Literacy, numeracy, and learning in school-aged children identified as having speech and language impairment in early childhood

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Abstract

The progress of a nationally representative sample of 3,632 children was followed from early childhood through to primary school, using data from the Longitudinal Study of Australian Children (LSAC). The aim was to examine the predictive effects of different aspects of communicative ability, and of early vs. sustained identification of speech and language impairment, on children's achievement and adjustment at school. Four indicators identified speech and language impairment: parent-rated expressive language concern; parent-rated receptive language concern; use of speech-language pathology services; below average scores on the adapted Peabody Picture Vocabulary Test-III (PPVT). School outcomes were assessed by teachers' ratings of language/literacy ability, numeracy/mathematical thinking and approaches to learning. Comparison of group differences, using ANOVA, provided clear evidence that children who were identified as having speech and language impairment in their early childhood years did not perform as well at school, two years later, as their non-impaired peers. The effects of early speech and language status on literacy, numeracy, and approaches to learning outcomes were similar in magnitude to the effect of family socio-economic factors, after controlling for child characteristics. Additionally, early identification of speech and language impairment (at age 4 to 5) was found to be a better predictor of school outcomes than sustained identification (at aged 4 to 5 and 6 to 7 years). Parent-reports of speech and language impairment in early childhood are useful in foreshadowing later difficulties with school and providing early intervention and targeted support from speech-language pathologists and specialist teachers.

The early years of school are an important and challenging transition stage for all children, but for those with speech and language impairment it may be additionally challenging. According to Law, Boyle, Harris, Harkness, and Nye (2000, p. 180), children with expressive and receptive language impairment "are likely to find it difficult to process incoming language, to initiate communication with others and to formulate their responses appropriately. Accordingly they are less likely to compensate for their difficulties and are most likely to find difficulty in coping with the demands of school". In this paper, the difficulties associated with speech and language impairment are examined in relation to three of the demands (or expectations) of school education: (1) literacy and language, (2) numeracy and mathematical thinking, and more generally, (3) approaches to or involvement in learning. Each of these areas is reviewed in relation to children with speech and language impairment.

Literacy and language

A significant number of research studies have reported that children and young people identified with speech and language impairment have literacy difficulties at school (Felsenfeld Broen & McGue, 1994; Gregory, Shanahan, & Walberg, 1985; Hall & Tomblin, 1978; Lewis & Freebairn, 1992; Lewis, Freebairn & Taylor, 2000, 2002; Lewis et al., 2006; Nathan, Stojanovik & Riddell, 2008; Stackhouse, Goulandris & Snowling, 2004a, 2004b; Olson Wagner, Gray & Potter, 1983; Scarborough, 1990; Sheridan & Peckham, 1975; Sices, Taylor, Freebairn, Hanson & Lewis, 2007; Wise, Sevcik, Morris, Lovett, & Wolf, 2007). Other studies, however, do not support this association, suggesting that the extent and nature of the association between early speech and language impairment and later literacy difficulties can vary according to the particular skills being assessed and individual children's abilities (Hesketh, 2004; Hesketh, Adams, & Nightingale, 2000; Holm, Farrier, & Dodd, 2008).

Specific literacy difficulties associated with early speech and language impairment include difficulties with spelling (Holm et al., 2008; Leitão & Fletcher, 2004; Lewis et al., 2002; Snowling & Stackhouse, 1983), reading comprehension (Catts, Bridges, Little, Tomblin, 2008; Fraser & Conti-Ramsden, 2008; Leitão & Fletcher, 2004; Rescorla, 2005), reading accuracy (Holm et al., 2008; Leitão & Fletcher, 2004), phonological awareness (Fraser & Conti-Ramsden, 2008; Leitão & Fletcher, 2004), and writing (Sices et al., 2007). In contrast, Bishop and Adams (1990) and Catts (1993) reported that some children identified as having speech and language impairment in early childhood have typical reading skills in school.

When considering speech and language status, some studies have indicated that children with concomitant speech and language impairment or language impairment alone are more likely to have subsequent literacy difficulties than those with speech impairment alone (Fraser & Conti-Ramsden, 2008; Sices et al., 2007); however, most studies indicate that children with speech and/or language difficulties are more likely to have greater difficulty than their typically developing peers (Leitão & Fletcher, 2004). For example, Fraser and Conti-Ramsden (2008) found that speech and language abilities were associated with reading and spelling acquisition, but that language (not speech) abilities were associated with reading comprehension. Lewis et al. (2006) found that children with speech impairment alone were more likely to have literacy difficulties if their speech impairment persisted, or if they had a family member who had a history of speech and language impairment. Leitão and Fletcher (2004) reported that children with non-developmental speech errors performed significantly more poorly on literacy tasks than those with developmental speech errors.

Numeracy and mathematical thinking

Researchers have also demonstrated that children with early speech and language impairment are likely to have difficulties with numeracy (Arvedson, 2002; Dockrell & Lindsay, 1998; Fazio, 1996; 1999; Hall & Segarra, 2007; Koponen, Mononen, Rasanen, & Ahonen, 2006;

Nathan et al., 2004b). Areas of numeracy associated with early language impairment include difficulties with storage and/or retrieval of rote sequential material (Fazio, 1996; 1999), number recall (Fazio, 1996; 1999) and mathematical calculations (Fazio, 1999). Mathematical computational skills have been linked to the ability to use symbolic representation (of both numerals and letters), as well as phonological processing skills such as phonological memory and phonological awareness (Hecht, Torgesen, Wagner & Rashotte, 2001). Arvedson (2002) found that children with specific language impairment had less success with verbal counting as a strategy for solving mathematical problems than their typically matched peers.

However, some areas of inquiry have demonstrated that children with language impairment are a heterogeneous group with respect to numeracy (Koponen, et al., 2006). Indeed some studies have demonstrated similar numeracy skills between typically developing children and those with language impairment. For example, Fazio (1996) found that children with language impairment did not have difficulties with conceptual knowledge of mathematics (such as indicating which plate contained "more"). Arvedson (2002) demonstrated that children with specific language impairment performed similarly to their aged-matched peers and better than their grammar matched peers on tasks involving numerical identity, transformation of sets, addition and subtraction.

Approach to learning

School adjustment describes students' wellbeing, classroom behaviour and approach to learning, including work habits, motivation, attentiveness, task orientation, and independence (Gresham & Elliot, 1990). To date, few studies have directly examined the association between approach to learning and speech and language impairment; however, there is evidence that children with speech impairment may experience difficulty with attention (McGrath et al., 2008) and information processing (Ozcebe & Belgin, 2005). Additionally,

students with speech and/or language impairment are reportedly at risk for school drop-out possibly because they feel less connected to school (Robertson, Hardin & Morrison, 1998).

Limitations of the current studies

Despite the number of studies that have considered the association between early speech and language impairment and subsequent educational outcomes, there are a number of factors limiting the broad application of the currently available data to population-based educational policy making. First, whilst previous researchers have demonstrated specific links between speech and language impairment and aspects of literacy or numeracy ability, few studies have considered the multi-dimensional nature of children's experience of school. In the present study, consideration is given to school achievement outcomes in literacy and numeracy, as well as to the broader area of adjustment to the learning demands of the classroom.

Second, most of the reviewed studies rely on relatively small sample sizes and clinically-based populations. Such studies, although informative, are somewhat restricted in their capacity to examine a range of predictors of children's performance at school-age, additional to their speech and language ability. In the present study, it has been possible to include known predictors of school achievement and adjustment, for example, child gender and family socio-economic and cultural background, in the examination of links between speech and language impairment and school performance.

Aims of the present study

This investigation presents longitudinal findings for the Kindergarten Cohort of *Growing Up in Australia: The Longitudinal Study of Australian Children* (LSAC) (Gray & Smart, 2008; Sanson et al., 2002). It builds on and extends earlier analyses of the LSAC data set showing that speech and language impairment is a high prevalence condition in 4- to 5-year-old Australian children (McLeod & Harrison, 2009) and identifying child and family

characteristics that were associated with the identification of childhood speech and language impairment (Harrison & McLeod, 2009).

The aim of the present paper was to examine the progress of children identified with speech and language impairment in early childhood (at age 4 to 5 years) two years later, when they were attending the early years of primary school (at age 6 to 7 years). The following questions were addressed:

1. Are children identified with speech and language impairment at age 4 to 5 years at risk of poorer achievement in literacy and numeracy and poorer adjustment in their early years of school?
2. What are the unique and combined effects of the LSAC indicators of early speech and language impairment on children's school outcomes? Is there a "best" predictor?
3. Is early identification of speech and language impairment (at age 4 to 5 years) as effective as identification of sustained impairment (at ages 4 to 5 years and 6 to 7 years) in explaining children's progress at school?

Method

Participants

The Longitudinal Study of Australia Children (LSAC)

In 2004, a nationally representative sample of 10,000 children was recruited for *Growing Up in Australia: The Longitudinal Study of Australia Children* (Australian Institute of Family Studies AIFS, 2009; Sanson et al., 2002). The study used a cross-sequential research design to follow two cohorts of children, each comprising 5,000 children. At recruitment, most children in the Birth Cohort (B cohort) were between 6 and 12 months of age and children in the Kindergarten Cohort (K cohort; also called the child cohort) were aged between 4 years 6 months and 5 years.

The sampling frame for LSAC was the enrolment database of Medicare Australia. The sampling strategy involved a stratified cluster design. Random selection was made of just over 300 postcodes across Australia, stratified by state and metropolitan and ex-metropolitan (regional, rural and remote) status. A random selection of children within the two target age ranges was then made within postcodes. Both cohorts of children were identified within the same postcodes. On average, the intention was to recruit up to 20 children per cohort per postcode. The sample is broadly representative of all Australian children (citizens and permanent residents) in each of the two selected age cohorts. Children in very remote parts of Australia were excluded from the sampling because of the high data collection costs.

In the biennial data collection procedure, multiple informants were contacted in order to gather information about the child's development and learning across differing contexts (Gray & Smart, 2008). This included information collected from the parents who live with the child, the child (including direct assessment of development and learning, and child interview), and the child's teacher (for the K cohort) or caregiver (for the B cohort). The primary parental informant (P1) participated in a face-to-face interview in the family home and also completed questionnaires. With parental permission, a mail-back questionnaire was sent to the child's teacher.

Sample for the present study

The analyses presented in this paper draw on parent (P1) and teacher data for the K cohort collected at Wave 1 (2004) and Wave 2 (2006). There were 3,632 children who participated in both waves and also had teacher reports of their school achievement and approaches to learning at Wave 2. The sample size was restricted by the availability of teacher questionnaire data for the child at Wave 2.

Key socio-demographic variables considered in the analyses included child age and sex, child's primary home language, Aboriginal/Torres Strait Islander background, and family socio-economic position (SEP). At Wave 1, the children were aged between 4 and 5 years (M = 56.9 months; SD = 2.6 months) at the time of assessment. At Wave 2, the children were aged between 6 and 7 years (M = 81.9 months; SD = 2.9 months) at the time of assessment. The sample included 50.5% boys and 49.5% girls. For the majority of the children, the primary language was English: 10.5% of the children spoke a language other than English at home and 3.4% of the children were identified as being of Aboriginal/Torres Strait Islander background. A measure of family Socio-Economic Position (SEP) was derived using LSAC data (Blakemore, Gibbings, & Strazdins, 2006). The SEP variable combines information on three elements of a family's socio-economic position (parental education, family income, and occupational prestige). Although these different elements can be considered separately, these indicators are interrelated (Lynch & Kaplan, 2000; Willms, 2003). The continuous measure of relative SEP derived by Blakemore et al. (2006) shows associations with other indicators of disadvantage. The directions of such relationships indicate that a lower SEP score is associated with a higher probability of the family experiencing disadvantage. For this study, an ordinal form of the SEP was constructed by dividing the SEP continuous score into low, medium, and high socio-economic position categories. Low socio-economic position refers to SEP scores in the range of 0-25%, medium socio-economic position to SEP scores in the range of 26-75%, and high socio-economic position to SEP scores in the range of 76-100%.

Indicators of speech and language impairment

The identification of children with speech and language impairment at ages 4 to 5 years and 6 to 7 years was based on four indicators: parent-reported expressive speech and language concerns; parent-reported receptive language concerns; child's use of speech-language pathology services; and below average scores on a test of receptive vocabulary.

Parent-reported expressive and receptive speech and language concerns

Two items from the Parents' Evaluation of Developmental Status (PEDS) (Glascoe, 2000) were used in the analyses. The PEDS is frequently used as a screener for young children to identify developmental delays or impairments (e.g., Coghlan, Kiing, & Wake, 2003). The two questions of interest in these analyses were parent evaluations of their child's expressive and receptive language abilities. The parent responded to the question: "Do you have any concerns about how [child] talks and makes speech sounds?" (no, yes or a little); and "Do you have any concerns about how [child] understands what you say to (him/her)?" (no, yes or a little). For the purposes of subsequent analyses, children whose parents gave a rating of "yes" or "a little" were identified as having a speech and language impairment. Identifications were made separately for expressive and receptive language, at age 4 to 5 years and 6 to 7 years.

Use of speech-language pathology services

Parents were asked the question: "Now thinking about community services you might have used. In the last 12 months, have you used any of these services for [the study child]?" (Speech-language pathology: no, yes). In Wave 1, but not Wave 2, teachers were also asked to indicate whether the child had received any speech-language pathology services provided through the centre/school. Parent and teacher responses were combined to identify all children who had attended speech-language pathology services at age 4 to 5 years.

Direct assessment of receptive vocabulary

Children's receptive vocabulary ability was assessed at Wave 1 and Wave 2 with an adaptation (short form) of the Peabody Picture Vocabulary Test-III (PPVT) (Dunn & Dunn, 1997). The adapted PPVT-III was developed for use in LSAC (Rothman, 2003) and used a standardised Rasch-modelled score (further details on scaling are available on the LSAC website; AIFS, 2009). For the analyses in the present study, a score of one standard deviation,

or more, below the mean score for the sample was used as an indicator of speech and language impairment (see McLeod & Harrison, 2009).

Numbers and percentages of children in the sample on each of these four indicators are presented in Table 1. In making these classifications, it is important to note the following limitations: the first two indicators are based on parent report; the third assumes a clinical diagnosis by a speech-language pathologist, but was not confirmed; and the fourth indicator meets research criteria but only for identifying receptive language impairment. Additionally, account has not been taken of possible confounds arising from developmental disorders such as autism, intellectual disability, or deafness. The four indicators of speech and language impairment were originally defined and reported in McLeod and Harrison (2009), and their use in the present paper provides consistency in the reporting of LSAC results.

Longitudinal indicators of speech and language impairment status: Sustained, early-only, and later-only

The above indicators reported over two waves of LSAC were used to produce four categories of speech and language impairment status: sustained, early only, later only, and none. Children were categorized as (1) having sustained speech and language impairment if they were identified as impaired on the indicator variable at Wave 1 (4 to 5 years) and at Wave 2 (6 to 7 years); (2) early only impairment status if they were identified at Wave 1 only; (3) later only status if they were identified at Wave 2 only; and (4) non-impaired (none) if they were not identified at Wave 1 or Wave 2. Categories were produced for the three indicators of speech and language impairment that were assessed at both waves 1 and 2: parent-reported expressive speech and language concern; parent-reported receptive language concern; below average scores on the adapted PPVT-III. Since there was no wave 2 data for use of speech-language pathology services, this outcome measure was not able to be used for examining earlier, later and sustained speech and language impairment.

The longitudinal distribution pattern for the three indicators of speech and language impairment is illustrated in Figure 1. Parent-reported expressive speech and language concern (PEDS-Exp) identified the larger proportion of children, with 10.2% (n = 363) in the sustained speech and language impairment group; 14.1% (n = 502) in the early only group; and 5.2% (n = 184) in the late only group (total of 29.4%, n = 1049). For parent-reported receptive language impairment (PEDS-Rec), 3.8% (n = 137) of children were in the sustained group; 4.4% (n = 158) in the early only group; and 5.4% (n = 194) in the later only group (total of 13.7%, n = 489). For below average scores on the adapted PPVT-III (Low PPVT), 3.7% (n = 120) were identified in the sustained receptive language impairment group; 7.7% (n = 249) in the early only group; and 5.3% (n = 171) in the late only group (total of 16.6%, n = 549).

Insert Figure 1 here

Measurement of child achievement and adjustment outcomes

Three measures of children's achievement and adjustment in the early years of school were collected at Wave 2: teacher-ratings of language and literacy competence, mathematical thinking, and approach to learning in the classroom.

Achievement

Teachers were asked to rate the child's skills, knowledge, and behaviours within two scales of academic learning on the Academic Rating Scale (National Center for Educational Statistics, N. D.). The Language and Literacy Scale has ten items that rate children's proficiency in communication and early literacy skills (e.g., contributes relevant information to classroom discussions; able to understand a story or other text read to him/her; reads words with regular/irregular vowel sounds; able to write sentences with more than one clause; uses the computer for a variety of purposes). The Mathematical Thinking Scale has eight items which rate the child's competencies for numeracy and understanding of measurement and

spatial concepts (e.g., can continue a pattern using three items; demonstrates an understanding of place value; surveys, collects and organises data into simple graphs; measures to the nearest whole number using common instruments). These scales were adapted for LSAC from measures used in the Early Childhood Longitudinal Study of Kindergarteners (ECLS-K) (National Center for Educational Statistics, N. D.). The adaptations for LSAC were made to ensure that the skills, knowledge, and behaviours reflected Australian curriculum standards. Items in these scales were rated on a 5-point scale (not yet = 1, beginning = 2, in progress = 3, intermediate = 4, proficient = 5). Internal consistency of the Language and Literacy scale on Cronbach's alpha was 0.96 and 0.95 for the Mathematical Thinking Scale. The correlation between the scores on the Language and Literacy Scale and Mathematical Thinking scales was high, $r = 0.83$.

Adjustment to school

The child's approach to learning in the classroom was measured by teacher ratings of six items adapted from the Social Skills Rating Scale (SSRS) (Gresham & Elliot, 1990). The items in the scale rate: attentiveness, task persistence, eagerness to learn, learning independence, flexibility, and organization on a 4-point scale (never = 1, sometimes = 2, often = 3, and very often = 4) (Cronbach's alpha = 0.91). The correlations of this scale with the Academic Rating Scales for Language and Literacy and Mathematical Thinking were *r*s = 0.61 and 0.53, respectively.

Data analysis

Comparison of means and Analyses of Variance (ANOVA, $p \leq .05$) tests were used to examine differences in achievement measures and learning on the Language and Literacy Scale, Mathematical Thinking Scale, and Approaches to Learning at school-age (6 to 7 years) for children identified at aged 4 to 5 years as having or not having speech and language

impairment on the four indicators (PEDS-Exp, PEDS-Rec, use of speech-language pathology services (SLP), and low PPVT).

Hierarchical regression analyses were then used to examine the unique and combined predictive effects of these four indicators of early speech and language impairment on each of the three child outcomes, after controlling for child and family socio-demographic characteristics (child age and sex, child spoke a language other than English at home, Aboriginal/Torres Strait Islander background, and family SEP). Final regression analyses added indicators of 'sustained' speech and language impairment to the above regression models, to test the relative predictive effect of early vs. sustained identification of speech and language impairment.

Results

Are children identified with speech and language impairment at age 4 to 5 years at risk of poorer achievement and adjustment at school?

A series of One-way ANOVAs were used to test for differences between speech and language impaired and non-impaired groups for each of the four early indicators (PEDS-Exp, PEDS-Rec, use of SLP services, and Low-PPVT) for each of the outcome measures (language and literacy, mathematical thinking, and approach to learning). Means, Standard Deviations, and Confidence Intervals (95%) are presented in Table 2. Overall, children identified as having speech and language impairment on each of the four indicators received significantly lower ratings on all three outcomes, compared to children without speech and language impairment. Mean differences in the ratings for literacy ability ranged from 0.44 to 0.68, and for numeracy from 0.35 to 0.60, on a 5 point scale. Mean differences for approach to learning ranged from 0.23 to 0.47 on a 4 point scale. Significant differences between mean values were noted for all of the comparisons, with the criteria for significance being the non-overlap of their respective 95 per cent confidence intervals.

Insert Table 2 here

On the PEDS-Expressive language indicator, children identified as having speech and language impairments were rated significantly lower by their teachers on the scales for Language and Literacy, F (1, 3614) = 131.79, p = .000; Mathematical Thinking, F (1, 3601) = 87.62, p = .000; and Approaches to Learning, F (1, 3616) = 75.08, p = .000. Similar differences were also found on the PEDS-Receptive language indicator for Language and Literacy, F (1, 3615) = 127.65, p = .000; Mathematical Thinking, F (1, 3602) = 120.14, p = .000; and Approaches to Learning, F (1, 3617) = 131.23, p = .000. Children identified as receiving SLP services were also rated significantly lower for Language and Literacy, F (1, 3194) = 114.01, p = .000, Mathematical Thinking, F (1, 3182) = 73.75, p = .000; and Approaches to Learning, F (1, 3194) = 57.32, p = .000. For the Low-PPVT indicator, lower levels scores for the speech and language impaired group was also identified for Language and Literacy, F (1, 3267) = 219.69, p = .000; Mathematical Thinking, F (1, 3257) = 165.05, p = .000; and Approaches to Learning, F (1, 3264) = 99.22, p = .000.

The effect sizes for the observed differences between speech and language impaired vs. non-impaired groups were predominately in the medium (.2 to .5) to large (.6 and above) range on Cohen's d (Cohen, 1988). Effect sizes between groups for PEDS Expressive Language concern were as follows: d = .43 for Language and Literacy; d = .35 for Mathematical Thinking; and d = .24 for Approaches to Learning. For PEDS Receptive Language concern the effect sizes confirmed large differences between groups: for Language and Literacy d = .65; for Mathematical Thinking d = .59; and for Approaches to Learning d = .56. Medium effect sizes were noted for the use of SLP services: for Language and Literacy d = .53; for Mathematical Thinking d = .43; and for Approaches to Learning d = .32. For children identified as performing poorly on the PPVT, effect sizes were large for Language

and Literacy (d = .68) and Mathematical thinking (d = .56) and medium for Approaches to Learning (d = .36).

What are the unique and combined predictive effects of early speech and language impairment indicators on school outcomes?

The observed differences between children identified as impaired and non-impaired on the four speech and language indicators were further explored in a series of regression analyses. In order to study the independent effects of child speech and language status, these analyses took account of the effects on school performance outcomes of child and family socio-demographic characteristics. Five separate equations were run for each of the three outcomes (total of 15 regressions). For each outcome, the first four equations tested the unique effect of each speech and language impairment indicator (Models 1 to 4), and the fifth entered all four indicators to test their combined effect (Full Model). The Full Model, whilst having the smallest sample size (ns = 2903 to 2912), tested the maximum number of children identified as having speech and language impairment.

Step-wise hierarchical regression was used, entering child characteristics on the first step, family SEP on the second step, and child speech and language status on the third step. The overall effect of each set of variables is shown by the additional explained variance (ΔR^2) for each step. The magnitude and direction of each variable within the set is shown by the unstandardised Beta coefficient and Confidence Intervals (95%). The proportion change in R^2 at the entry of the variable of interest (speech and language impairment status) is compared and assessed for significance and magnitude. Results are presented in Table 3.

Insert Table 3 here

With respect to the language and literacy outcome (Table 3, Column 1), results for Models 1 to 4 showed that each of the four indicators for early speech and language

impairment explained significant variance over and above the contribution of child and family characteristics. Receptive vocabulary scores as measured by below average scores on the adapted PPVT-III explained slightly more variance (3.2% than the parent-reported expressive speech and language concern (2.5%), parent-reported receptive language concern (2.3%) and use of speech-language pathology services (2.6%). Results for the full model, which assessed the combined effect of all four predictors together, explained 5.4% of the variance, which was equivalent to the variance explained by family SEP (5.3%), after accounting for the effect of for child characteristics .

For mathematical thinking (Table 3, column 2), assessed receptive vocabulary (PPVT) and parent-reported receptive language concern each explained 2.5% of the explained variance. The unique contributions of PEDS parent-reported expressive speech and language concern and the use of speech-language pathology services were 1.9% of the variance. The combined effect of all four predictors was 4.3%, which was equivalent to the variance explained by family SEP (4.0%).

For approaches to learning (Table 3, Column 3), parent-reported concern about their child's receptive language explained the larger proportion of variance (2.3%), followed by assessed receptive vocabulary (PPVT = 1.6%), use of speech-language pathology services (1.0%) and PEDS expressive speech and language concern (0.9%). The full model explained 2.6% of the variance which was equivalent to the variance explained by family SEP (2.6%).

The results of these regression analyses provided confirmation that children who were identified as having speech and language impairment in their early childhood years (age 4 to 5 years) did not perform as well in the key learning areas of literacy and numeracy, or in their more general approach to learning, at school, two years later, as children who did not have any identified speech and language impairment. In considering these findings, it is important to note that the proportion of explained variance for each of the regression models was modest:

11.5% to 13.9% for teacher-rated literacy and language; 9.4% to 11.3% for mathematical thinking; and 11.0% to 12.7% for approaches to learning. However, a substantial amount of unexplained variance is not unusual in this type of naturalistic, non-experimental, correlational study. The questions of interest centred on the relative contribution that speech and language impairment status makes to school achievement and adjustment, after accounting for child and family socio-demographic characteristics that are known to influence these outcomes. With this in mind, although the amount of the variance explained by speech and language status was small, the magnitude is similar to that explained by the independent contribution of family socio-economic position, after controlling for the effects of child characteristics to the outcomes.

Is early identification as effective as identification of sustained speech and language impairment in explaining school outcomes?

In order to test the relative contribution of early identification of speech and language impairment (children identified at 4 to 5 years) vs. sustained impairment status (children identified at 4 to 5 years and 6 to 7 years) to the explanation of children's school performance the above 15 regression equations were repeated with the addition of a fourth step to test for any additional explained variance accounted for by sustained impairment status. Three indicators of sustained speech and language impairment were available: PEDS-Exp, PEDS-R, and below average PPVT (as noted previously and illustrated in Figure 1). Results presented in Table 4 show the additional explained variance (ΔR^2) for these variables (Model b) (along with the unstandardised Beta coefficients and confidence Intervals (95%).

Insert Table 4 here

Results showed that sustained speech and language impairment status for each of the predictors added significantly to the explained variance for all of the outcomes. As noted for the figures for early speech and language status, the amount of additional variance (ΔR^2) was

small, ranging from 0.3% to 1.7%. The focus, however, is on the comparative magnitude of the proportion change in R^2 for early and sustained speech and language impairment.

For language and literacy, the effect of early identification was consistently and substantially larger than the effect of sustained identification: 2.5% vs. 1.5% for parent-reported expressive language concern; 2.3% vs. 1.1% for parent-reported receptive language concern; and 3.2% vs. 0.7% for below average receptive vocabulary using the adapted PPVT. For mathematical thinking, early and sustained identification of parent-reported expressive language concern made similar contributions to the explained variance (1.9% and 1.7%), but for parent-reported receptive language concern and below average PPVT the contribution was larger for early than for sustained identification (2.5% vs. 0.8% and 2.5% vs. 0.5%, respectively). A similar pattern was noted for approaches to learning; that is, an equivalent contribution by parent-reported expressive language concern (0.9%); a larger contribution for early vs. sustained identification for parent-reported receptive language concern (2.3% vs. 1.0%) and for below average PPVT (1.6% vs. 0.3%).

Discussion

The results from this study of a nationally representative sample of 4- to 5-year-old Australian children have shown that speech and language status (impaired vs. non-impaired) in early childhood predicted differences in children's school achievement in literacy, numeracy, and school adjustment two years later. For each of these outcomes, hierarchical regression analyses established that the predictive effects of early speech and language impairment on school outcomes were equivalent in magnitude to the effects of family socio-economic position, after controlling for child characteristics. The findings for language and literacy achievement accord with a large number previous studies reporting that children and young people with speech and language impairment have difficulties with specific areas of literacy such as spelling, reading comprehension, phonological awareness, and writing (see earlier

review). In the present study, lower scores were noted for teachers' ratings of overall proficiency in early communication and early literacy skills for children identified with speech and language impairment, relative to other children of the same age level at school. The results for numeracy and mathematical thinking also add to an existing, but smaller research base. As with the findings for language and literacy, children identified as having speech and language impairment were rated by their teachers as less proficient than their same-aged peers. On average, literacy and numeracy ratings were about half-a-point lower on a 5-point scale. In addition, teachers' ratings of children's adjustment to the broader, non-subject-specific expectations of school, such as being organised, persistent and adaptable, eager to learn, and able to work independently also showed that children with speech and language impairment were less well adjusted than non-impaired children. Of concern is that these difficulties with literacy, numeracy and approaches to learning in the first years of schooling are likely to have long-term impacts, not only throughout children's school careers but also on their occupational and social outcomes (Felsenfeld et al., 1994; McCormack, McLeod, McAllister, & Harrison, 2009).

In the LSAC, speech and language impairment were identified by parent report and assessed receptive vocabulary, using an adapted short-form of the PPVT-III. The findings presented here complement other research on this dataset in demonstrating that a simple screener completed by parents, such as the PEDS, is effective in identifying speech and language impairment in early childhood. McLeod and Harrison (2009), in their comparative analysis of these identifiers of speech and language impairment, reported modest associations between parents' and teachers' ratings of children's expressive and receptive speech and language abilities, and between parents' ratings of receptive language concern and direct assessment using the adapted PPVT-III. Results reported in the present study suggested that receptive language impairment, identified either by parent report or by direct assessment, was

an important predictor of poorer school performance, and made a larger contribution than expressive language impairment to the explained variance (albeit within a relatively small range). Not all studies of the long-term influence of speech and language impairment have identified children's receptive language impairment (e.g., Rescorla, 2005; Rice et al., 2008); however, those that have point to the increased long-term risk for problems with reading (Stojanovik & Riddell, 2008; Wise et al., 2007) and behaviour (Beitchman, Wilson, Brownlie, Walters, Inglis, & Lancee, 1996). For example, Beitchman et al. (1996, p. 815) specifically highlighted the influence of receptive language on behavioural outcomes by stating "Early auditory comprehension problems may be a specific risk factor for later aggressive and hyperactive symptoms". A greater propensity to behavioural difficulties in class may partially explain the process whereby speech and language impairment negatively affects children's school achievement and adjustment. Further analyses of the LSAC data set will be able to address the possibility of mediating factors, such as child socio-emotional wellbeing, hyperactivity and behaviour problems, that may impact the observed relationship between early speech and language impairment and school outcomes.

The credibility of the LSAC identifiers of children's early speech and language impairment status was further demonstrated by analyses comparing the effects of early vs. sustained impairment status (i.e., identified at ages 4 to 5 years and 6 to 7 years) on school outcomes. Results showed that the variance explained by early impairment status (at 4 to 5 years) was larger than the additional variance accounted for by sustained impairment status. In considering these findings it is relevant to note that a sizable proportion of children in the early impairment group were no longer identified as having speech and language problems at age 6 to 7 (early status vs. early only status = 24.4% vs. 14.1% for PEDS-Exp; 8.3% vs. 4.4% for PEDS-Rec; and 13.3% vs. 7.7% for below average PPVT). This is not unexpected, given the difficulty of accurately predicting later linguistic status (age 6) from earlier measures (age 3 to

4 years) (Dollaghan & Campbell, 2009). Findings from the present study, however, suggest that early identification of speech and language impairment is more useful in foreshadowing later difficulties with school. Indeed, the benefit for children of being identified early (in preschool or before entering school) is that their needs can be assessed and addressed by speech-language pathologists and targeted support can be provided by early childhood or specialist teachers in prior to school settings. A number of studies, including randomized controlled trials, have indicated that early interventions are effective in improving both communication and literacy difficulties (Almost & Rosenbaum, 1998; Bernhardt & Major, 2005; Gillon, 2002; Hesketh, Dima & Nelson, 2007). Less work has been done to assess interventions targeting mathematical skills, despite recommendations for the development of numerical interventions for children with language impairment (Arvedson, 2002).

Limitations and further research

There are a number of limitations when researching on a large-scale. One significant limitation is that direct assessment of each child's literacy, numeracy and approaches to learning at school was not possible; instead this study relied on teacher-report of these skills using previously validated tools. However, a review of relevant research indicates that teachers can make accurate judgements on children's achievement outcomes (Perry & Meisels, 1996) and that their judgements are valid and reliable in discriminating accurately between children who are or who are not at risk (Meisels, Bickel, Nicholson, Xue & Atkins-Burnett, 2001). Second, there is limited detail regarding access to, extent, type and outcome of intervention received by the LSAC children for speech, language, literacy, numeracy, behavioural and other additional needs. While it was known whether the children had accessed speech-language pathology services, it was not known whether they had received sufficient intervention for this support to be effective.

The results presented in this report suggest that parent-reported expressive speech and language concern was a weaker predictor of academic achievement and adjustment outcomes than receptive language impairment. However, direct assessment of children's expressive speech and language was not undertaken in this study; thus, conclusions cannot be made about whether direct assessment of these skills may also be predictive of children's academic achievement and adjustment. Further research could include direct assessment of expressive speech and language skills. Additionally, further work using the LSAC data set will extend our analyses to include social and emotional outcomes, which we expect will be more strongly predicted by children's expressive speech and language abilities.

Conclusion

Children identified with speech and language impairment in early childhood are at risk for subsequent difficulties with achievement and adjustment in the early school years. This study underlines the usefulness of parent-reported speech and language concern as a means of identifying children with speech and language impairment in early childhood (age 4 to 5 years). Early identification is the key to the providing intervention and support services for children as they make the transition from early childhood into formal schooling.

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Table 1: Frequencies and percentages on indicators for speech-language impairment

Indicators for speech-language impairment	**4 to 5 years**[a] **(Wave 1) N (%)**	**6 to7 years**[a] **(Wave 2) N (%)**
Parent reported expressive speech and language concerns (PEDS-Exp: Yes/a little)	884 (24.4%)	549 (15.4%)
Parent reported receptive language concerns (PEDS-Rec: Yes/a little)	300 (8.3%)	332 (9.3%)
Use of speech-language pathology services (SLP)	448 (14.0%)	Not collected
Low receptive language score (adapted PPVT-III: ≤ 1 SD below the mean)	587 (13.3%)	462 (10.5%)

Note:

[a] n ~ 3632 on these various indicators. There are small variations due to missing data. The exception is for parent and teacher report that child receives speech-language pathology services (4 to 5 years of age) for which n = 3207.

Table 2. Teachers' ratings of school achievement and adjustment at 6 to 7 years for groups identified on speech language impairment indicators at 4 to 5 years

Indicators of speech and language impairment at age 4 to 5 years (Wave 1)		**Achievement and Adjustment at 6 to 7 years**		
		Language and literacy	**Mathematical thinking**	**Approaches to learning**
		Mean (SD) [95% CI]	**Mean (SD) [95% CI]**	**Mean (SD) [95% CI]**
Parent reported expressive speech and language concerns (PEDS-Exp)	Yes/A little	3.30 (1.11) [3.23 - 3.37]	3.28 (1.08) [3.20 - 3.34]	3.07 (0.74) [3.02 - 3.12]
	No	3.74 (0.97) [3.71 - 3.78]	3.63 (0.94) [3.60 - 3.67]	3.30 (0.68) [3.28 - 3.33]
Parent reported receptive language concerns (PEDS-Rec)	Yes/A little	3.01 (1.18) [2.87 - 3.14]	2.95 (1.11) [2.82 - 3.08]	2.81 (0.78) [2.72 - 2.90]
	No	3.69 (0.99) [3.66 - 3.73]	3.55 (0.99) [3.51 - 3.63]	3.28 (0.68) [3.26 - 3.30]
Received speech-language pathology services (SLP)	Yes	3.20 (1.13) [3.10 - 3.30]	3.20 (1.11) [3.10 - 3.31]	3.02 (0.75) [2.95 - 3.09]
	No	3.74 (0.97) [3.71 - 3.78]	3.63 (0.94) [3.59 - 3.66]	3.29 (0.68) [3.27 - 3.31]
Receptive language (adapted PPVT)	≤ 1 SD below mean	3.09 (1.10) [3.00 - 3.18]	3.08 (1.04) [2.99 - 3.17]	2.98 (0.75) [2.91 - 3.05]
	Average or	3.78 (0.94)	3.66 (0.92)	3.31 (0.67)

	above average score	[3.74 - 3.81]	[3.64 - 3.70]	[3.30 - 3.33]

Note: ANOVA results are as follows: PEDS-Exp: Language and Literacy, F (1, 3614) = 131.79, p = .000; Mathematical Thinking, F (1, 3601) = 87.62, p = .000; Approaches to Learning, F (1, 3616) = 75.08, p = .000. PEDS-Rec: Language and Literacy, F (1, 3615) = 127.65, p = .000; Mathematical Thinking, F (1, 3602) = 120.14, p = .000; Approaches to Learning, F (1, 3617) = 131.23, p = .000; SLP: Language and Literacy, F (1, 3194) = 114.01, p = .000, Mathematical Thinking, F (1, 3182) = 73.75, p = .000; Approaches to Learning, F (1, 3194) = 57.32, p = .000; adapted PPVT: Language and Literacy, F (1, 3267) = 219.69, p = .000; Mathematical Thinking, F (1, 3257) = 165.05, p = .000; Approaches to Learning, F (1, 3264) = 99.22, p = .000.

Table 3. Unique and combined predictive effects: Four indicators of speech and language impairment on achievement and adjustment at 6 to 7 years

Predictor Variables	**Achievement and Adjustment at age 6 to 7 years**		
	Language and literacy	**Mathematical thinking**	**Approaches to learning**
	ΔR^2 Beta [95% CI]	ΔR^2 Beta [95% CI]	ΔR^2 Beta [95% CI]
Child characteristics[a]	**.032**	**.030**	**.074**
Gender (girls = 1, boys = 0)	.20 [.13 - .27]	.02 [-.05 - .08]	.34 [.29 - .39]
Age (months)	.02 [.00 - .03]	.05 [.03 - .06]	-.01 [-.01 - .00]
Language other than English (yes = 1, no = 0)	.10 [-.03 - .22]	.15 [.03 - .27]	.10 [.02 - .19]
Aboriginal/Islander background (yes = 1; no = 0)	-.41 [-.62 - -.21]	-.36 [-.56 - -.15]	-.16 [-.30 - -.01]
Family characteristics[a]	**.053**	**.040**	**.027**
Socioeconomic Position	.27 [.22 - .32]	.23 [.18 - .28]	.14 [.10 - .17]
Speech and language impairment indicators[b]			
Model 1. PEDS-Expressive	**.025**	**.019**	**.009**
	.38 [.31 - .45]	.32 [.25 -.40]	.16 [.11 - .21]
Model 2. PEDS-Receptive	**.023**	**.025**	**.023**
	.57 [.45 - .68]	.57 [.46 - .69]	.39 [.31 - .47]

Model 3. Received Speech-Language Pathology Services	**.026**	**.019**	**.010**
	.47 [.38 - .57]	.39 [.30 - .49]	.20 [.14 - .27]
Model 4. Below average PPVT	**.032**	**.025**	**.016**
	.59 [.48 - .69]	.50 [.40 - .61]	.29 [.21 - .36]
Full Model. 4 indicators added	**.054**	**.043**	**.026**
Total Variance: Full Model R^2	**.139**	**.113**	**.127**

Notes:

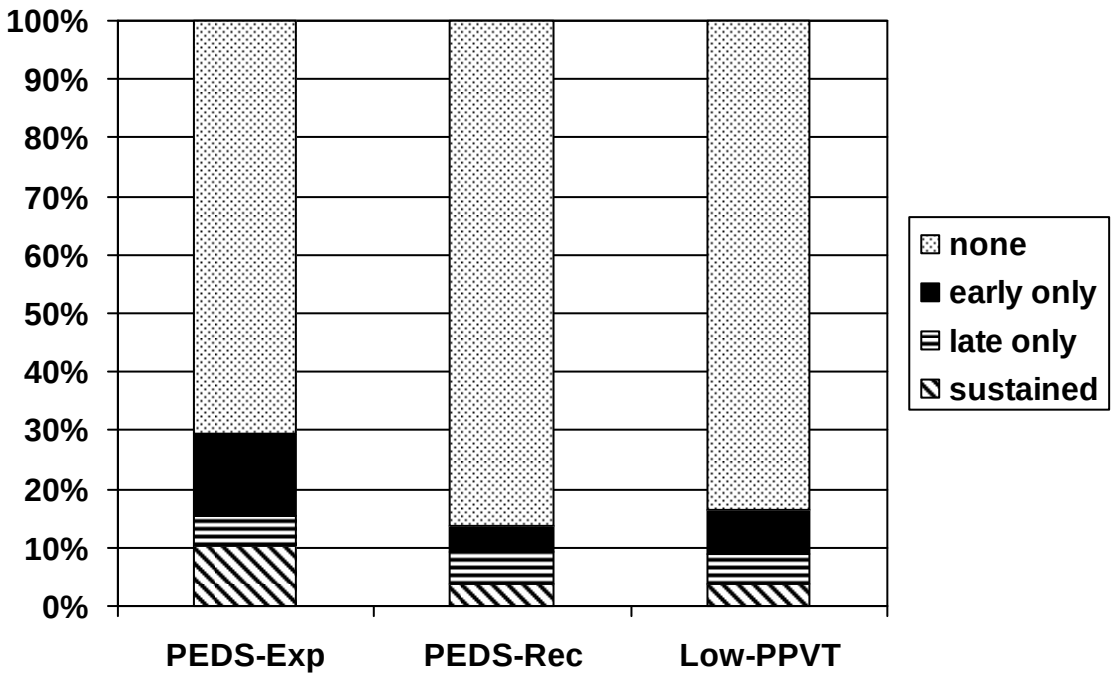
[a] Figures for ΔR^2 and Beta (95% CI) are presented for the Full Model

[b] For each model the number of children in the sample (*n)* varied by speech and language predictor and also by the dependent variable, as follows: PEDS-Exp *n*s = 3607, 3594, 3609, PEDS-Rec *n*s = 3608, 3595, 3610; SLP *n*s = 3191, 3179, 3191; below average PPVT *n*s = 3261, 3251, 3258; Full Model *n*s = 2912, 2903, 2909.

Table 4. Additional predictive effects of sustained speech and language impairment on children's school achievement and adjustment

Predictors of speech and language impairment	Achievement		Adjustment
	Language and literacy	Mathematical thinking	Approaches to learning
	ΔR^2 Beta [95% CI]	ΔR^2 Beta [95% CI]	ΔR^2 Beta [95% CI]
Child characteristics	**.032**	**.030**	**.074**
Family characteristics	**.053**	**.040**	**.027**
Model 1. PEDS-Exp (early)	**.025**	**.019**	**.009**
Model 1b. PEDS-Exp (sustained)	**.015**	**.017**	**.009**
	.51 [.38 - .64]	.53 [.40 - .65]	.28 [.19 – .37]
Model 2. PEDS-Rec (early)	**.023**	**.025**	**.023**
Model 2b. PEDS-Rec (sustained)	**.011**	**.008**	**.010**
	.75 [.53 - .97]	.63 [.42 - .84]	.48 [.33 - .63]
Model 3. Below average PPVT (early)	**.032**	**.025**	**.016**
Model 3b. Below average PPVT (sustained)	**.007**	**.005**	**.003**
	.54 [.34 - .75]	.44 [.24 - .65]	.23 [.08 - .37]

Figure 1. Longitudinal indicators of speech and language impairment status: Sustained, early, late



Key: PEDS-Exp = parent-reported expressive speech and language concern, PEDS-Rec = parent-reported receptive language concern, and Low-PPVT = one standard deviation, or more, below the mean on the adapted Peabody Picture Vocabulary Test-III.

Early only = identified at age 4 to 5 years; Late only = identified at age 6 to 7 years; Sustained = identified at ages 4 to 5 years and 6 to 7 years.