = 0.38$, $p < 0.001$) and expressive baseline scores ($B = 0.23$, $p < 0.001$), gender ($B = 1.63$, $p = 0.01$), non-verbal IQ ($B = 0.17$, $p < 0.001$) and socio-economic disadvantage ($B = 0.63$, $p = 0.02$). For expressive language, only receptive ($B = 0.19$, $p < 0.001$) and expressive ($B = 0.56$, $p < 0.001$) baseline scores and IQ ($B = 0.07$, $p = 0.002$) were significant. A diagnosis of autism and social ability at 4 years were not significant predictors of either receptive or expressive language ability at 7 years once gender, baseline receptive language skills, baseline expressive language skills and IQ at 4 years of age were taken into account. The model explained 44% of the variance in receptive language outcome ($p < 0.001$) and 58% of the variance in expressive language outcome ($p < 0.001$). See Table 3.

We investigated the social communication variables further to test whether they influenced language outcomes for the three groups differentially. First, we conducted bivariate linear regression with each social communication measure for each language outcome by group. Here the PedsQL social and SDQ peer problems variables were found to be significant predictors for receptive language in children with ASD ($\beta = 0.46$, $p = 0.038$ and $\beta = -4.1$, $p = 0.032$, respectively). Pro-social behaviour was a significant predictor ($\beta = 0.43$, $p = 0.017$) of receptive language for the TD group. None of the social variables reached significance for children with LI. For expressive language, SDQ-peer problems was a significant predictor ($\beta = 5.46$, $p = 0.011$) for the ASD group and no other social communication variables reached significance for either language outcome in any other group. Next we added non-verbal IQ (KBIT-2) to the model for those analyses where social variables were found to be significant predictors of language outcome. No social variables maintained significance for any of the three groups once non-verbal IQ was added to the regression model.

Discussion

To our knowledge this study is the first to report on verbal children with ASD (IQ > 70) using clinician administered, comprehensive, standardised language assessments in a longitudinal community sample that has used the same measures for children with LI and TD. The community sample minimizes ascertainment bias and enables important comparisons.

This study found individual variation in the type of language pattern observed for children across all three groups (LI, TD and ASD), however, the groups were remarkably similar in the proportions of children with declining, maintaining and accelerating patterns from 4 to 7 years. For children with ASD, 81–85% had relatively stable standard scores in receptive and expressive language respectively from 4 to 7 years. Only 7–8% of children had standard scores that had decreased more than one standard deviation from their previous scores and 8–11% of children had more than one standard deviation increase in receptive and expressive language standard scores (acceleration).

This finding is consistent with two other studies that used different methodology to the current study. Fountain et al. (2012) mapped trajectories of communication functioning based on interview questions from an annual Client Development Evaluation from 3 to 14 years. Most children with ASD improved their communication functioning over time with around 7.5% described as "bloomers" (communication

Table 3 Predictors of language outcomes

Variable	Coefficient	t statistic	95% CI	p value
Receptive language outcome (n = 1086)				
Baseline receptive	0.38	12.48	0.32 to 0.44	< 0.001
Baseline expressive	0.23	7.43	0.17 to 0.29	< 0.001
PedsQL social	0.01	0.26	− 0.05 to 0.06	0.794
SDQ pro-social[a]	− 0.12	− 0.68	− 0.47 to 0.22	0.497
SDQ peer problems[b]	− 0.22	− 0.97	− 0.68 to 0.23	0.334
Autism	3.66	1.66	− 0.67 to 8.0	0.098
Female gender	1.63	2.57	0.38 to 2.88	0.01
Nonverbal IQ	0.17	6.34	0.12 to 0.22	< 0.001
SEIFA disadvantage	0.63	2.30	0.09 to 1.18	0.022
Expressive language outcome (n = 1086)				
Baseline receptive	0.19	7.64	0.14 to 0.24	< 0.001
Baseline expressive	0.56	21.5	0.50 to 0.61	< 0.001
PedsQL social	− 0.03	− 1.18	− 0.08 to 0.02	0.240
SDQ pro-social[a]	0.04	0.29	− 0.25 to 0.34	0.773
SDQ peer problems[b]	− 0.01	− 0.06	− 0.40 to 0.38	0.953
Autism	− 0.75	− 0.40	− 4.41 to 2.92	0.689
Female gender	− 0.80	− 1.48	− 1.85 to 0.26	0.139
Nonverbal IQ	0.07	3.11	0.03 to 0.11	0.002
SEIFA disadvantage	0.31	1.30	− 0.16 to 0.77	0.194

Baseline receptive and expressive language at 4 or 5 years was measured using the CELF-P or CELF-4. Outcome expressive and receptive language was measured at 7 years using the CELF-4. Social communication was measured at 4 years using the pro-social and peer problems subscales from the SDQ and the social subscale from the PedsQL. Nonverbal IQ was measured at 4 years using the KBIT-2. Socio-Economic Indexes for Areas (SEIFA) quintiles were used based on the Australian Bureau of Statistics reference

[a]Lower score in this subscale indicates more difficulties in this domain

[b]Higher score in this domain indicates more difficulties in this domain

functioning accelerated over time). For the whole sample, most rapid development was found to occur prior to 6 years with functioning becoming more stable beyond this time (Fountain et al. 2012). Pickles et al. (2014) investigated parent-reported adaptive communication skills in children with ASD from 2 to 9 years and found that despite substantial heterogeneity in language development in the early years, progress beyond 6 years was mostly uniform. Pickles et al. (2014) hypothesised that heterogeneity in early language development may be related to increased brain plasticity and greater sensitivity to environmental stimuli that facilitate early language development. This pattern of development over time is supported by a prior study that used the same cohort as the current study and mapped language from 1 to 2 years (Brignell et al. 2016). Language change from 1 to 2 years was found to be more variable than that reported in the current study from 4 to 7 years. There are, however, other possible explanations for his change in development over time including less accurate measurement of language ability in the early years or multiple different language development pathways that all progress to the same endpoint in later childhood. Furthermore, our study used more than one standard deviation change (i.e. decline, maintain, accelerate) to indicate a clinically meaningful change, consistent with some other studies (e.g., Snowling et al. 2016). Criteria used to assess variation in patterns has differed from study to study and the threshold used in the current study may be wider and less likely to find more subtle differences in development compared to others.

Children with ASD had lower mean scores in receptive and expressive language compared with typically developing children but scored higher than children with language impairment across the three time periods. Despite some heterogeneity in language development, most children with ASD demonstrated rates of language development comparable to those with LI and TD. In other words, progress over time for the ASD group was similar to the LI and TD group, albeit with the ASD and LI groups starting from a lower baseline. Stability in communication progress has also been reported to occur in two other studies of children with ASD (Fountain et al. 2012; Pickles et al. 2014) and is consistent with studies of children with language impairment (Conti-Ramsden et al. 2012; Law et al. 2008) and the 'tracking hypothesis'. The 'tracking hypothesis' suggests despite children with LI having lower mean scores than children with TD, on average they track in parallel, with stable growth in language ability over time (Law et al. 2008). The current study presents mean scores for each group and did not subgroup children with ASD based on language ability. However, it has been argued that children with ASD and co-occuring LI may present with comparable language phenotypes to children with LI alone and children with ASD who have age appropriate language skills may present with phenotypes comparable to those with typical language development (Tager-Flusberg 2006, 2015). If phentotypes are reported to be similar and language impairment is co-morbid to ASD rather than integral, it is feasible language trajectories may also be similar and that a diagnosis of ASD in itself may be less relevant to language change over time.

Mean receptive and expressive language standard scores were lower for girls with ASD compared with all other groups in this study and female gender was a significant predictor of receptive language outcome at 7 years. However, the small sample of four girls in our study limits any specific conclusions we can make about language development in girls with ASD.

A strength of this study is that we were able to report on receptive and expressive language separately and compare each of these domains across several time points. Here we found a diagnosis of ASD did not predict a greater difference in receptive relative to expressive language. Furthermore, this study did not find a significant mean difference between the two language domains for children with ASD at any of the three time points measured. This finding is in contrast to some other studies that have found slower growth in receptive language relative to expressive language (Kover et al. 2013) and expressive language advantage over receptive language for a substantial group of children with ASD (Ellis Weismer et al. 2010; Hudry et al. 2010; Luyster et al. 2008; Mitchell et al. 2006). However, our results are consistent with a meta-analytic review investigating receptive-expressive discrepancy in ASD (Kwok et al. 2015). This review (n = 74 studies) examined receptive and expressive language performance in children with ASD and found no evidence that expressive language was stronger than receptive language in children with ASD. Furthermore, the child's developmental stage, cognitive abilities, vocabulary, overall language ability and type of tool used to assess language and diagnose ASD were not found to be significant contributors to relative receptive-expressive discrepancy (Kwok et al. 2015). Most of these studies have not included comparison groups which has limited our understanding of whether language profiles are specific to ASD.

Several factors predicted later language ability in the whole cohort. Receptive and expressive language ability and nonverbal IQ at 4 years were found to be important predictors of language at 7 years. This is convergent with previous research using clinical samples of children with ASD that have highlighted the importance of early language and IQ (Ellis Weismer and Kover 2015; Fountain et al. 2012; Luyster et al. 2007; Paul et al. 2008; Thurm et al. 2007; Wodka et al. 2013; Yoder et al. 2015). In longitudinal studies of children without ASD earlier language ability has been found to be a predictor of later language (Bishop and Edmundson 1987; Hayiou-Thomas et al. 2014), with expressive syntax and narrative retell the strongest predictors in one study of children with language impairment (IQ > 70) from 7 to 11 years of age (Botting et al. 2001). The same study found IQ was an important predictor of later language outcome (Botting et al. 2001).

Socio-economic disadvantage (specifically being in the most disadvantaged quintile), and gender were predictors of receptive but not expressive language in the current study. This finding is consistent with other studies of children with ASD that have found caregiver education discriminated higher vs low verbal outcomes (Anderson et al. 2007; Ellis Weismer and Kover 2015). Furthermore, socioeconomic characteristics (more educated, non-minority mothers) predicted which children with ASD were more likely to make the most rapid progress in communication functioning in another study (Fountain et al. 2012). Low maternal education and low family income have been identified as a risk factor of receptive vocabulary at 7 years in another large cohort longitudinal population-based study, although expressive vocabulary was not measured (Taylor et al. 2013), and low maternal education and socioeconomic status predicted adverse receptive and expressive language outcomes at 4 years in another study that used data from the same cohort as the current study (Reilly et al. 2010). Samples of children with language impairment have also been found to contain disproportionate numbers of children with socio-economic disadvanatage (Roy and Chiat 2013; Toppelberg and Shapiro 2000).

This study did not enable us to identify the mechanisms by which socio-economic disadvantage may impact later language outcomes, however a range of factors may be at play including a possible link between socioeconomic disadvantage and parental language ability that could be inherited, family stress, access to interventions and level of language stimulation and learning opportunities in the child's home and community environment. There is some evidence, for example, that parents in higher socioeconomic groups expose their children to larger vocabularies compared with those in lower socioeconomic groups and better outcomes have been found to be a function of parent interaction style and language input in typically developing children (Hart and Risely 1995; Hoff 2003).

It is unclear why socioeconomic disadvantage predicted lower receptive but not expressive language at 7 years in this study. We might hypothesise that receptive language development is more sensitive to the language environment than expressive language. It is also possible different factors influence receptive and expressive language outcomes in dissociable ways. For example, a study of 129 children with ASD found while ASD symptom severity predicted growth in both receptive and expressive language, cognition only predicted growth in expressive language (Ellis Weismer and Kover 2015). Moreover, another study found joint attention, intentional communication and verbal responses from parents predicted outcomes in both language domains. However, consonant inventory only predicted expressive language growth and early receptive vocabulary and autism severity predicted only receptive language growth (Yoder et al. 2015).

Diagnosis of ASD and parent-reported social ability at 4–5 years of age were not predictors of expressive or receptive language at 7 years once factors such as IQ and baseline language ability were taken into account. The methodology used in this study was unique in being able to test a categorical diagnosis of ASD as a predictor of language outcomes in a large cohort of children with and without ASD. Direct comparison to the findings of previous studies that have examined the influence of ASD symptoms on later language (e.g. Ellis Weismer and Kover 2015; Wodka et al. 2013; Yoder et al. 2015) was not possible. Our sample of children with ASD was small (and therefore may be too small to observe an effect) and we were not able to classify children into different levels of severity of ASD symptoms. Furthermore, children in our study with ASD may have had milder social communication symptoms than children from clinically-derived samples. Results should therefore be viewed with caution and await replication.

Our finding that social ability at 4 years (social functioning, peer relationship problems and pro-social behaviour) did not predict language at 7 years is consistent with the findings of some studies of children with ASD (Sigman and McGovern 2005; Thurm et al. 2015) but not others (Baghdadli et al. 2012; Ellis Weismer and Kover 2015; Magiati et al. 2011; Wodka et al. 2013). Variable findings across studies may relate to different ages being studied, the different tools used to measure social ability, or the different types of social abilities captured by the tool. It is possible some social abilities have more influence over language than others and that there are more sensitive ages and language levels where social ability has greater influence on language. For example, social ability may have more impact when children are in the early stages of learning language or for children who have more significantly delayed language.

This study did not collect detailed information on interventions children had received and is therefore not able to investigate whether intervention type or dosage predicted language outcomes. Of studies that have investigated the impact of intervention on language there have been mixed findings with some reporting intervention was not a significant predictor (e.g, Ellis Weismer and Kover 2015) and others reporting intensity of speech therapy (along with age and non-verbal IQ) predicted acquisition of speech (Mazurek et al. 2012) and number of hours of speech/language therapy (along with motor imitation) predicted later language ability (Stone and Yoder 2001).

Recently studies have started to explore neural substrates that may contribute to the heterogeneity in language trajectories in ASD. In one study, the best predictor of later language outcomes for children with ASD was a combination of behavioural measures (standardised tests of adaptive communication, language and autism symptoms) and speech-related neuroimaging biomarkers (specifically, superior temporal cortex activity as measured using fMRI; Lombardo et al. 2015). The afore-mentioned findings are yet to be replicated and our understanding of the brain mechanisms underlying language ability and outcomes in ASD is still in its infancy. Understanding the neurobiological underpinnings of language will be important to delineate ASD subtypes, to assist clinicians with applying appropriate language interventions and for better predicting language outcomes.

Limitations

The analysis in this study was limited to children who could complete the CELF, with qualitative information provided about three children with ASD who were not able to complete the CELF at two time points due to limited language and/or cognitive ability and floor effects on tools (i.e. children were not able to achieve basal scores). Therefore, the main findings are only relevant to children who had verbal language and an IQ > 70.

Standardised tools such as the CELF are not designed to assess children with very limited verbal ability and being a large scale community-based study meant there were limitations to the customisation of assessments for children with different verbal abilities. However, best practice recommendations have been developed for the assessment of minimally-verbal children with ASD and appropriate assessment tools (formal and informal) are available (Kasari et al. 2013). Children in the study with minimal verbal ability made progress in their communication skills, however it was not possible to assess their rate of development. To date evidence points to children with ASD who had relatively lower expressive language ability at baseline experiencing a slower rate of language growth compared to children with higher language development (Anderson et al. 2007; Baghdadli et al. 2012; Ellis Weismer and Kover 2015; Tek et al. 2014). The exclusion of children who were minimally verbal may skew our findings and limits their application to assessable children.

Our sample size of children with ASD (n = 27, including four female) is small which reduces statistical power. The substantial difference in sample size between the children with ASD and those without ASD also needs to be considered when interpreting our findings. Given this was a community-based study, the children in the study were not diagnosed with ASD uniformly using the same methods and we relied on parent report of ASD, with verification through interview. Different versions of the CELF were used at 4 years compared to 5 and 7 years, however mean scores, standard deviations and ranges for the whole sample were very similar for each version of the CELF (4 years: M 99.62, SD 15.1, 50–140; 5 years: M 100.6, SD 13.9, 55–144; 7 years: M 98.8, SD 13.6, 45–136). While it is possible our subgroups may respond differently to different versions of the CELF the change in version should impact all groups equally. Lastly, our language impairment group included children who had expressive language disorder, receptive language disorder, or combined receptive/expressive language disorder. Inclusion criteria for the LI group were based on prior research and recommendations (Bishop et al. 2017; Reilly et al. 2014), however, combining language subgroups rather than examining language domains separately (i.e. children with expressive compared with receptive language disorder) may have impacted our findings around group differences.

Clinical Implications

Our findings contribute new knowledge to our current understanding of language development in children with ASD. The findings provide preliminary information that in verbal children with ASD aged 4–7 years with intelligence within the normal range, most children will develop language at a similar pace to typically developing children and a diagnosis of ASD in itself does not necessarily mean a child will fall further behind their peers in language development. Rather, other factors may be more relevant to later language ability such as nonverbal IQ and earlier language level than a diagnosis of ASD. This is important information for clinicians to consider when parents ask them about their child's likely language outcome. It may also have implications for the types of factors to consider and prioritise when providing language interventions.

The age at which this study investigated predictors (4 years) of later outcomes is consistent with the mean age children are typically diagnosed with ASD in Australia before 7 years of age (Bent et al. 2015) and the factors found to be predictive of language outcomes should be readily available to clinicians who diagnose children with ASD, as part of recommended best practice assessment.

This study was not able to provide clinicians with useful prognostic information on language development in children with ASD who have intellectual disability and/or those children who could not complete formal testing on the CELF. Predictors of language outcomes have, however, been investigated in studies specifically designed for minimally verbal children with ASD (e.g., Yoder et al. 2015) and change in language over time for these children is also being examined (Rose et al. 2016). Such studies are highly valuable and this area of research needs to be a research priority given the poor outcomes for children who do not develop verbal language. Further research is also needed to bring together the multiple factors that interact and impact language outcomes so more personalised prognostic information can be provided to families.

Acknowledgments Funding for the Early Language in Victoria Study was provided by Project Grants #237106 and #9436958 from the Australian National Health and Medical Research Council (NHMRC) and small grants from the Murdoch Children's Research Institute and the Faculty of Health Sciences, La Trobe University. The researchers acknowledge the Australian NHMRC for salary support through Practitioner Fellowships #491210 (S.R) and #1105008 (A.M); NHMRC Centre of Research Excellence in Speech and Language Neurobiology #1116976 (A.M, A.B). This paper is based on work completed by A.B for her PhD. A.B was supported by an Australian Postgraduate Award scholarship. Infrastructure support was provided by the Victorian Government's Operational Infrastructure Support Program. We wish to thank the William Collie Trust Fund for their financial support. This funding organization was not involved in the development, design, analysis, or interpretation of the study.

Author Contributions AB conceived and planned this study with input from ATM, KW, SR, MP. KJ and AB completed the statistical analyses. AB, ATM, KW, MP, KJ, SR contributed to the interpretation of the results. AB wrote the manuscript and all authors provided critical feedback on the manuscript.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5 ed.). Arlington: American Psychiatric Association.

Anderson, D. K., Lord, C., Risi, S., DiLavore, P. S., Shulman, C., Thurm, A., et al. (2007). Patterns of growth in verbal abilities among children with autism spectrum disorder. *Journal of Consulting & Clinical Psychology, 75*(4), 594–604.

Baghdadli, A., Assouline, B., Sonie, S., Pernon, E., Darrou, C., Michelon, C., et al. (2012). Developmental trajectories of adaptive behaviors from early childhood to adolescence in a cohort of 152 children with autism spectrum disorders. *Journal of Autism & Developmental Disorders, 42*(7), 1314–1325.

Barger, B. D., Campbell, J. M., & McDonough, J. D. (2013). Prevalence and onset of regression within autism spectrum disorders: A meta-analytic review. *Journal of Autism & Developmental Disorders, 43*(4), 817–828.

Bent, C. A., Dissanayake, C., & Barbara, J. (2015). Mapping the diagnosis of autism spectrum disorders in children aged under 7 years in Australia, 2010–2012. *Medical Journal of Australia, 202*(6), 317–320.

Billstedt, E., Gillberg, I. C., & Gillberg, C. (2011). Aspects of quality of life in adults diagnosed with autism in childhood: A population-based study. *Autism, 15*(1), 7–20.

Bishop, D. V., & Edmundson, A. (1987). Specific language impairment as a maturational lag: Evidence from longitudinal data on language and motor development. *Developmental Medicine & Child Neurology, 29*(4), 442–459.

Bishop, D. V. M., Snowling, M. J., Thompson, P. A., & Greenhalgh, T. (2017). Phase 2 of CATALISE: A multinational and multidisciplinary Delphi consensus study of problems with language development: Terminology. *Journal of Child Psychology and Psychiatry, 58*(10), 1068–1080.

Botting, N., Faragher, B., Simkin, Z., Knox, E., & Conti-Ramsden, G. (2001). Predicting pathways of specific language impairment: What differentiates good and poor outcome? *Journal of Child Psychology & Psychiatry, 42*(8), 1013–1020.

Brignell, A., Williams, K., Prior, M., Donath, S., Reilly, S., Bavin, E. L., et al. (2016). Parent-reported patterns of loss and gain in communication in 1- to 2-year-old children are not unique to autism spectrum disorder. *Autism, 21*(3), 344–356.

Centers for Disease Control and Prevention. (2014). Prevalence of autism spectrum disorder among children aged 8 years—Autism and developmental disabilities monitoring network, 11 sites, United States, 2010. *Morbidity and Mortality Weekly Report, 63*, 1–21.

Condouris, K., Meyer, E., & Tager-Flusberg, H. (2003). The relationship between standardized measures of language and measures of spontaneous speech in children with autism. *American Journal of Speech Language Pathology, 12*(3), 349–358.

Conti-Ramsden, G., St Clair, M. C., Pickles, A., & Durkin, K. (2012). Developmental trajectories of verbal and nonverbal skills in individuals with a history of specific language impairment: From childhood to adolescence. *Journal of Speech, Language, & Hearing Research, 55*(6), 1716–1735.

Ellis Weismer, S., & Kover, S. T. (2015). Preschool language variation, growth, and predictors in children on the autism spectrum. *Journal of Child Psychology & Psychiatry, 56*(12), 1327–1337.

Ellis Weismer, S., Lord, C., & Esler, A. (2010). Early language patterns of toddlers on the autism spectrum compared to toddlers with developmental delay. *Journal of Autism and Developmental Disorders, 40*(10), 1259–1273.

Fountain, C., Winter, A. S., & Bearman, P. S. (2012). Six developmental trajectories characterize children with autism. *Pediatrics, 129*(5), e1112-20.

Gillespie-Lynch, K., Sepeta, L., Wang, Y., Marshall, S., Gomez, L., Sigman, M., et al. (2012). Early childhood predictors of the social competence of adults with autism. *Journal of Autism & Developmental Disorders, 42*(2), 161–174.

Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A research note. *Journal of Child Psychology & Psychiatry, 38*(5), 581–586.

Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experiences of young American children*. Baltimore: Paul Brookes.

Hayiou-Thomas, M. E., Dale, P. S., & Plomin, R. (2014). Language impairment from 4 to 12 years: Prediction and etiology. *Journal of Speech, Language, & Hearing Research, 57*(3), 850–864.

Hoff, E. (2003). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. *Child Development, 74*(5), 1368–1378.

Howlin, P., & Moss, P. (2012). Adults with autism spectrum disorders. *The Canadian Journal of Psychiatry/La Revue canadienne de psychiatrie, 57*(5), 275–283.

Howlin, P., Moss, P., Savage, S., & Rutter, M. (2013). Social outcomes in mid- to later adulthood among individuals diagnosed with autism and average nonverbal IQ as children. *Journal of the American Academy of Child & Adolescent Psychiatry, 52*(6), 572–581.

Hudry, K., Leadbitter, K., Temple, K., Slonims, V., McConachie, H., Aldred, C., et al. (2010). Preschoolers with autism show greater impairment in receptive compared with expressive language abilities. *International Journal of Language & Communication Disorders, 45*(6), 681–690.

Iizuka, C., Yamashita, Y., Nagamitsu, S., et al. (2010). Comparison of the strengths and difficulties questionnaire (SDQ) scores between children with high-functioning autism spectrum disorder (HFASD) and attention-deficit/hyperactivity disorder (AD/HD). *Brain & Development, 32*(8), 609–612.

Ikeda, E., Hinckson, E., & Krageloh, C. (2014). Assessment of quality of life in children and youth with autism spectrum disorder: A critical review. *Quality of Life Research, 23*(4), 1069–1085.

Kasari, C., Brady, N., Lord, C., & Tager-Flusberg, H. (2013). Assessing the minimally verbal school-aged child with autism spectrum disorder. *Autism Research, 6*(6), 479–493.

Kaufman, A. S., & Kaufman, N. L. (2004). *Kaufman brief intelligence test*: Hoboken: Wiley.

Kim, Y. S., Leventhal, B. L., Koh, Y. J., Fombonne, E., Laska, E., Lim, E. C., et al. (2011). Prevalence of autism spectrum disorders in a total population sample. *American Journal of Psychiatry, 168*(9), 904–912.

Kjelgaard, M. M., & Tager-Flusberg, H. (2001). An investigation of language impairment in autism: Implications for genetic subgroups. *Language and Cognitive Processes, 16*(2–3), 287–308.

Kover, S., McDuffie, A., Hagerman, R., & Abbeduto, L. (2013). Receptive vocabulary in boys with autism spectrum disorder: Cross-Sectional developmental trajectories. *Journal of Autism and Developmental Disorders, 43*(11), 2696–2709.

Kwok, E. Y. L., Brown, H., Smyth, R. E., Cardy, O., J. E (2015). Meta-analysis of receptive and expressive language skills in autism spectrum disorder. *Research in Autism Spectrum Disorders, 9*, 202–222.

Landa, R. J., Gross, A. L., Stuart, E. A., & Bauman, M. (2012). Latent class analysis of early developmental trajectory in baby siblings of children with autism. *Journal of Child Psychology & Psychiatry, 53*(9), 986–996.

Landa, R. J., Gross, A. L., Stuart, E. A., & Faherty, A. (2013). Developmental trajectories in children with and without autism spectrum disorders: The first 3 years. *Child Development, 84*(2), 429–442.

Law, J., Tomblin, J. B., & Xuyang, Z. (2008). Characterizing the growth trajectories of language-impaired children between 7 and 11 years of age. *Journal of Speech, Language, & Hearing Research, 51*(3), 739–749.

Lombardo, M. V., Pierce, K., Eyler, L. T., Barnes, C.C., Ahrens-Barbeau, C., Solso, S. et al. (2015). Different functional neural substrates for good and poor language outcome in autism. *Neuron, 86*(2), 567–577.

Luyster, R., Kadlec, M. B., Carter, A., & Tager-Flusberg, H. (2008). Language assessment and development in toddlers with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 38*(8), 1426–1438.

Luyster, R., Qiu, S., Lopez, K., & Lord, C. (2007). Predicting outcomes of children referred for autism using the MacArthur-Bates Communicative Development Inventory. *Journal of Speech Language, & Hearing Research, 50*(3), 667–681.

Magiati, I., Moss, J., Charman, T., & Howlin, P. (2011). Patterns of change in children with autism spectrum disorders who received community based comprehensive interventions in their pre-school years: A seven year follow-up study. *Research in Autism Spectrum Disorders, 5*(3), 1016–1027.

May, T., Sciberras, E., Brignell, A., & Williams, K. (2017). Autism spectrum disorder: Updated prevalence and comparison of two birth cohorts in a nationally representative Australian sample. *BMJ Open, 7*(5), e015549.

Mazurek, M. O., Kanne, S. M., & Miles, J. H. (2012). Predicting improvement in social–communication symptoms of autism spectrum disorders using retrospective treatment data. *Research in Autism Spectrum Disorders, 6*(1), 535–545.

McDuffie, A., & Yoder, P. (2010). Types of parent verbal responsiveness that predict language in young children with autism spectrum disorder. *Journal of Speech Language, & Hearing Research, 53*(4), 1026–1039.

McKean, C., Law, J., Mensah, F., Cini, E., Eadie, P., Frazer, K., et al. (2016). Predicting meaningful differences in school-entry language skills from child and family factors measured at 12 months of age. *International Journal of Early Childhood, 48*(3), 329–351.

McKean, C., Mensah, F. K., Eadie, P., Bavin, E. L., Bretherton, L., Cini, E., et al. (2015). Levers for language growth: Characteristics and predictors of language trajectories between 4 and 7 years. *PLoS One, 10*(8), e0134251. https://doi.org/10.1371/journal.pone.0134251.

Mitchell, S., Brian, J., Zwaigenbaum, L., Roberts, W., Szatmari, P., Smith, I., & Bryson, S. (2006). Early language and communication development of infants later diagnosed with autism spectrum disorder. *Journal of Developmental & Behavioral Pediatrics, 27*(2), S69–S78.

Paul, R., Chawarska, K., Cicchetti, D., & Volkmar, F. (2008). Language outcomes of toddlers with autism spectrum disorders: a two year follow-up. *Autism Research, 1*(2), 97–107.

Pickles, A., Anderson, D. K., & Lord, C. (2014). Heterogeneity and plasticity in the development of language: A 17-year follow-up of children referred early for possible autism. *Journal of Child Psychology & Psychiatry, 55*(12), 1354–1362.

Randall, M., Sciberras, E., Brignell, A., Ihsen, E., Efron, D., Dissanayake, C., & Williams, K. (2015). Autism spectrum disorder: Presentation and prevalence in a nationally representative Australian sample. *The Australian and New Zealand Journal of Psychiatry, 50*(3), 243–253.

Reilly, S., Eadie, P., Bavin, E. L., Wake, M., Prior, M., Williams, J., et al. (2006). Growth of infant communication between 8 and 12 months: A population study. *Journal of Paediatrics & Child Health, 42*(12), 764–770.

Reilly, S., Tomblin, B., Law, J., McKean, C., Mensah, F. K., Morgan, A., … Wake, M. (2014). Specific language impairment: A convenient label for whom? *International Journal of Language and Communication Disorders, 49*(4), 416–451.

Reilly, S., Wake, M., Bavin, E. L., Prior, M., Williams, J., Bretherton, L., et al. (2007). Predicting language at 2 years of age: A prospective community study. *Pediatrics, 120*(6), 1441–1449.

Reilly, S., Wake, M., Ukoumunne, O. C., Bavin, E., Prior, M., Cini, E., et al. (2010). Predicting language outcomes at 4 years of age: Findings from Early Language in Victoria Study. *Pediatrics, 126*(6), 1530–1537.

Rose, V., Trembath, D., Keen, D., & Paynter, J. (2016). The proportion of minimally verbal children with autism spectrum disorder in a community-based early intervention programme. *Journal of Intellectual Disability Research, 60*(5), 464–77.

Roy, P., & Chiat, S. (2013). Language and socioeconomic disadvantage: Teasing apart delay and deprivation from disorder. In C. R. Marshall (Ed.), *Current issues in developmental disorders* (pp. 125–150). Hove: Psychology Press.

Russell, G., Rodgers, L. R., & Ford, T. (2013). The strengths and difficulties questionnaire as a predictor of parent-reported diagnosis of autism spectrum disorder and attention deficit hyperactivity disorder. *PLoS ONE, 8*(12), e80247.

Rutter, M., Bailey, A., & Lord, C. (2003). *The Social Communication Questionnaire*. Los Angeles CA Western Psychological Services.

Semel, E., Wiig, E., & Secord, W. A. (2003). *Clinical evaluation of language fundamentals, Australian version* (4th ed.). San Antonio: The Psychological Corporation.

Sigman, M., & McGovern, C. W. (2005). Improvement in cognitive and language skills from preschool to adolescence in autism. *Journal of Autism &Developmental Disorders, 35*(1), 15–23.

Siller, M., Hutman, T., & Sigman, M. (2013). A parent-mediated intervention to increase responsive parental behaviors and child communication in children with ASD: A randomized clinical trial. *Journal of Autism &Developmental Disorders, 43*(3), 540–555.

Snowling, M. J., Duff, F. J., Nash, H. M., & Hulme, C. (2016). Language profiles and literacy outcomes of children with resolving, emerging, or persisting language impairments. *Journal of Child Psychology & Psychiatry, 57*(12), 1360–1369.

Stone, W. L., & Yoder, P. J. (2001). Predicting spoken language level in children with autism spectrum disorders. *Autism, 5*(4), 341–361.

Tager-Flusberg, H. (2006). Defining language phenotypes in autism. *Clinical Neuroscience Research, 6*(3-4), 219–224.

Tager-Flusberg, H. (2015). Defining language impairments in a subgroup of children with autism spectrum disorder. *Science China Life Science, 58*(10), 1044–1052.

Tager-Flusberg, H., Calkins, S., Nolin, T., Baumberger, T., Anderson, M., & Chadwick-Dias, A. (1990). A longitudinal study of language acquisition in autistic and Down syndrome children. *Journal of Autism & Developmental Disorders, 20*(1), 1–21.

Tager-Flusberg, H., Edelson, L., & Luyster, R. (2011). Language and communication in autism spectrum disorders. In D. Amaral, G. Dawson, & D. Geschwind (Eds.), *Autism spectrum disorders*. Oxford: Oxford University Press.

Taylor, C. L., Christensen, D., awrence, D., Mitrou, F., & Zubrick, S. R. (2013). Risk factors for children's receptive vocabulary development from four to eight years in the longitudinal study of Australian children. *PLoS One, 8*(9), 1–20. https://doi.org/10.1371/journal.pone.0073046.

Tek, S., Mesite, L., Fein, D., & Naigles, L. (2014). Longitudinal analyses of expressive language development reveal two distinct language profiles among young children with autism spectrum disorders. *Journal of Autism & Developmental Disorders, 44*(1), 75–89.

Thurm, A., Lord, C., Lee, L. C., & Newschaffer, C. (2007). Predictors of language acquisition in preschool children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 37*(9), 1721–1734.

Thurm, A., Manwaring, S. S., Swineford, L., & Farmer, C. (2015). Longitudinal study of symptom severity and language in minimally verbal children with autism. *Journal of Child Psychology & Psychiatry, 56*(1), 97–104.

Tomblin, J. B., Records, N. L., & Zhang, X. (1996). A system for the diagnosis of specific language impairment in kindergarten children. *Journal of Speech Hearing Research, 39*(6), 1284–1294.

Toppelberg, C. O., & Shapiro, T. (2000). Language disorders: A 10-year research update review. *Journal of the American Academy of Child and Adolescent Psychiatry, 39*(2), 143–152.

Toth, K., Munson, J., Meltzoff, A. N., & Dawson, G. (2006). Early predictors of communication development in young children with autism spectrum disorder: Joint attention, imitation, and toy play. *Journal of Autism & Developmental Disorders, 36*(8), 993–1005.

Turner, L. M., Stone, W. L., Pozdol, S. L., & Coonrod, E. E. (2006). Follow-up of children with autism spectrum disorders from age 2 to age 9. *Autism, 10*(3), 243–265.

Varni, J. W., Seid, M., & Kurtin, P. S. (2001). PedsQL™ 4.0: Reliability and validity of the Pediatric Quality of Life Inventory™ Version 4.0 Generic Core Scales in healthy and patient populations. *Medical Care, 39*(8), 800–812.

Venker, C., Ray-Subramanian, C., Bolt, D., & Weismer, S. (2014). Trajectories of autism severity in early childhood. *Journal of Autism & Developmental Disorders, 44*(3), 546–563.

Waugh, I. (2016). The prevalence of autism (including Asperger syndrome) in school age children in Northern Ireland. *Health do* Belfast, Northern Ireland: Northern Ireland Statistics & Research Agency. Retrieved September 19, 2017, from https://www.health-ni.gov.uk/topics/dhssps-statistics-and-research.

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence*. New York: Psychological Corporation.

Wiig, E. H., Secord, W., & Semel, E. (2006). *Clinical evaluation of language fundamentals preschool, Australian edition—CELF Preschool* (2nd ed.). Marrickville: Harcourt Assessment.

Wittke, K., Mastergeorge, A. M., Ozonoff, S., Rogers, S. J., & Naigles, L. R. (2017). Grammatical language impairment in autism spectrum disorder: Exploring language phenotypes beyond standardized testing. *Frontiers in Psychology, 8*, 532. https://doi.org/10.3389/fpsyg.2017.00532.

Wodka, E., Mathy, P., & Kalb, L. (2013). Predictors of phrase and fluent speech in children with autism and severe language delay. *Pediatrics, 131*(4), 1128–1134.

Yoder, P., Watson, L. R., & Lambert, W. (2015). Value-added predictors of expressive and receptive language growth in initially nonverbal preschoolers with autism spectrum disorders. *Journal of Autism & Developmental Disorders, 45*(5), 1254–1270.

Zablotsky, B., Black, L. I., Maenner, M. J., Schieve, L. A., & Blumberg, S. J. (2013). Estimated prevalence of autism and other developmental disabilities following questionnaire changes in the 2014 National Health Interview Survey. *National Health Statistics Reports, 13*(87), 1–21.