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Subgroups in language trajectories from 4 to 11 years: the nature and predictors of stable, improving and decreasing language trajectory groups

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Background: Little is known about the nature, range and prevalence of different subgroups in language trajectories extant in a population from 4 – 11 years. This hinders strategic targeting and design of interventions, particularly targeting those whose difficulties will likely persist. **Methods:** Children's language abilities from 4-11 years were investigated in a specialist language longitudinal community cohort (N=1910). Longitudinal trajectory latent class modelling was used to characterise trajectories and identify subgroups. Multinomial logistic regression was used to identify predictors associated with the language trajectories children followed. **Results:** Three language trajectory groups were identified: 'stable' (94% of participants); low-decreasing (4%) and low-improving (2%). A range of child and family factors were identified that were associated with following either the low-improving or low-increasing language trajectory; many of them shared. The low-improving group was associated with mostly environmental risks: non-English speaking background, social disadvantage, few children's books in the home. The low-decreasing group was associated with mainly biological risks: low birthweight, socio-emotional problems, lower family literacy, learning disability. **Conclusions:** By 4 years services can be confident most children with low language will remain low to 11 years. Using rigid cut-points in language ability to target interventions is not recommended due to continued individual variability in language development. Service delivery models should incorporate monitoring over time, targeting according to language abilities and associated risks and delivery of a continuum of interventions across the continuum of need. **Keywords:** language development, Language Disorder, longitudinal trajectory, latent class

There is growing recognition that limited language abilities in childhood can have lifelong implications. The associated difficulties with forming and maintaining peer relationships (Conti-Ramsden & Botting, 2008), and with literacy, and educational attainment (Snowling, Adams, Bishop, & Stothard, 2001) have measurable downstream consequences for adult mental health, social inclusion and employment (Law, Rush, Schoon, & Parsons, 2009). The promotion of robust child language development is therefore recognised as a global priority in many educational and social policies. This paper characterises the prevalence and natural history of developmental trajectory subgroups in child language development between 4 - 11 years in a specialist language longitudinal community cohort of children in Victoria, Australia.

Instability in language profiles in the pre-school years is well recognised (Bornstein, Hahn, & Putnick, 2016). Longitudinal population samples have demonstrated most children who experience early ‘delays’ catch up with their peers (Ghassabian et al., 2014; Henrichs et al., 2011; Reilly et al., 2010; Zambrana, Pons, Eadie, & Ystrom, 2014). Conversely these studies also reveal that after a positive start some children develop later language difficulties (Ghassabian et al., 2014; Zambrana et al., 2014). Approximately 7% of 4-5 year-old children are estimated to have language problems (Norbury et al., 2016) and although instability is more pronounced in the pre-school than school years (Bornstein et al., 2016) a significant proportion of children continue to move between impaired and non-impaired categories after school-entry (McKean et al., 2017; Zubrick, Taylor, & Christensen, 2015).

Current knowledge regarding children’s language trajectories means intervention services are likely to both over and under-service some children. Identifying and understanding the differences between children likely to have persisting long-term difficulties, those whose difficulties may resolve and those for whom language difficulties emerge later in development, is therefore an important research priority. Such analysis could inform public policy aiming to meet the needs of this population with respect to supporting language development and intervention targeting (Bishop, Snowling, Thompson, Greenhalgh, & CATALISE-2 consortium, 2016; Conti-Ramsden, St. Clair, Pickles, & Durkin, 2012).

Previous studies have explored subgroups in language trajectories, however methodological limitations exist with respect to both analytical approach and sampling. The most common approach to defining subgroups in language is a ‘categorical’ one; assigning children to either impaired or unimpaired groups at specific cut-points in language scores at two or more time points (Beitchman et al., 1996; Bishop & Edmundson, 1987; Law, Rush, Anandan, Cox, & Wood, 2012; Snowling, Duff, Nash, & Hulme, 2015; Zambrana et al., 2014; Zubrick et al., 2015). Whilst providing important insights this approach has significant disadvantages. Measurement error inevitably leads to instability in group membership for children whose scores fall near a cut-point. Regression to the mean can suggest changes in children’s profile that are, in fact, artefacts of repeated measurement. Furthermore, the cut-point at which ‘impairment’ is defined is necessarily arbitrary in such approaches and creates a bias *a-priori* to finding a ‘disordered’ pathway.

Advanced analytical approaches such as longitudinal trajectory latent class analyses and the multi-level model of change have been applied to understanding school-age language trajectories. However studies have either used clinical samples of children with Developmental Language Disorder (DLD) and considered trajectories within that group (Law, Tomblin, & Zhang, 2008), or used matched cohorts of children with DLD and typically developing children (Beitchman et al., 2008; Rice & Hoffman, 2015), or have not identified subgroups (McKean et al., 2015; Taylor, Christensen, Lawrence, Mitrou, & Zubrick, 2013). Thus estimates of prevalence of different subgroups have not been made nor are we certain that the full range of school-age trajectories extant in a population have been uncovered. We address these challenges through the application of longitudinal trajectory latent class analysis, a method which minimises issues associated with measurement error and repeated measurement, to data from a specialist language longitudinal community cohort (the Early Language in Victoria Study - ELVS) considering children aged 4 to 11 years.

Predictors of prognosis

Recently, Zambrana et al (2014) and Snowling et al (2015) examined 'trajectories' of DLD in early to middle childhood (3–5 and 3–8 years respectively). They suggest a 'late emerging' trajectory may be most influenced by genetic mechanisms, as indicated by family history of language or literacy difficulties, and a 'persisting ' trajectory may reflecting multiple accumulative risks (Zambrana et al., 2014) including social disadvantage (Snowling et al., 2015). In addition to characterising the nature of subgroups in language trajectories this paper also aims to build on these previous studies to identify the specificity with which predictors are associated with the language trajectories that children will follow. In this special edition, Bishop and colleagues advocate the term Language Disorder be used for children who are likely to have language problems "enduring into middle childhood and beyond" (p. x). Bishop acknowledges a major challenge in operationalising this for practice is the "relatively limited evidence regarding prognostic indicators" (p. x) making identification of children likely to have 'enduring' difficulties challenging. Indeed, as children transition into formal schooling even those who may go on to receive diagnoses of co-occurring conditions such as Autistic Spectrum Disorder (ASD) or Attention Deficit Hyperactivity Disorder ADHD often have not been identified. Clinicians and educators may remain unsure as to which of the children they support are most at risk. We therefore examine whether clinically applicable predictors can be identified which indicate whether children's difficulties are likely to persist or indeed worsen over time to support implementation of Bishop et al's recommendations to practice.

Empirical analyses using ELVS

Given the limited knowledge of the subgroups of trajectories in school-age language development across the range of language ability we adopted an exploratory approach. In a community sample beginning as children transition into formal schooling and ending at the threshold of high school and adolescence, we asked:

- What are the *subgroups in trajectories of language development* from 4–11 years that may be identified within a community sample using longitudinal latent class analysis?

- What are the predictors of the trajectories children follow that hence can be used as indicators of prognosis?

Methods

Participants and procedures

Participants were from the ELVS cohort, a specialist language longitudinal community cohort which is largely representative of children in Victoria. Detailed recruitment, sampling procedures, and exclusion criteria are provided elsewhere (Reilly et al., 2006). At baseline 1910 children aged 7.5-10 months were recruited (see Appendix S1 for participant flowchart and demographic data). Parents completed questionnaires at baseline, annually from 1 to 7 years, and then at 9 and 11 years. Direct child assessments were carried out at 4, 5, 7 and 11 years of age. Ethical approval was provided by the Human Research Ethics Committees at the Royal Children's Hospital, Melbourne and La Trobe University.

Measures

Language

The Clinical Evaluation of Language Fundamentals (CELF) Australian Standardised Edition was administered at 4 (CELF P2) (Wiig, Secord, & Semel, 2006) 5, 7 and 11 years of age (CELF 4) (Semel, Wiig, & Secord, 2006). For the statistical analyses, the CELF raw score was standardized to a z-score with respect to the sample at each wave, (*Mean (M)*=0; *Standard Deviation (SD)*=1) to ensure consistency and ease of interpretability across waves.

Predictors

Child factors

At baseline parents reported gender, low birth weight (<2500 grams) and birth position and from 6 years indicated whether their child had ever been diagnosed with ADHD, a learning disability, or ASD. All ASD diagnoses were later validated through telephone interview with a qualified clinician experienced in ASD. At 4 years non-verbal cognition was assessed (Kaufman Brief Intelligence Test (K-BIT) (Kaufman & Kaufman, 2004)) screening for speech disorder was undertaken (≤ 10th centile (Goldman & Fristoe, 2000)) and parents completed the Strengths and Difficulties Questionnaire (SDQ). Clinical cut-points were used to determine the presence of socio-emotional problems (Goodman, 1997).

Maternal and family factors

A range of family and maternal factors were determined by parent report at baseline including: whether languages other than English were spoken in the home (non-English speaking background-

NESB); family history of language and/or literacy difficulties (i.e. whether the mother, father or siblings had been late to talk, had ongoing problems with speech or language, stuttered or had problems learning to read); maternal age at birth (> 24 years; ≤ 24 years); and maternal education (completed < year 12 – the last year of formal schooling in Australia; ≥ year 12). At 4 years parents reported whether the main language spoken to the child was not English (non-English speaking background-NESB).

Socioeconomic disadvantage was calculated using baseline postcodes and the census-derived SEIFA Index of Relative Disadvantage (Australian Bureau of Statistics, 2001) (*M*=1000, *SD*=100: a lower score representing greater disadvantage). Family literacy was derived using a composite score calculated from mothers' and fathers' Mill Hill Vocabulary Scale at child age 2 years (Raven, Court, & Raven, 1998) and the Wide Range Achievement Test Reading subtest at child age 4 years (WRAT-4) scores (Wilkinson & Robertson, 2006). Measures were each scaled to a z score, then summed and a further z score calculated from the sum.

Home learning environment factors included the number of books in the home (at 2 years: < 10; 10-20; 21-30; > 30 books); the frequency the child was read to (measured at all waves from 8 months - 4 years using the Brigance Infant and Toddler Screen (BITS) (Glascoe & Brigance, 2002) item "I look at or read children's books to my child" (not very often; sometimes; often); and average child television exposure (hours per week) measured at 4 years). To aid data analysis, quintiles were derived from a composite score of the BITS item across data waves and from the average exposure to television each week.

Support/intervention factors

At each wave parents reported on any additional help sought relating to the child's speech and language in the last 12 months.

Statistical analysis

Latent trajectories

For the latent class trajectory analysis modelling was conducted on the subset of children completing at least two language assessments at 4, 5, 7 and 11 years, consisting of 1,279 children (from the total of 1,910). Using the statistical software package 'R' (R Core Team, 2014), the 'hlme' function of the `lcmm' package (Proust-Lima, Philipps, Diakite, & Liquet, 2015) was used to model the language scores across time, identifying groups of children with similar patterns or trajectories. Parameter estimates were derived using a full information maximum likelihood (FIML) estimator which is a commonly accepted way to handle missing data (Schafer & Graham, 2002).

Latent class growth modelling was completed using standardized CELF Core z score (*M*=0, *SD*=1) as the outcome. Preliminary analysis of the distribution of scores at each time point supported assuming the groups were normally distributed. A quadratic trend over time allowed for curvilinear trajectories. Models were run with 1, 2, 3 and 4 groups with each group allowed to have different parameters (e.g. different intercept, linear, quadratic trend and variance). We additionally examined a number of alternative modelling approaches, including random effects models (allowing individual trajectories to be more variable than the group mean) and those allowing for autocorrelation (due to the repeated nature of the measurements) (Ohlssen, Sharples, & Spiegelhalter, 2007; Wraith & Wolfe, 2014). Model fit statistics for the alternative modelling approaches are presented in Appendix S2.

For further analysis, we selected the best model using both statistical goodness of fit criteria and interpretability, the latter taking into account the size of the groups, the complexity of the model and the size of the difference between the groups. To assess the statistical goodness of fit we used estimates of the log-likelihood (LR), the Akaike Information Criteria (AIC) and the Bayesian Information Criteria (BIC) (Akaike, 1974; Lo, Mendell, & Rubin, 2001; Schwartz, 1978). Lower estimates of all these measures indicate better fitting and in the case of AIC and BIC, more parsimonious models. Following these criteria, the fixed effects model allowing for autocorrelation and including three trajectory groups was chosen. This model was then used to calculate for each participant the posterior probability of following each language trajectory and identify the most likely trajectory.

Bivariable models

To identify predictor variables associated with group membership a series of bivariable multinomial logistic regressions were completed in Stata (StataCorp., 2013). The results are presented as relative risks (RR) in our analyses which may be similarly interpreted to standard odds ratios in logistic regression. To account for uncertainty in group memberships we used weighting with the posterior probabilities of group membership representing the weights (Wraith & Wolfe, 2014).

Multivariable model

To examine the unique impact of individual risks and possible effects of accumulative risk exposures a multivariable multinomial logistic regression analysis was conducted. Variables significant at ≤ 0.05 level in the bivariable multinomial logistic regression analyses were included. To account for collinearity, minimise the effect of missing predictors, and not over-fit the model given the small sample sizes in some of the groups a highly conservative approach was taken. First variables most likely to account for differences in trajectories were included (NESB, and the neurodevelopmental disorders: learning disability, ADHD and ASD). We then identified the minimum number of predictors which represented factors from the Child, Family, Maternal and Support/intervention categories whilst also considering collinearity and missing data. At each stage the multivariable model was assessed using model fit criteria, LR tests and pseudo-R^2 values.

Results

Participants

Compared to the entire ELVS cohort (N=1910) participant families in the latent class analysis (N=1,279) were more likely to have higher SEIFA, and be more highly educated and older mothers (Appendix S1).

Language trajectories

Figure 1 illustrates the individual growth trajectories and Table 1 presents the numbers of children within the ELVS sample classified according to their most likely trajectory group.

Figure 1

Table 1

Between 4 - 11 years ~ 4% of children were classified as having a low-decreasing trajectory and ~ 2% a low-improving trajectory. The remaining children had a stable trajectory (~94%) with language scores ranging from 2 *SD* below or above the mean.

The majority of the low-decreasing group and all the low-increasing group had language scores below the mean at 4 years. Approximately 50% of children in the low-decreasing class had either a learning disability, ASD or ADHD diagnosis and 50% of the low-improving class were from a NESB.

Bivariable analyses

Tables 2 and 3 present the findings of bivariable analyses testing the association between child, family and support/intervention factors and group membership using the stable group as the reference and including those factors which reach or approach significance at the $p < .05$ level.

A large number of factors placed children at increased risk of being in *either* the low-decreasing or low-increasing group rather than the stable group. These included the *child factors* of speech disorder, peer problems, learning disability diagnosis, and lower non-verbal cognitive score; the *family factors* family history of language difficulties, lower family literacy and SEIFA, 10-30 books in the home (relative to having > 30); higher average hours of TV viewing per week; seeking additional support at 6 years. For these factors RR were usually similar across the two groups except in the case of learning disability diagnosis (low-decreasing RR = 12.96, p <.001; low-increasing RR = 2.66, $p = .01$), and help-seeking (low-decreasing RR = 8.54, $p < .001$; low-increasing RR = 2.17, $p = .04$). Factors associated *only* with an increased risk of *low-decreasing group* membership were low birth weight, emotional problems, conduct problems, inattention and hyperactivity, ADHD or ASD diagnosis, and seeking help for the child's difficulties at ages 4, 9 and 11 years. Factors associated *only* with an increased risk of *low-increasing group* were NESB (RR = 41.25, $p < .001$), a younger mother and < 10 children's books in the home (RR = 15.44, $p < .001$).

Tables 2, 3 & 4

Multivariable analysis

A multivariable analysis examined the unique impact and possible effects of accumulative exposures of individual factors on group membership. Analyses should be interpreted with caution given small group sizes. Children were at increased risk of being members of the *low-decreasing group* if they had lower non-verbal cognition, low birth weight, a learning disability diagnosis, lower family literacy, 10-20 children's books in the home and if parents had sought additional support (age 6 years). Children were at increased risk of being in the *low-increasing group* if they were NESB, had lower non-verbal cognition and SEIFA scores, <10 children's books in the home and were not low birth weight.

Discussion

This study applied longitudinal trajectory latent class modelling in a community sample with repeated direct testing of children's language to identify subgroups in trajectories of language development from 4–11 years across the full range of ability. Three groups were identified: a large 'stable' group with wide ranging but relatively stable language ability which included the majority of children (94%), 5% of whom had language abilities falling > 1.25 SD below the mean; a 'low-decreasing' group; and a 'low-increasing' group. Of significant concern was the small group of children following a low-decreasing trajectory, starting with below average language abilities at 4 years and falling substantially over time so that all children in the group experienced severe language difficulties by age 11. Over the course of the study approximately half of this group received a diagnosis of learning disability, ASD or ADHD. In contrast by 11 years all of the children in the low-increasing group (the smallest group) had language scores within the typical range, and by 7 years were indistinguishable from the stable group (McKean et al., 2015). Around half were from a NESB providing further support for the argument that children from NESB require prolonged exposure to the language of instruction in preschool and school to consolidate skills in both languages.

In terms of identifying which children are likely to have enduring language problems these data suggest that the relative position in language ability of most children is established by 4 years of age: those with low language at 4 years are likely to stay low to 11 years. The clear exception were children from a NESB who were likely to catch up with their peers by 7 years. Although the mean trajectory in the 'stable' trajectory group was flat, a small degree of variability in rate of progress was present such that children would continue to move above and below any given cut-point over time (McKean et al., 2017). Indeed ~ 22% of the 'stable' group had a difference in score from 4 -11 years of > .75 SD; a meaningful change in relative ability.

Early identification of the vulnerable children in the low-decreasing group would be beneficial for children and families, enabling access to earlier intervention and educational support. Children following this low-decreasing trajectory were more likely to have socio-emotional and behavioural problems, lower family literacy and be of low birth weight. These may be important 'signals of risk' for children presenting with mild-moderate language difficulties at 4 years, indicating the need for monitoring, preventative interventions and multi-disciplinary assessment. Especially given that only half this group received a neurodevelopmental diagnosis over the course of the study, many not doing so until 7 years or older. Targeting interventions should be guided by cumulative risk models based on child and family factors identified as important to prognosis. These factors are considered when children present to specialist services however many children with low language do not (Morgan et al., 2016; Skeat et al., 2014). The application of cumulative risk models to targeting in communities 'at risk' of both language difficulties *and* limited access to services should be considered.

Despite the relatively large study sample two subgroups contained small numbers. Combined with missing data for some predictors, this limited our ability to build a comprehensive multivariable risk model and so the findings regarding predictors of group membership should be interpreted with caution. Taking the bivariable and multivariable analyses together there is tentative evidence to suggest that the low-decreasing group was associated with biological risks (i.e. low birth weight; lower family literacy; neurodevelopmental diagnoses) and the low-increasing group with environmental factors (i.e. NESB; young mother; few children's books in the home; lower SEIFA scores) (Snowling et al., 2015; Zambrana et al., 2014). Larger samples, and/or meta-analyses are likely to be required to yield sufficient power to test these findings and those of previous studies. As no previous studies have attempted to define subgroups in longitudinal trajectory across a community sample of school-age children the approach taken to the identification of subgroups was exploratory. Replication in other samples is required to determine whether similar trajectory groups exist in different populations.

Conclusion

For most children individual differences in relative language ability are established before 4 years. Those factors which drive individual differences would appear to exert their influences early or continue to act across development, maintaining children's relative position. By 4 years services can be confident children with low language will remain low over the primary years. However, using rigid cut-points in language ability to determine eligibility to access support is not recommended due to continued individual variability. Our findings suggest service delivery models should incorporate monitoring over time, targeting according to both language abilities and associated risks and delivery of a continuum of interventions across a continuum of need.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Participant Flow chart from 4 months to 11 years (denominator is number participating at baseline – 1910).

Appendix S2. Model fit statistics for the 3 modelling approaches applied.

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Figure 1. Plots of individual growth trajectories by class for Model M1 (on the x-axis is age (years) and on the y-axis is the CELF score, Group 1 = Low-decreasing (n=50), Group 2 = Stable (n=1199), Group 3 = Low-Increasing (n=30))

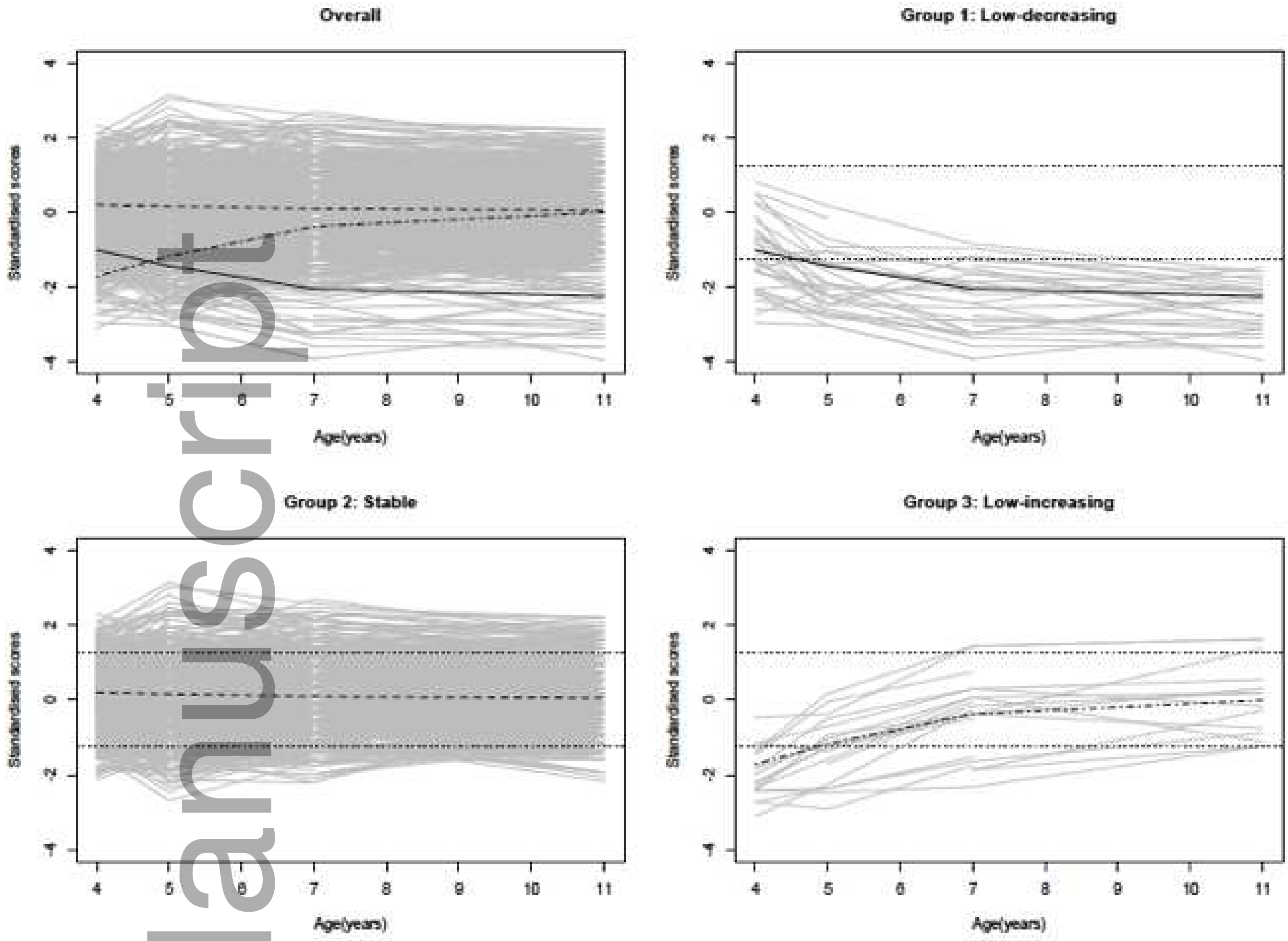
Overall
Group 1: Low-decreasing
Group 2: Stable
Group 3: Low-increasing
Standardised scores
Age(years)

Table 1: Number of children by group and threshold (with percentages) and change in scores from 4 to 11 years by group

	n (%)					Change in scores 4-11 years *M(SD)*
	All waves	4 years	5 years	7 years	11 years	
Overall (total sample)	*1279*	*1239*	*978*	*1188*	*820*	
Above mean		717 (57.9)	496 (50.7)	627 (52.8)	413 (50.4)	
Below mean		522 (42.1)	482 (49.3)	561 (47.2)	407 (49.6)	
1.25 SD below mean		112 (9.0)	116 (11.9)	123 (10.4)	63 (7.7)	
Low-Decreasing group	*50*	*49*	*32*	*45*	*31*	*- 1.51 (.76)*
Above mean		6 (12.2)	1 (3.1)	0 (0.0)	0 (0.0)	
Below mean		43 (87.8)	31 (96.9)	45 (100.0)	31 (100.0)	
1.25 SD below mean		25 (51.0)	26 (81.3)	41 (91.1)	31 (100.0)	
Stable scores group	*1199*	*1161*	*928*	*1115*	*773*	*-.20(.74)*
Above mean		711 (61.2)	494 (53.2)	618 (55.4)	405 (52.4)	
Below mean		450 (38.8)	434 (46.8)	497 (44.6)	368 (47.6)	
1.25 SD below mean		61 (5.3)	80 (8.6)	74 (6.6)	32 (4.1)	
Low-Increasing group	*30*	*29*	*18*	*28*	*16*	*1.96(.75)*
Above mean		0 (0.0)	1 (5.6)	9 (32.1)	8 (50.0)	
Below mean		29 (100.0)	17 (94.4)	19 (67.9)	8 (50.0)	
1.25 SD below mean		26 (89.7)	10 (55.6)	8 (28.6)	0 (0.0	

Table 2: Results of bivariable analysis: child factors

Variables	Groups					Low-decreasing compared to low-increasing group
	Stable group (reference) [a]	Low-decreasing group		Low-increasing group		
	n (%) or *M (SD)*	n (%) or *M (SD)*	RR (95% CI), *p*-value	n (%) or *M (SD)*	RR (95% CI), *p*-value	RR (95% CI), *p*-value
Gender						
Female	615 (51.3)	20 (40.0)	(base)	12 (40.0)	(base)	(base)
Male	584 (48.7)	30 (60.0)	1.39 (0.96, 2.03), p = 0.08	18 (60.0)	1.54 (0.97, 2.45), p = 0.07	0.91 (0.51, 1.61) p = 0.74
Low birth weight						
No	1140 (96.5)	39 (81.3)	(base)	28 (96.5)	(base)	(base)
Yes	41 (3.5)	9 (18.7)	4.05 (1.97, 8.34), p < 0.001	1 (3.5)	0.78 (0.19, 3.24), p = 0.74	5.18 (1.12, 24.02), p=0.04
Non verbal cognition [b]	0.12 (0.91)	-0.92 (1.32)	0.48 (0.39, 0.58), p < 0.001	-0.81 (1.27)	0.53 (0.43, 0.66), p < 0.001	0.90 (0.70, 1.17), p=0.44
Speech disorder						
> than 11th centile	1099 (94.9)	37 (80.4)	(base)	25 (89.3)	(base)	(base)
10th centile or less	59 (5.1)	9 (19.6)	3.22 (1.73, 6.00), p < 0.001	3 (10.7)	2.35 (1.13, 4.86), p = 0.02	1.37 (0.57, 3.33), p=0.49
Socio-emotional problems						
Peer problems						
No	1039 (91.1)	34 (73.9)	(base)	20 (74.1)	(base)	(base)
Yes	101 (8.9)	12 (26.1)	2.90 (1.70, 4.97), p < 0.001	7 (25.9)	3.35 (1.81, 6.22), p < 0.001	0.87 (0.41, 1.87), p=0.72
Emotional problems						
No	1077 (94.5)	39 (84.8)	(base)	26 (96.3)	(base)	(base)
Yes	63 (5.5)	7 (15.2)	2.20 (1.13, 4.29), p=0.02	1 (3.7)	0.65 (0.23, 1.89), p=0.43	3.36 (1.01, 11.20), p=0.05
Conduct problems						
No	1022 (89.7)	35 (76.1)	(base)	25 (92.6)	(base)	(base)
Yes	118 (10.4)	11 (23.9)	2.14 (1.28, 3.57), p=0.004	2 (7.4)	1.12 (0.53, 2.35), p=0.77	1.91 (0.81, 4.54), p=0.14
Inattention/hyperactivity problems						
No	1043 (91.5)	32 (69.6)	(base)	27 (100.0)	(base)	(base)
Yes	97 (8.5)	14 (30.4)	3.45 (2.04, 5.82), p< 0.001	0 (0.0)	0.73 (0.36, 1.47), p=0.38	4.71 (2.07, 10.70), p < 0.001

Neurodevelopmental diagnoses							
ADHD							
	No	1137 (98.8)	38 (84.4)	(base)	27 (100.0)	(base)	(base)
	Yes	14 (1.2)	7 (15.6)	8.78 (3.66, 21.06), p<0.001	0 (0.0)	1.21 (0.23, 6.37), p=0.83	7.29 (1.27, 41.79), p=0.03
Learning disability diagnosis							
	No	1083 (95.0)	21 (47.7)	(base)	23 (88.5)	(base)	(base)
	Yes	57 (5.0)	23 (52.3)	12.96 (7.99, 21.03), p<0.001	3 (11.5)	2.66 (1.26, 5.63), p=0.01	4.87 (2.16, 10.98), p < 0.001
Autism							
	No	1175 (98.0)	42 (84.0)	(base)	29 (96.7)	(base)	(base)
	Yes	24 (2.0)	8 (16.0)	9.33 (3.96, 21.98), p<0.001	1 (3.3)	1.69 (0.22, 12.91), p=0.61	2.58 (0.80, 8.34), p=0.11

a. stable group was the reference group against which the low-decreasing and low-increasing groups were compared in the weighted (multinomial) logistic regression expressed as relative risks (RR); b. standardised ($M = 0$, $SD = 1$)

Table 3: Results of bivariable analysis: family and support/intervention factors

Variable		Classes					Low-decreasing compared to low-increasing group
		Stable group (ref) [a]	Low-decreasing group		Low-increasing group		
		n (%) or *M (SD)*	n (%) or *M (SD)*	RR (95% CI), *p*-value	n (%) or *M (SD)*	RR (95% CI), *p*-value	RR (95% CI), *p*-value
NESB	No	1121 (98.7)	44 (95.7)	(base)	13 (48.2)	(base)	(base)
	Yes	15 (1.3)	2 (4.3)	3.14 (0.96, 10.23), p=0.06	14 (51.9)	41.25 (20.10, 84.77), p < 0.001	0.08 (0.02, 0.26), p < 0.001
Social disadvantage [b]		1043.24 (53.64)	1010.49 (71.43)	0.99 (0.98, 0.99), p < 0.001	995.23 (75.91)	0.99 (0.98, 0.99), p < 0.001	1.00 (1.00, 1.01), p=0.33
Family history	No	906 (75.6)	35 (70.0)	(base)	18 (60.0)	(base)	(base)
	Yes	293 (24.4)	15 (30.0)	1.50 (1.00, 2.25), p = 0.05	12 (40.0)	1.75 (1.07, 2.85), p = 0.03	0.86 (0.47, 1.58), p=0.62
Family literacy [c]		0.19 (0.87)	-0.36 (0.90)	0.57 (0.47, 0.70), p < 0.001	-0.83 (1.39)	0.43 (0.32, 0.58), p < 0.001	1.33 (0.95, 1.87), p=0.10
Home learning environment							
Books in the home							
	More than 30 books	824 (71.3)	20 (43.5)	(base)	10 (35.7)	(base)	(base)
	21 to 30	180 (15.6)	11 (23.9)	1.95 (1.17, 3.24), p = 0.01	4 (14.3)	2.01 (1.09, 3.70), p = 0.03	0.97 (0.45, 2.08), p=0.94
	10 to 20	135 (11.7)	13 (28.3)	2.72 (1.64, 4.53), p < 0.001	8 (28.6)	3.29 (1.74, 6.23), p < 0.001	0.83 (0.38, 1.80), p=0.63
	Less than 10	16 (1.4)	2 (4.4)	2.62 (0.69, 9.94), p = 0.16	6 (21.4)	15.44 (6.30, 37.85), p < 0.001	0.17 (0.04, 0.74), p=0.02

Frequency child read to [d]							
	2	282 (26.7)	7 (18.4)	(base)	1 (4.4)	(base)	(base)
	3	211 (20.2)	4 (10.5)	0.89 (0.44, 1.78), p = 0.74	2 (8.7)	1.43 (0.55, 3.70), p = 0.46	0.62 (0.20, 1.96), p=0.42
	4	341 (32.6)	11 (29.0)	1.22 (0.68, 2.21), p = 0.51	8 (34.8)	2.93 (1.37, 6.29), p = 0.006	0.42 (0.16, 1.06), p=0.07
	Low	211 (20.2)	16 (42.1)	2.60 (1.41, 4.78), p = 0.002	12 (52.2)	6.23 (2.90, 13.37), p < 0.001	0.42 (0.16, 1.07), p=0.07
TV watching/week [d]							
	High	178 (15.9)	13 (29.6)	(base)	5 (20.0)	(base)	(base)
	2	94 (8.4)	5 (9.1)	0.65 (0.30, 1.41), p=0.27	0	0.37 (0.15, 0.90), p=0.03	1.77 (0.57, 5.49), p=0.32
	3	176 (15.7)	4 (36.4)	0.45 (0.24, 0.84), p = 0.01	5 (20.0)	1.11 (0.51, 2.40), p=0.79	0.41 (0.16, 1.05), p=0.06
	4	425 (38.0)	16 (36.4)	0.52 (0.31, 0.87), p = 0.01	12 (48.0)	0.81 (0.40, 1.62), p=0.55	0.64 (0.28, 1.47), p=0.30
	Low	246 (22.0)	6 (13.6)	0.32 (0.17, 0.63), p = 0.001	3 (12.0)	0.44 (0.20, 0.97), p=0.04	0.73 (0.27, 1.99), p=0.54
Maternal factors							
Maternal education							
	> year 12	957 (80.0)	35 (71.4)	(base)	23 (76.7)	(base)	(base)
	≤ year 12	240 (20.1)	14 (28.6)	1.62 (1.06, 2.48), p = 0.03	7 (23.3)	1.14 (0.68, 1.92), p = 0.62	1.42 (0.75, 2.70), p=0.29
Young Mum							
	Age > 24 years	1153 (96.4)	45 (90.0)	(base)	27 (90.0)	(base)	(base)
	Age ≤ 24 years	43 (3.60)	5 (10.0)	2.11 (0.88, 5.04), p = 0.10	3 (10.0)	2.80 (1.23, 6.38), p=0.01	0.75 (0.24, 2.31), p=0.62
Sought help last 12mths							
4 years	No	952 (84.0)	34 (73.9)	(base)	23 (85.2)	(base)	(base)
	Yes	181 (15.9)	12 (26.1)	2.03 (1.29, 3.18), p=0.002	4 (14.8)	1.24 (0.71, 2.17), p=0.45	1.64 (0.83, 3.24), p=0.16
6 years	No	815 (88.4)	13 (35.1)	(base)	14 (73.7)	(base)	(base)
	Yes	107 (11.6)	24 (64.9)	8.54 (5.38, 13.56), p < 0.001	5 (26.3)	2.17 (1.04, 4.54), p=0.04	3.93 (1.72, 8.94), p=0.001
9 years	No	918 (92.0)	22 (57.9)	(base)	22 (95.7)	(base)	(base)
	Yes	80 (8.0)	16 (42.1)	7.16 (4.37, 11.76), p < 0.001	1 (4.3)	1.11 (0.48, 2.59), p = 0.80	6.44 (2.55, 16.24), p < 0.001
11 years	No	740 (95.2)	15 (48.4)	(base)	14 (87.5)	(base)	(base)
	Yes	37 (4.8)	16 (51.6)	18.51 (10.09, 33.96), p < 0.001	2 (12.5)	2.72 (0.94, 7.88), p = 0.07	6.80 (2.18, 21.16), p=0.001

NESB = non-English speaking background; a. stable group was the reference group against which the low-decreasing and low-increasing groups were compared in the weighted (multinomial) logistic regression expressed as relative risks (RR); b. measured using SEIFA = socio-economic index for areas (*M*=1000, *SD*=100); c. standardised *M* = 0; *SD* = 1; d. quintiles

Table 4: Results of multivariable model

Variables		Groups [a]		Low-decreasing compared to low-increasing group
		Low-decreasing group	Low-increasing group	
		RR (95% CI), p-value	RR (95% CI), p-value	RR (95% CI), p-value
Child Factors	Non-verbal cognition [b]	0.60 (0.46, 0.77), p < 0.001	0.61 (0.45, 0.82), p = 0.001	0.98 (0.71, 1.37), p=0.91
	Low birth weight	2.98 (1.23, 7.22), p = 0.02	0.09 (0.03, 0.26), p < 0.001	34.67 (9.21, 130.49), p < 0.001
	Neurodevelopmental diagnosis			
	ADHD	2.07 (0.75, 5.71), p=0.16	0.74 (0.09, 6.29), p=0.78	2.82 (0.36, 21.73), p = 0.32
	Autism	1.00 (0.31, 3.24), p = 0.99	1.15 (0.19, 7.08), p=0.88	0.87 (0.12, 6.30), p = 0.89
	Learning disability diagnosis	2.83 (1.35, 5.92), p=0.006	2.46 (0.52, 11.61), p=0.26	1.15 (0.23, 5.69), p=0.86
Family Factors	NESB	0.36 (0.06, 1.96), p=0.24	43.42 (14.68, 128.45), p < 0.001	0.01 (0.00, 0.05), p < 0.001
	Social disadvantage [c]	1.00 (0.99, 1.00), p=0.19	0.99 (0.99, 1.00), p=0.02	1.00 (1.00, 1.01), p=0.27
	Family literacy [b]	0.73 (0.54, 0.98), p = 0.03	1.01 (0.69, 1.48), p=0.95	0.72 (0.45, 1.14) , p=0.16
	Home learning environment			
	Books in the home			
	More than 30 books	(base)	(base)	(base)
	21 to 30	1.30 (0.68, 2.49), p=0.44	2.13 (0.96, 4.70), p=0.06	0.61 (0.23, 1.63), p=0.32
	10 to 20	2.37 (1.19, 4.71), p=0.01	3.15 (1.28, 7.77), p=0.01	0.75 (0.26, 2.21), p=0.61
	Less than 10	0.62 (0.18, 2.20), p=0.46	5.75 (1.55, 21.37), p=0.009	0.11 (0.02, 0.54), p = 0.007
Support/intervention factors	Seeking help/extra support in last 12mths (6 yrs)	2.99 (1.59,5.62), p = 0.001	1.32 (0.42, 4.15), p=0.64	2.27 (0.65, 7.89), p=0.20

Note: a. stable group was the reference group against which the low-decreasing and low-increasing groups were compared in the weighted (multinomial) logistic regression expressed as relative risks (RR); b. standardised $M = 0$; $SD = 1$; c. measured using SEIFA = socio-economic index for areas (M=1000, SD=100);

Key points

- There is considerable instability in child language profiles over development. This hinders the strategic targeting and design of interventions. There is emerging evidence to suggest differing child, family and societal factors may be associated with differing language trajectories
- Three language trajectory groups were identified: a ‘stable’ trajectory (94% of participants); a low-decreasing trajectory (4%) and a low-improving trajectory (2%)
- A very vulnerable low-declining group was associated with low birth weight, socio-emotional and behavioural problems and lower family literacy
- By four years of age services can be confident that most children with low language abilities will remain low over the primary years. However using rigid cut-points in language ability to target interventions is not recommended due to continued individual variability in rates of language development
- Service delivery models should incorporate monitoring over time, targeting according to both language abilities and associated risks and delivery of a continuum of interventions across a continuum of need.

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