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The Early Language in Victoria Study (ELVS): A prospective, longitudinal study of communication skills and expressive vocabulary development at 8, 12 and 24 months

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Abstract

The aim of this paper is to provide an overview of the methods and preliminary findings from the Early Language In Victoria Study (ELVS) a prospective, longitudinal study of child language impairment. Specifically, we provide a summary of early communication and vocabulary development and examine the contributions a range of risk factors and predictors make to these outcomes. The sample was a community-ascertained cohort of 1911 infants, recruited at 8 months and followed at ages 12 and 24 months. The main outcomes of interest were parent reported infant and toddler communication (Communication and Symbolic Behavior Scales, CSBS) and expressive vocabulary (MacArthur-Bates Communicative Development Inventories, CDI). Predictors included gender, preterm birth, birth weight, multiple birth, birth order, socioeconomic status, maternal mental health, maternal vocabulary and education, maternal age at birth of child, non–English-speaking background, and a family history of speech and/or language difficulties. Results demonstrated rapid development in communication skills measured by the three CSBS domains (social, speech and symbolic) and in vocabulary development (CDI). There was rapid growth in gesture use between 8 and 12 months and symbolic use of objects between 12 to 24 months. At approximately 24 months, 19.7% had delayed expressive vocabulary. Male gender and family history were associated with poorer outcomes on the CSBS and the CDI at 8, 12 and 24 months, although the regression models explained only a small amount of the variance in outcome. In summary we measured rapid growth in communication skills and vocabulary between 12 and 24 months, but the hypothesized early risk factors and predictors explained little of the variation in these outcomes. We conclude that the risk factors/predictors examined in this study therefore seem unlikely to be helpful in screening for early language delay.

Keywords: *Child language, language delay, vocabulary, late talking, epidemiology.*

Much has been learned from longitudinal studies about social change and the dynamic processes underpinning social and economic life (The UK Longitudinal Studies Centre [ULSC], 2007–2009). Data from longitudinal studies have been used to track developmental changes of interest at the individual and group level and also to study change across generations. In contrasting longitudinal studies with other designs, the United Kingdom Longitudinal Studies Centre (ULSC) stated that "In contrast to the single snapshot they [longitudinal studies] are analogous to the photograph album, showing how individuals or families have changed over time" (ULSC, 2007–2009).

A variety of longitudinal studies designed to understand how speech and language skills develop have been conducted. These include studies that focus on (i) individual children (Levy, 2004), (ii) groups of children (Paul, Looney, & Dahm, 1991), (iii) clinical groups of interest (Parisse & Maillart, 2007), (iv) referred clinical populations (Chiat & Roy, 2008), (v) twin studies (Oliver & Plomin, 2007) and (vi) community or population samples (Zubrick, Taylor, Rice, & Slegers, 2007). There have been few longitudinal studies of childhood speech and language that utilize a community sample, representative of the broader population of children. As highlighted by Lubker and Tomblin (1997) the usefulness of many longitudinal studies are limited by factors including designs that are not grounded in the principles of epidemiology, inappropriate definitions and flawed causal models.

Law, Plunkett, Wake, Reilly and Roulstone (2009) systematically reviewed all identifiable, longitudinal

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cohort studies, which included language as either a dependent or independent variable. They developed two inclusion criteria. First, that the cohorts were derived from the general population and second, that they provided longitudinal data on children whose language had been formally assessed in the first 7 years of life. 18 cohorts were identified and amongst these were longitudinal studies with a broad focus on social or developmental issues in childhood that included a measure of child language (e.g., the Longitudinal Study of Australian Children (http://www.aifs.gov.au/growingup/) and a smaller group of studies that focused specifically on child language development (e.g., Tomblin et al., 1997). Law et al. (2009) provided an overview of the 18 studies in the form of a narrative review and also provided supplementary information on some related outcomes that included cognitive ability, behaviour and literacy. Ten of the cohorts were developed to focus specifically on aspects of language development. The majority commenced in middle or late childhood, with few starting in the pre-school years. Thus there are few community-ascertained cohort studies that commence in infancy and that have been designed to focus specifically on speech and language development.

In this paper we describe a prospective, longitudinal, cohort study designed to answer specific questions about the evolution of language impairment in pre-school children. The Early Language in Victoria Study (ELVS) commenced in 2003 and was designed to address some of the shortcomings outlined by Lubker and Tomblin (1998) highlighted earlier. This paper is confined to a description of the first phase of ELVS, which commenced when the children were 8 months of age and continued until 4 years of age. The specific aim of the first phase was to study the epidemiology and natural history of language impairment up to 4 years of age. Our ultimate goal was to identify potential precursors of expressive and receptive language impairment that would allow reliable detection of those who go on to have persistent, disabling language impairment. Of interest were precursors that might be amenable to prevention and/or early intervention.

The specific aims of ELVS were as follows:

1. Describe and quantify early (8 months, 12 months, 2 and 3 years) predictors of language impairment confirmed at age 4.
2. Describe the potential of the strongest predictors to underpin new prevention, detection and/or intervention strategies for early language delay.
3. Identify co-morbidities of language impairment in these children (e.g., behavioural and emotional adjustment, academic/pre-literacy skills, school readiness and health and well being).

In 2006 a systematic review on screening for childhood speech and language delay (Nelson, Nygren, Walker, & Panoscha, 2006) was published. The review compiled a list of potential risk factors and predictors which we were able to compare with the existing measures available in ELVS. We identified 12 potential predictors; female gender, twin birth, preterm birth, birth weight, birth order, non-English speaking background, socioeconomic status, family history of speech and language difficulties as well as a number of maternal measures of mental health, vocabulary level, education and age at birth of the target child. Further details about each of these predictors can be found later and more information can also be obtained in Reilly et al. (2007).

Analysis of the 4-year-old data is currently being completed. In this paper we will describe the design and methodology of the first phase of ELVS and present an overview of the early findings obtained from the first three waves of data collection at 8, 12 and 24 months.

Design and methodology

Design principles

ELVS was designed as a prospective cohort study in order to follow a broad sample of Australian children (in the state of Victoria) from 8 months through to 4 years of age. There were a number of critical elements (as outlined in Lubker & Tomblin, 1998) considered in the design of ELVS and these are listed below:

- A sample that was large enough and sufficiently powered to answer the questions we posed about language impairment as the outcome at 4 years of age.
- A study that started at an earlier age and continued for a longer period of time than had previously been attempted.
- Development of a sampling framework that ensured a broad cross-section of Australian infants was studied.
- Inclusion of a variety of well-validated measures already demonstrated to be associated with pre-school language outcomes so as to facilitate our study of the determinants of language impairment.
- Inclusion of a combination of direct assessment techniques with self-report, surveys and questionnaires.

Pilot study

Essential to any large longitudinal study is thorough testing of the feasibility of the recruitment methods, sampling procedures, measures and assessment techniques. Therefore prior to the commencement of ELVS a pilot study was conducted, the Victorian Early Language Pilot Study (VELPS). One hundred and thirty three (133) families from one of the six Local Government Areas (LGAs) that were to be used in the main study were recruited and agreed to take part.

A proportion of the original sample of children (now aged 7 years) and families still remain involved.

Study setting and sample

ELVS was set in 6 of the 31 metropolitan local government areas (LGAs) in the state of Victoria Australia. The 31 LGAs were stratified into three tiers (highest, middle and lowest) using the census-based Socioeconomic Indexes for Areas (SEIFA) developed by the Australian Bureau of Statistics (Australian Bureau of Statistics, 2001). Two LGAs were selected from each tier, taking into account the annual number of births and the ranges of SEIFA indices in each LGA to obtain approximately even numbers from each tier. These LGAs averaged approximately 1600 births per year. Approximately 82% of these families attend the routine visit offered at 8–10 months of age (Victorian Department of Human Services, 1999).

Sampling and recruitment procedures

During March-June 2002, the six LGAs were invited to participate in a detailed briefing session. The target population was 8–10-month-old children living in one of the six participating LGAs and all children in this age range between September 2003 and April 2004 were eligible to participate. The aims, rationale and anticipated outcomes of the study, study design, workload, and any other issues arising were discussed. After the briefing, each LGA was asked to sign a Memorandum of Understanding agreeing to take part in the study and outlining the roles of the researchers and LGA staff. Maternal and Child Health (MCH) nurses within each LGA attended their own briefing sessions, in which more detailed information about recruitment processes (including possible barriers and their solutions identified from focus groups and the pilot study) were also discussed.

Prior to recruitment commencement, group and individual meetings were held with MCH nurses to train them in recruitment protocols, which included familiarity with the exclusion criteria (see below). Each nurse was provided with a recruitment protocol, recruitment record sheets, ELVS information brochures, reply-paid envelopes to return record forms if needed and ELVS stickers. Between September 2003 and April 2004, study participants were recruited in 1 of 3 ways; firstly, MCH nurses were asked to sequentially approach parents of all infants attending their 8-month visit. They also kept a tally of all parents that were and were not approached and indicated the reasons for not approaching. Interested parents gave written permission to be contacted by the research team. Second, study participants were recruited whilst waiting for their 8-month hearing screening sessions. The majority of these sessions had 20–40 families attend with infants aged between 7 and 10 months. Finally, the study also received some publicity in local newspapers and in the Health Watch column of the Herald Sun newspaper in the six LGAs. Contact details were provided so that interested parents were able to directly contact the research team to participate. A website was set up to provide information about the study. The website (http://www.mcri.edu.au/projects/elvs/) contained information about the study, what participation involved, information related to language development, and contact details. As the study progressed newsletters and recruitment targets were posted on the website. Posters and brochures were placed in MCH clinics and other appropriate community venues to advertise the study.

Informed consent was obtained at the time the parents completed the first questionnaire at 8 months of age. Parents were provided with a written statement explaining the purpose of the study and what was involved. They received two copies of the consent form and were asked to sign and return one copy to the investigators. The study was approved by the Royal Children's Hospital (#23018) and La Trobe University Human Ethics Committee (#03-32).

Inclusion and exclusion criteria

Our long-term objective was to focus on children with specific language impairment (SLI) which is an exclusionary diagnosis that would not include children with any known physical, sensory or cognitive deficit. Therefore children with developmental delay, hearing loss, Down syndrome, cerebral palsy or other serious intellectual or physical disability were excluded. Children whose parents did not speak and understand English were also excluded because they would be unable to complete the parent report questionnaires upon which the study relied. We were however, keen to encourage English-speaking parents of low literacy to participate, and also parents whose dominant language was not English but who could read and write in English. Thus developing bilinguals, that is, children learning a language other than English were included. Questionnaires were written at no more than a Year 6 reading level and completion by telephone interview was made available.

Data collection measures

Five waves of data collection were undertaken and each comprised a broad range of child, family and environmental factors. Questionnaire data were collected at each wave and supplemented by face-to-face assessments at 12 months and 4 years. Instruments were selected because they had established validity and reliability and measured predictors or risk factors of interest. The major measurement domains for the 5 waves of data collection are summarized in Table I. The specific measurement domains and instruments relevant to the first three waves are detailed in Table II.

Analysis plan

The CSBS scores for children born prematurely, defined as less than 36 weeks gestation, were age-corrected prior to analysis. The proportions of participants that demonstrate specific items of communication behaviour on the CSBS at 8 and 12 months are reported with 95% confidence intervals.

The covariates were 12 putative predictors or risk factors including sex, twin birth status, premature birth status, non-English speaking background, Index of Disadvantage, family history of speech/language difficulties, maternal mental health problems, maternal vocabulary score, and maternal education level. Further details about each of the covariates can be found in Table III.

Linear regression models were fitted to the standardized total CSBS outcome scores at 8, 12 and 24 months and the CDI vocabulary score at 24 months. A logistic regression model was fitted to identify which of the risk factors was associated with low expressive vocabulary at 24 months. Analyses of the 8-month CSBS outcomes were restricted to cohort members who had their assessment between the ages of 7.5 and 9.5 months; analyses of the 12-month CSBS to those who had their assessment between 11.5 and 13.5 months; analyses of the 24-month CSBS outcomes those who had their 24-month assessment between the ages of 23.5 and 25 months; and analyses of CDI vocabulary production and low expressive vocabulary status to those who completed assessments between 23.5 and 25.5 months. Analyses were implemented by using Stata 10.1. R^2 values are reported for the linear regression and the squared Pearson correlation measure of R^2 is reported for the logistic regression analysis. Partial R^2 values for individual risk factors are not shown, but their relative predictive strength may be assessed by ranking the P values in order of size. Unstandardized coefficients are reported for the linear regression analyses.

Results

Early findings from ELVS: 8, 12 and 24 months

The findings reported in this paper utilize child, demographic, family and environmental data from the first three waves of data collections (8, 12 and 24 months) and summarize previously published results (Bavin et al., 2008; Prior et al., 2008; Reilly et al., 2006; Reilly et al., 2007).

One thousand nine hundred and eleven (1911) children and families were recruited at 8 months of age to participate in ELVS. Retention rates at 12 months (n = 1760, 92.1%) and 24 months (n = 1720, 91.1%) were excellent. Table III summarizes the participant characteristics of the cohort at baseline and at each subsequent wave of data collection. At baseline 126 children (6.6%) were being raised in homes where language(s) other than English were being spoken and we documented that 50 different languages were being spoken. Data from the 2006 census (Australian Bureau of Statistics, 2006) reported that languages other than English were spoken in the homes of 32% of the respondents in Melbourne. The mean (SD) Index for Disadvantage score (SEIFA) was 1037.6 (59.7) which was slightly higher than that for all metropolitan Melbourne (1020.6 [66.4]); although the spread of values was similar, 80% were in the 3rd, 4th, and 5th (i.e., less disadvantaged) quintiles. The demographic characteristics of the participants did not change markedly across the first three waves of data collection. This was important because some of demographic indices such as socioeconomic status, maternal education and maternal vocabulary levels were hypothesized to influence language development and it would be of concern if attrition were to be greater in any of these groups.

Growth of infant communication skills: 8–24 months

The mean CSBS composite standard score at 8 months was 99.2 (SD = 14.3), at 12 months 96.4 (SD = 13.1) and at 24 months 104.3 (SD = 14.8). Table IV summarizes the proportions of infants achieving each CSBS skill at 8, 12 and 24 months. The skills are grouped by CSBS domain. 95% confidence intervals for each percentage are reported. Significant improvement between waves at the 5% level can be detected where confidence intervals do not overlap (e.g., Item 10. Social Gestures: Shows object with giving). Where the confidence intervals overlap it can be inferred that there has been no major change (e.g., Item 14. Speech: Sounds: Uses sounds/words to get help). By 8 months the majority of infants were using emotional indicators and eye gaze to communicate with

Table I. Measurement domains pertaining to at least one of the five waves of data collection.

Domain	Areas Measured
Descriptor/Demographic	Socio-economic disadvantage, Non-English speaking background, Gender, Twining, Gestation, Birth order
Childhood Communication	Communication skills, Language, Speech, Fluency, Voice, Phonological awareness
Child Development	General development, Behaviour, Temperament, Cognition, Health-related quality of life, Pre-literacy skills
Family Factors	Maternal: Mental health, Education level, Age at birth of child Parental: Family history of speech, language, literacy, fluency problems, Vocabulary levels, Literacy, Reading habits, Parent-child interaction, Child care

Table II. Specific measures relevant to the 8, 12 and 24-month waves of data collection.

			Wave Collected (Age in Months)		
	Domain	Measure	8	12	24
Child	Communication	The Communication and Symbolic Behaviour Scales (CSBS) – Infant-Toddler Checklist provides a standardised total score (normative mean 100, SD 15) (Wetherby & Prizant, 2002)	✓	✓	✓
	Vocabulary	MacArthur Bates Communicative Development Inventory (CDI) – words and gestures; words and sentences (Fenson, Dale, & Reznik, 1993). To accommodate differences between American and Australian usage, we received permission (from the authors) to substitute 24 vocabulary items (e.g., "footpath" for "sidewalk")		✓	✓
	Gender	Female/Male	✓		
	Twinning	Yes/No	✓		
	Gestation	<36 / ≥ 36 weeks	✓		
	Birth Weight	Kilograms	✓		
	Birth Order	First to fifth or more Birth order was reported at wave 1 (8 months) and derived for all children within specified age range at 12 months (11.5–13.5). Information on birth order was updated at wave 3 (24 months).	✓		
Family & Environmental Factors	NESB	Non-English speaking background – (Yes/No)	✓	✓	✓
	Maternal Characteristics	*Age at birth of child* (years) Maternal age was reported at wave 1 (8 months) and used to calculate maternal age at birth of the target child.	✓	✓	✓
		Mental health. Measured by the Kessler screen for Psychological Stress. A score greater than 4 indicated the presence of mental health problems (Kessler & Mroczek, 1994)	✓	✓	✓
		Education level. Number of school years completed (less than 13 years, university degree, postgraduate qualification)	✓	✓	✓
		Vocabulary. Raw scores obtained on the modified version of the Mill Hill vocabulary scale, a self-completed written vocabulary measure – high scores indicate better vocabulary (Raven, 1997)	✓	✓	✓
	Family History	Yes/No response to a family history of speech, language, literacy, fluency problems	✓		
	Disadvantage	Disadvantage score measured by the census-based Socioeconomic Indexes for Areas (SEIFA) codes (Australian Bureau of Statistics, 2001)	✓		

Table III. Summary of participant characteristics at 8, 12 and 24 months.

Characteristic	Recruited Sample	CSBS Questionnaire			CDI Vocabulary Checklist
		8 Month[a]	12 Month[b]	24 Month[c]	24 Month[d]
(n, (%))	n = 1911	n = 1746	n = 1734	n = 1680	n = 1720
Female	945 (49.5)	862 (49.4)	862 (49.7)	824 (49.0)	844 (49.1)
Male	966 (50.5)	884 (50.6)	872 (50.3)	856 (51.0)	876 (50.9)
Twin Birth	53 (2.8)	45 (2.6)	42 (2.4)	43 (2.6)	43 (2.5)
Premature Birth (<36 weeks)	59 (3.1)	22 (1.3)	44 (2.5)	48 (2.9)	49 (2.8)
Non-English Speaking Background	126 (6.6)	114 (6.5)	102 (5.9)	97 (5.8)	101 (5.9)
Maternal Education Level					
<13 Years	431 (22.9)	387 (22.4)	379 (22.2)	358 (21.6)	370 (21.8)
13 Years	758 (40.1)	696 (40.3)	678 (39.6)	666 (40.2)	682 (40.2)
University Degree	445 (23.6)	407 (23.6)	414 (24.2)	398 (24.0)	407 (24.0)
Postgraduate Qualification	254 (13.5)	238 (13.8)	242 (14.1)	236 (14.2)	239 (14.1)
Birth Order					
1st Child	954 (50.1)	876 (50.4)	864 (50.0)[e]	858 (50.1)	838 (50.1)
2nd Child	672 (35.3)	609 (35.0)	612 (35.4)	603 (35.2)	589 (25.2)
3rd Child	226 (11.9)	210 (12.1)	210 (12.2)	206 (12.0)	204 (12.2)
4th Child	42 (2.3)	36 (2.1)	36 (2.1)	39 (2.3)	35 (2.1)
5th Child or More	8 (.4)	7 (.4)	6 (.4)	8 (.5)	8 (.5)
Family History of Speech/Language Problems	476 (24.9)	430 (24.6)	426 (24.6)	419 (24.9)	424 (24.7)
Maternal Mental Health Problems Indicated (Mean, (SD))	555 (31.7)	510 (31.8)	548 (31.7)	513 (31.6)	522 (31.6)
Birthweight (kgs)	3.4 (.5)	3.4 (.5)[f]	3.4 (0.5)	3.4 (.5)	3.4 (.5)
Index of Disadvantage SEIFA	1036 (61)	1036 (62)	1038 (60)	1038 (60)	1038 (60)
Maternal Vocabulary Score	27.5 (5.1)	27.5 (5.1)	27.5 (5.1)	27.7 (5.0)	27.6 (5.0)
Maternal Age at Birth of Child (Years)[g]	31.8 (4.6)	31.8 (4.5)	32.0 (4.4)	31.3 (4.5)	31.3 (4.4)

[a]Questionnaires completed within a 2 month age band (7.5 to 9.5 months).
[b]Questionnaires completed within a 2 month age band (11.5 to 13.5 months).
[c]Questionnaires completed within a 1.5 month age band (23.5 to 25.0 months).
[d]Questionnaires completed within a 2 month age band (23.5 ad 25.5 months).
[e]Birth order was reported at wave 1 (8 months) and derived for all children within specified age range at 12 months (11.5–13.5).
[f]Birth weight in kilograms was reported at wave 1 (8 months) and derived for all children within the specified age ranges at 12 and 24 months.
[g]Data collected at wave 1 (8 months) was used to calculate maternal age at the time of the child's birth for all children in the specified age ranges at 12 and 24 months.

others (see items 1 to 4 in Table IV) and were beginning to communicate to get attention or action (see items 5 and 6 in Table IV). As early as 8 months the majority of infants were using sounds or words to get help and could "string consonants together" (see items 14, 15 and 16 in Table IV). There was evidence of dramatic development in aspects of social communication between 8 and 12 months. This was particularly noticeable in the increased proportion of infants using gesture to communicate (see items 9 to 13 Table IV). Similarly, the proportion of infants meaningfully using words increased markedly between 8 and 12 months and again between 12 and 24 months (see item 17). Communication behaviours that showed obvious growth between 12 and 24 months included the symbolic use of objects (see items 23 and 24 Table IV), gesture use (see items 12 and 13 in Table IV), word use and the ability to put two words together (see items 17 and 18 in Table IV). Interestingly by 24 months the majority were scoring 99–100% indicating they had reached the ceiling for 18/24 items.

Vocabulary development at 12 and 24 months

At 12 months of age (range: 11.5–13.5 months) the mean expressive vocabulary was 6 words (SD 9) and at 24 months (range: 23.5–25.5 months) 260 words (SD 162) as measured by the MacArthur Bates CDI: Words and Gestures and Words and Sentences (Fenson, Dale, & Resnick, 1993). Expressive vocabularies at 12 months ranged from 0 to 123 words and at 24 months 0 to 679 words. Four hundred and fifty-eight (458) children (26.4%) were reported to have no words in their expressive vocabularies at 12 months and ten children (.6%) reportedly had no words at 24 months.

At 24 months we identified 333/1691 children (19.7%) to be less or equal to the gender specific 10th percentile for expressive vocabulary (Fenson et al., 1993). The expressive vocabulary of a girl less than or equal to the 10th percentile was 119 words or less and for a boy, 79 words or less. 203 children (12.0%), (109 boys and 94 girls), were below the more stringent cut point of the 5th percentile (70 words or less for girls and 48 words or less for boys). 287 children (17%) comprising 105 girls (12.6%) and 182 boys (21.1%) were not using any word combinations at 24 months according to the questions about word combinations obtained by parent report on the CDI: Words and Sentences. Table V illustrates those children with low expressive vocabularies (less than the 5th and 10th percentile) and no word combinations. In addition, we also include

those with low expressive vocabularies *or* no word combinations.

Predicting outcomes at 8, 12 and 24 Months

One of our main aims was to quantify whether the contributions made to early communication skill development and expressive vocabulary could be predicted by a range of early risk factors. Table VI combines data from a series of regression analyses. Twelve predictors were included in the original analysis (more detailed information may be found in previous publications including Reilly et al., 2006, 2007). Here we present results for the nine predictors that were significantly associated with the outcomes of interest at one or more waves. Three predictors (from the 12) were not significantly associated with any of the outcomes at any of the waves and are not included in Table VI. These included two child factors (premature birth and birth-weight) and one maternal factor (maternal mental health problems). We have chosen to present the linear regression analyses for both the continuous outcomes of interest, the CSBS and the CDI vocabulary scale and the logistic regression analyses for the dichotomous outcome, low expressive vocabulary in the same table. As will be discussed later it is of interest to contrast the predictors of both good and poor outcomes.

Table IV. Communication and symbolic behaviour scales infant toddler checklist item analysis at 8, 12 and 24 months.

	Percentage (95% CI) of Sample Demonstrating the Behaviour[1]		
ITEM	8 Months (n = 1746)	12 Months (n = 1734)	24 Months (n = 1720)
Social: Emotion and Eye Gaze			
1. Know when child is happy/upset	99.9 (99.7 to 100)	99.8 (99.6 to 100)	99.8 (99.8 to 100)
2. When playing child checks to see if you are watching	91.3 (89.9 to 92.6)	98.3 (97.7 to 98.9)	99.1 (98.5 to 99.5)
3. Smile/laugh while looking at you	99.8 (99.6 to 100)	99.8 (99.5 to 100)	99.9 (99.7 to 100)
4. Child looks when you point	78.1 (76.2 to 80.1)	95.5 (94.5 to 96.5)	99.8 (99.5 to 100)
Social: Communication			
5. Lets you know when needs help to reach toy	88.5 (87.0 to 90.0)	96.0 (95.1 to 96.9)	100 (99.8 to 100)
6. Tries to get your attention	96.1 (95.2 to 97.0)	97.9 (97.2 to 98.6)	99.6 (99.2 to 99.8)
7. Do things to make you laugh	54.9 (52.6 to 57.3)	83.4 (81.7 to 85.2)	97.0 (96.1 to 97.8)
8. Try to get you to notice things	24.5 (22.5 to 26.6)	65.6 (63.3 to 67.8)	95.5 (94.4 to 96.4)
Social: Gestures			
9. Pick up objects and give to you	35.0 (32.8 to 37.3)	92.8 (91.5 to 94.0)	99.9 (99.6 to 100)
10. Show objects with giving	46.0 (43.6 to 48.3)	88.4 (86.9 to 89.9)	99.1 (98.6 to 99.5)
11. Wave to greet people	29.8 (27.7 to 32.0)	82.3 (80.5 to 84.2)	96.7 (95.8 to 97.5)
12. Point to objects	18.8 (16.9 to 20.6)	78.5 (76.6 to 80.5)	99.5 (99.0 to 99.8)
13. Nod head to indicate yes	5.5 (4.4 to 6.6)	23.8 (21.8 to 25.8)	88.8 (87.2 to 90.3)
Speech: Sounds			
14. Use sounds/words to get help	93.0 (91.7 to 94.2)	97.6 (96.9 to 98.3)	99.7 (99.3 to 99.9)
15. String sounds together	80.4 (78.5 to 82.3)	94.7 (93.6 to 95.7)	99.5 (99.1 to 99.8)
16. Consonant sounds used	95.5 (94.5 to 96.5)	99.7 (99.4 to 99.9)	99.8 (99.5 to 100)
Speech: Words			
17. Words used meaningfully that you recognize	33.0 (30.7 to 35.2)	77.1 (75.1 to 79.1)	99.0 (98.4 to 99.4)
18. Put two words together	3.2 (2.4 to 4.1)	11.8 (10.3 to 13.4)	92.7 (91.3 to 93.8)
Symbolic: Understanding			
19. Child responds to their name	98.9 (98.4 to 99.4)	99.5 (99.2 to 99.9)	99.8 (99.5 to 100)
20. Child understands words/phrases without gestures	60.0 (57.6 to 62.3)	92.0 (90.7 to 93.3)	99.8 (99.5 to 100)
Symbolic: Object Use			
21. Shows interest playing with a variety of objects	99.3 (98.9 to 99.7)	99.7 (99.5 to 100)	100 (99.8 to 100)
22. Objects used appropriately	81.1 (79.2 to 83.0)	98.9 (98.4 to 99.4)	100 (99.8 to 100)
23. Child can stack blocks	9.9 (8.4 to 11.3)	53.8 (51.4 to 56.2)	99.2 (98.6 to 99.6)
24. Child pretends to play with toys	1.4 (0.8 to 2.0)	24.9 (22.9 to 27.0)	96.8 (95.8 to 97.6)

[1]Behaviour demonstration is defined as greater than "none". CI, confidence interval.

Table V. The proportion of children with low expressive vocabulary (less than or equal to the 5th and less than or equal to the 10th percentile on the CDI words and sentences) and presence of word combinations at 2 years of age.

	CDI Vocabulary Checklist			
	≤5th Percentile n (%)		≤10th Percentile n (%)	
CDI Words and Sentences	Boys	Girls	Boys	Girls
And No Word Combinations	80 (9.5)	53 (6.5)	113 (13.4)	71 (8.7)
Or No Word Combinations	211 (12.7)	146 (8.8)	248 (14.9)	188 (11.3)

Table VI. Summary of the nine predictors that were most strongly associated with the CSBS total score at 8, 12 and 24 months, the CDI vocabulary production at 24 months (linear regression) and late talking status at 24 months (logistic regression). Shaded cells indicate either that the predictor was treated differently (e.g., the disadvantage index (SEIFA)[ab]) or was not included in the regression analysis (e.g., maternal age at birth of child).

	CSBS Total Score			CDI – Vocabulary Production	Low expressive vocabulary
	Coefficient; 95% Confidence Intervals (CIs) *P*-value				Odds Ratio; 95% CIs *P*-value
Predictor	8 Months	12 Months	24 Months	24 Months	24 Months
Family History	−2.60; −4.20 to −1.01 .001	−2.27; −3.69 to −0.85 .002	−2.5; −4.2 to −.8 .004	−45.8; −63.9 to −27.7 <.001	1.58; 1.18 to 2.11 .002
Female Gender	2.97; 1.66 to 4.27 <.001	4.38; 3.19 to 5.58 <.001	3.2; 1.8 to 4.7 <.001	53.0; 37.4 to 68.6 <.001	.86; .66 to 1.12 .26
Twin Birth	−10.20; −16.47 to −3.93 .001	−10.51; −15.89 to 5.12 <.001	−2.3; −7.1 to 2.6 .36	−45.9; −97.7 to 5.9 .08	.66; .19 to 2.26 .51
Disadvantage[a] – SEIFA	−.025; −.03 to −.01 <.001	−.012; −.02 to −.00 .03			
Disadvantage[b] – SEIFA (1st Quintile Reference)					
2nd Quintile			1.0; −2.6 to 4.6	−19.3; −58.0 to 19.5	1.17; .62 to 2.19
3rd Quintile			−.4; −3.3 to 2.5	−9.3; 41.2 to 22.6	.74; .44 to 1.26
4th Quintile			−.7; −3.6 to 2.1	−26.4; −57.6 to 4.7	1.01; .60 to 1.68
5th Quintile			.4; −2.7 to 3.6 .66	−13.4; −47.2 to 20.5 .31	.77; .44 to 1.37 .24
Non English Speaking Background (NESB)	3.58; .42 to 6.74 .03	2.29; −.54 to 5.12 .11	−.8; −4.31 to 2.7 .65	−75.4; −116.3 to −34.5 <.001	2.48; 1.33 to 4.61 .004
Maternal Vocabulary Score	.00; −.15 to .15 .97	−.006; −.14 to .13 .92	.3; .1 to .5 <.001	1.6; −.2 to 3.4 0.08	.98; .95 to 1.01 .18
Maternal age at Birth of Child			−.3; −.5 to −.2<.001	−.6; −2.6 to 1.3.53	1.02; .99 to 1.05.27
Birth Order (1st Child Reference)					
Second Child			1.1; −.5 to 2.7	−9.7; −27.3 to 7.9	1.16; .85 to 1.58
Third Child			.6; −1.8 to 3.0	−41.3; −67.0 to −15.5	1.81; 1.21 to 2.71
Fourth Child			.8; −4.5 to 6.0	−38.0; −94.7 to 18.7	1.69; .71 to 4.04
Fifth Child Or More			4.4; −7.21 to 16.0 .70	46.8; −78.3 to 172.0 .02	.66; .06 to 6.97 .06
Maternal Education (≤11 Years Reference)					
12 Years	.51; −2.49 to 3.51	.17; −2.47 to 2.82			
13 Years	−.10; −2.70 to 2.51	.30; −2.00 to 2.60			
University Degree	−2.16; −4.98 to .65	.89; −1.60 to 3.38			
Postgraduate Degree	−2.42; −5.51 to −.68 .05	−.09; −2.84 to −2.66 .88			

(*continued*)

Table VI. (*Continued*).

	CSBS Total Score			CDI – Vocabulary Production	Low expressive vocabulary
	Coefficient; 95% Confidence Intervals (CIs) *P*-value				Odds Ratio; 95% CIs *P*-value
Predictor	8 Months	12 Months	24 Months	24 Months	24 Months
Maternal Education (≤12 Year Reference)					
13 Years			1.1; −.9 to 3.0	8.4; −12.6 to 29.3	.62; .44 to .87
University Degree			1.8; −.5 to 4.0	15.5; −8.5 to 39.5	.67; .45 to .99
Postgraduate Degree			3.1; .5 to 5.6	8.1; −19.6 to 35.7	.67; .42 to 1.05
			.12	.66	.04

[a]The index of disadvantage, SEIFA was treated as a continuous variable in the linear regression analyses at 8 and 12 months.
[b]The index of disadvantage, SEIFA was categorised for analysis using quintiles in the linear regression analyses at 24 months. The quintiles were based on SEIFA values for the Victorian population in 1996 with lower scores representing greater disadvantage.

Predictors of communication skill and vocabulary

Being female was associated with better communication skills (CSBS outcomes) at 8, 12 and 24 months and a larger vocabulary at 24 months (CDI vocabulary checklist). At 24 months girls scored on average 3.2 points higher than boys on the CSBS total score (3.2; 95% CI: 1.8 to 4.7; $p < .001$) and girls had on average 53 more words in their expressive vocabularies as reported on the CDI vocabulary checklist (53.0; 95% CI: 37.4 to 68.6; $p < .001$). Having a family history of speech and language problems was associated with lower CSBS scores at 8, 12 and 24 months and low expressive vocabulary. The negative coefficients for the CSBS score at 24 months indicated that the total CSBS score was 2.5 points lower. Similarly the negative coefficient for expressive vocabulary at 24 months (−45.8) indicates that these children had around 45 fewer words in their expressive vocabularies.

Although some of the nine predictors in Table VI were significantly associated with the particular outcome of interest, in the various regression models very little of the total variation in the outcomes was explained. For example, the regression model explained just 5% of the variation in the CSBS outcomes at 8 and 12 months and 4.3% of the variation in CSBS outcome at 24 months (Reilly et al., 2007). Similarly, the model only explained a small amount of variation (7.0%) in CDI vocabulary production at 24 months (Reilly et al., 2007). As we have demonstrated in previous publications the strongest predictor of communication skills at 12 and 24 months and vocabulary development at 24 months was communication skills already achieved at the earlier age. For example, communication skills achieved at 12 months explained a fifth of the variation in the CSBS outcome at 24 months (see Reilly et al., 2007).

Predictors of low expressive vocabulary at 24 months

For the logistic regression analysis, the outcome of interest, low expressive vocabulary was defined as those children scoring less than or equal to the gender specific 10^{th} percentile for expressive vocabulary on the CDI at 24 months (Fenson et al., 1993). As can be seen from Table VI, children with a family history of speech and language problems (odds ratio 1.58; 95% CI: 1.18 to 2.11; $p = .002$) and those from non-English speaking backgrounds were more likely to have low expressive vocabulary (odds ratio 2.48; 95% CI: 1.33 to 4.61; $p = .004$). Weaker associations were found between lower maternal education qualifications and higher scores on the CSBS at 8 months (.51; −2.49 to 3.51; $p = .05$) and low expressive vocabulary at 24 months (odds ratio .62; 95% CI .44 to 0.87; $p = .04$).

Discussion

Findings from the first three waves of this prospective study of the evolution of language impairment have documented (i) key findings about the emergence of early communication behaviours up to 24 months, (ii) reported vocabulary growth in the first 2 years, (iii) utilized different definitions of low expressive vocabulary and ''late talking'' and (iv) examined whether communication skill and vocabulary development at 2 years of age can be predicted by a range of social and environmental factors. Each of the key findings will be summarized and their significance discussed. Future directions will also be addressed.

Early communication behaviours

There was rapid, marked growth in the development of children's early communication skills across the first three waves of data collection at 8, 12 and 24 months. Growth was evident across all of the three domains of the CSBS including social, speech and symbolic. While gestural development was particularly noticeable between 8 and 12 months, marked growth in symbolic object use was evident between 12 and 24 months. A ceiling effect was also noticeable by 24 months with the majority of children demonstrating mastery of many CSBS items. For example, parents reported that 99–100% of the children were demonstrating 18 of the 24 behaviours. Many of these early communication behaviours are important precursors for later speech and language development (Thal & Tobias, 1992; Bavin et al., 2008). Understanding more about the rates of development across the early years will permit researchers to examine them at the individual level (e.g., gesture use) and at the level of the domain (e.g., the social composite). In subsequent regression analyses (discussed below) we have used the total CSBS score as a measure of communication skill development.

Vocabulary development

Early vocabulary development varied with large ranges reported at both 12 and 24 months. As expected there was marked growth in the size of expressive vocabularies between 12 and 24 months as well as marked gender differences. Girls had larger expressive vocabularies than boys at both 12 and 24 months. Low expressive vocabulary or late talking is a common marker or red flag used to identify children at risk of later language problems. However, different measures and inclusion criteria have been used to determine late talking (see Desmarais, Sylvestre, Meyer, Bairati, & Rouleau, 2007, for a detailed discussion) and a number of different study designs, some less rigorous than others, have been conducted. Comparison across studies is therefore not always possible or straightforward. Desmarais et al. (2007) identified 25 publications that reported on 10 groups of children indicating that our knowledge of late talking was at the time derived from just 500 late-talking participants. Recently two epidemiological studies (Reilly et al., 2007; Zubrick et al., 2007) from different states in Australia have increased knowledge in this area.

One-fifth of the 2-year-olds in ELVS had delayed expressive vocabulary based on a single language criterion, delay in expressive vocabulary acquisition. This report is in line with a number of studies reporting that ''late talking'' affects between 10–20% of 24-month-olds (Fenson et al., 1994; Horwitz et al., 2003; Klee et al., 1998; Rescorla, Hadick-Wiley, & Escarce, 1993) despite the use of different criteria and measures. For example, Zubrick et al. (2007) recently reported that 13.4% of their epidemiologically ascertained 24-month-old singletons had Late Emerging Language (LLE). When we applied a more stringent cut-point ($<5^{th}$ percentile), the number of 2-year-olds with delayed expressive vocabularies (12%) remained in this range. There are also stable findings from studies in the United Kingdom (Roulstone, Loader, Northstone, Beveridge, & the ALSPAC team, 2002), the United States of America (Bates, Dale, & Thal, 1996) and Australia (Zubrick et al., 2007) that consistently report that around 19% of 24-month-old children do not routinely combine words.

Ultimately we wish to identify early predictors of later language impairment. Exploring different vocabulary cut-points (e.g., less than the 10^{th} and less than the 5^{th} percentile for expressive vocabulary) and combinations (e.g., low expressive vocabulary and/or no word combinations) might therefore be important in exploring how many children recover from late talking versus how many go onto develop language impairment at 4 years of age. In addition, it will allow us to determine whether these different cut-points and criteria result in improved sensitivity and specificity and if in the future it might be possible to predict different types of language impairment.

Predictors of communication skills and expressive vocabulary

Having measured and documented early communication and vocabulary development at 12 and 24 months, we addressed a further aim which was to determine whether it was possible to predict communication behaviours and vocabulary outcomes using a range of well documented social, family and environmental factors. Only two factors, family history of speech and language problems and female gender were consistently associated with the outcomes across all three waves. A family history of speech and language problems was associated with poorer outcomes on the total score of the CSBS at all three waves, and being female was associated with a higher CSBS total score at each wave of data collection. By presenting the data together in one table (Table VI) we are able to contrast the predictors

across the 3 waves reported so far. We were also able to examine the effect of the same predictor (e.g., family history of speech and language problems) on both continuous (e.g., expressive vocabulary score) and dichotomous outcomes (e.g., low expressive vocabulary). For example, children from Non-English Speaking Backgrounds had lower scores on the CSBS at 8 months but not at 12 and 24 months. However their expressive English vocabulary was 75 words lower than their monolingual counterparts and they were more likely to be classified as having low expressive vocabulary. Second, when presented together the data illustrate how few of the predictors were consistently associated with the outcomes of interest, whether they be vocabulary development, a desired outcome or low expressive vocabulary, a risk factor for later language impairment.

Maternal educational qualifications were associated with higher CSBS scores at 8 months and this finding seemed counter intuitive. Fenson et al. (1993) have suggested that mothers with higher education levels might be more cautious about their child's performance and therefore underestimate their child's ability. Therefore we thought it reasonable to suggest that mothers with lower educational qualifications might be over reporting their children's abilities. This is speculative and there is no way to verify these findings. It is also worth highlighting that many samples, including the original norming sample for the CDI, contained fewer mothers with lower educational qualifications compared to other categories and the associations we are reporting here are not strong. Our findings regarding expressive vocabulary at 24 months are in line with those recently reported by Zubrick et al. (2007) who found that maternal education was not associated with their language outcomes at 24 months.

Our results regarding low expressive vocabulary concur with those reported by Zubrick et al. (2007) who also found that gender (male) and family history were significantly associated with late language emergence. Zubrick et al. (2007) also found that measures of early neurobiological growth were associated with late language emergence. Included in ELVS were just a few measures of neurobiological growth (e.g., gestational age and birth-weight) and these were not associated with low expressive vocabulary. Both studies found that a number of family and environmental factors such as mental health, and socioeconomic status did not predict late language emergence.

Significance of the early findings

Documenting early communication development is an important step in identifying the precursors of later language impairment. Very early communication skills have not previously been documented and verified in a large, prospective community-ascertained sample using parent report. The longitudinal nature and design of ELVS permits us to (i) examine a range of concurrently measured early communication behaviours, (ii) map their progression across multiple waves of data collection and (iii) study their relationship with later language impairment.

Speech-language pathologists and other health professionals are keen to identify early risk factors for, or predictors of, language impairment. Of particular interest to health professionals are factors that might be used to detect children at risk from an early age and to identify those risk factors and predictors that might be amenable to early intervention. However, both the findings of this study and those of Zubrick and colleagues (2007) suggest that there is a strong biological trajectory to early communication and vocabulary development and that this trajectory appears relatively unaffected by a range of social and environmental factors previously hypothesized to be influential (Nelson et al., 2006). These findings surprised us as they were in contrast to much of the published literature and accepted views on the subject. However, when we examined more closely the studies in the systematic review undertaken by Nelson and colleagues (2006) we found that only four of the 16 studies reviewed had tested any of the individual risk factors in children up to 24 months. Thus a major contribution of this study (and that of Zubrick et al., 2007) has been the opportunity to report that these predictors make a relatively small contribution to communication skill development and vocabulary development in early childhood. In this study we were able to explain just 4.3% to 7% of the variance and thus the variance explained by any one of the predictors was extremely small. It seems that a number of assumptions have been made about risk factors for early language delay and were most probably based on studies that involved older children in whom language impairment had been determined or derived from less rigorous studies.

We were able to explain more variance in outcome when we added a previous measures of communication skill development to the regression models. For example, when communication skills level at 12 months was added to the model to explain outcomes at 24 months (Reilly et al., 2007). Thus children's early trajectories of communication development might prove to be more important than environmental and social factors. Markers of early communication development therefore take on even greater significance. Rice, Taylor and Zubrick (2008) have continued to follow the singletons in their study. At 7 years they compared the children with a history of LLE to a group with no history of LLE. Children with LLE were almost twice as likely to have poorer general language ability at 7 years compared to the comparisons without LLE. These results suggest that not all children with LLE will develop language impairment and one in two may develop language abilities in the normal range. This finding concurs with previous reports in the literature regarding

recovery from early language delay albeit from clinical rather than community studies. Thus it remains difficult to reliably discriminate those children who will recover from those who will not. Of critical interest to clinicians and researchers is the possibility that some children with apparent normal early communication and vocabulary development may go on to exhibit language impairment at later ages. This possibility suggests that the early measures used in this and other studies may not be sensitive enough to detect all cases of language impairment. However, it could also be hypothesized that the measures adequately detect some but not all types of language impairment because the majority of early markers of delay rely on expressive vocabulary and expressive language development and include few markers of early receptive language delay.

Future directions

In future work we will explore the role that the identified risk factors and predictors play at each wave of data collection across the first 4 years of life, thereby testing a number of hypotheses about the relationship between language impairment and risk factors and predictors. By four years of age it may well be possible to demonstrate stronger associations between diagnosed language impairment and a range of social, family and environmental predictors. This may, in part, because in older children aged 4 years or more it is possible to conduct face-to-face assessments and reliably determine the presence of language impairment. Alternatively, it is possible that these factors will continue to play a limited role in language outcomes. We will also direct attention to ascertaining whether there are other specific components of infant communicative development that more strongly predict language outcomes in the toddler and preschool years.

Having access to data collected at different ages will also permit us to examine whether it is viable to predict outcomes at 2 years. There remain some challenges in measuring communication skill and vocabulary development during infancy. It is evident that parents can clearly report communication skill and vocabulary development across the early years as documented by the use of the CSBS and CDI in this current study as well as in many other studies. However, measuring the precursors of later language development or language impairment is more complex than the measurement of other outcomes such as height or weight where a single instrument or construct can be measured on the same scale on multiple occasions. In measuring a complex child behaviour such as language development it is important to ask if our measurements are sufficiently precise. Are we measuring comparable communication skills at each age? Are we measuring the right factors? Are there other behaviours of interest that should be measured/considered? If so, what are they and can parents reliably report on them? On the other hand perhaps the variation in early childhood development is too great. Our red flags, late talking and LLE, are also markers for general developmental delay and a range of other conditions, as well as language impairment. In other words the outcomes we are trying to predict at 2 years of age may not be sufficiently defined or robust.

Establishing a prospective, longitudinal study such as ELVS has afforded a number of unique opportunities to address subsidiary questions about other aspects of communication development in the preschool years. As a result, a number of related studies have been embedded within its framework. These include the study of speech sound development, language development in children learning a language other than English, and a unique opportunity to examine the early communication skill development of children who were later diagnosed with autism. One of the most unique opportunities available to ELVS was to be able to develop a study of stuttering onset in young children, and to recruit children and families to the study prior to the onset of stuttering. To our knowledge this is the first time such a study has been undertaken on a community ascertained sample of pre-school children and the predictors of stuttering onset have now been described for the first time (Reilly et al., 2009).

Despite the fact that we have recruited a large number of participants to ELVS and retention has been excellent, the sample of children with the outcome of interest, language impairment, whilst adequate to meet the needs of the study, will be potentially too small to conduct within-group analyses for children with particular types of language impairment. We are exploring opportunities to work with other cohorts, both nationally and internationally, in the future to pool or share data to permit analyses that might not otherwise be undertaken because of the limitations of sample size.

Conclusions

Longitudinal data from community-ascertained cohorts is particularly important for research into child language development and the evolution of language impairment. It provides a unique opportunity, not available in cross-sectional data or in the study of clinical samples, to examine the growth and evolution of language skills over time and to determine whether it is possible to identify key risk factors for, or predictors of, language impairment that could be used in screening or early identification. Ultimately, such data might also be valuable in identifying factors amenable to change that could be incorporated into the development of early prevention and intervention programs.

The primary aim in this paper was to describe and quantify predictors of communication skills

development and expressive vocabulary by 24 months. Our findings suggest that the risk factors and predictors identified in a major systematic review (Nelson et al., 2006) and examined in this study could not be used to predict communication and vocabulary development in 2-year-old children. These findings are in line with those of others (e.g., Zubrick et al., 2007) conducting similar studies. Thus our current recommendation is that they should not be used to screen for early language delay. It remains to be seen if there will be stronger predictors of outcome at 4 years or later when language impairment can be defined.

In the United Kingdom current best practice recommended in the UK National Screening Committee Child Health Subgroup's report on speech and language delay (2005) recommends that watchful waiting is reasonable where there is a good prognosis for children with isolated expressive language delay who present prior to 3 years of age (O'Hare, 2009). We concur and further suggest that (i) language promotion activities for infants aged up to 2 years be universal and (ii) if targeted they be based on the child's level of communication skill or vocabulary development.

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