



**CITY UNIVERSITY  
LONDON**

**Reading, Dyslexia and Oral Deaf Children:  
From Research to Practice**

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*Q: What measures can be used to identify dyslexia in oral deaf children? Are deaf children's reading difficulties similar to the typical dyslexic profile, or do some deaf children display uniquely dyslexic profiles? What are the key factors associated with good and poor reading in this group? What are the implications for interventions with poor deaf readers?*

## Summary

Literacy difficulties are more widespread among deaf\* children than hearing children but reasons for their problems differ. Hearing children are likely to be described as dyslexic and once diagnosed, may benefit from specialist support. However, for deaf children, their hearing difficulties are seen as primary. In this Briefing Paper, we report findings from the first stage of our research, funded by the Nuffield Foundation, which has focused exclusively on oral deaf children. In the next phase, we will investigate deaf children who use sign language to communicate.

Our analysis identified half of our group of oral deaf children as having reading difficulties. We were able to identify dyslexia sensitive measures and deaf children with dyslexic profiles; however, not all were amongst the poorest readers. Our findings highlight the scale of reading difficulty in oral deaf children and point to an urgent need for specialist intervention to be implemented along the lines currently offered to hearing children with dyslexia.

*\*The terms 'deaf' and 'hearing impaired' are often used with this group. We use the term 'deaf' here to refer to individuals with a prelingual severe-profound degree of hearing loss, i.e. one that is present at or shortly after birth.*

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## Reading and dyslexia

Reading involves two separate skills:

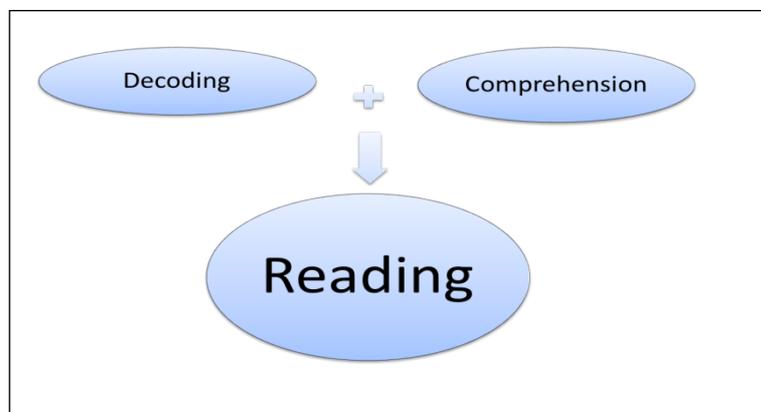


Figure 1. Skills involved in reading (Gough & Tunmer, 1986)

- *Decoding skills* involve translating the letters that make up written words into the sounds of spoken language, e.g. c-a-t. Decoding skills are important when learning to read and also when reading unfamiliar words or nonsense words (i.e. non-words, e.g. yutnip). Decoding skills are reliant upon an established speech sound (phonological) system.
- *Comprehension skills* are needed to understand the decoded words. Comprehension is based on a well-developed language system.

Children and adults with dyslexia have specific difficulties with the first of these areas and there is sometimes a genetic component to dyslexia. More boys than girls are affected and social factors may also be involved.

In addition to problems with decoding written words, dyslexia is associated with difficulties remembering certain types of information (such as telephone numbers), problems moving sounds around in words (such as exchanging the initial sounds of words, e.g. 'dog' with a 'l' becomes 'log') and accessing phonology at speed (e.g. naming pictures or digits as fast as possible). Together, these are known as phonological deficits. When testing a child for dyslexia it is common to use assessments that measure phonological skills and to look for discrepancies in these areas, in comparison with other areas of strength. (Note: although some reading problems may have other causes, our model of dyslexia relates to children whose reading difficulties stem from their struggle to link written symbols with sounds).

Figure 2 illustrates the profiles of readers with different strengths and weaknesses in decoding and language skills. Children with dyslexia are poor readers (PR) because of their poor decoding skills. This is in contrast with the profile of children who have adequate decoding skills but poor language skills. We will call this group 'poor language' (PL, see Figure 2). In addition to these two groups are children with decoding and language skills that are average for their age, we have called these 'average readers', and children with both poor decoding and poor language skills – we have termed these poor readers plus poor language (PR+PL).

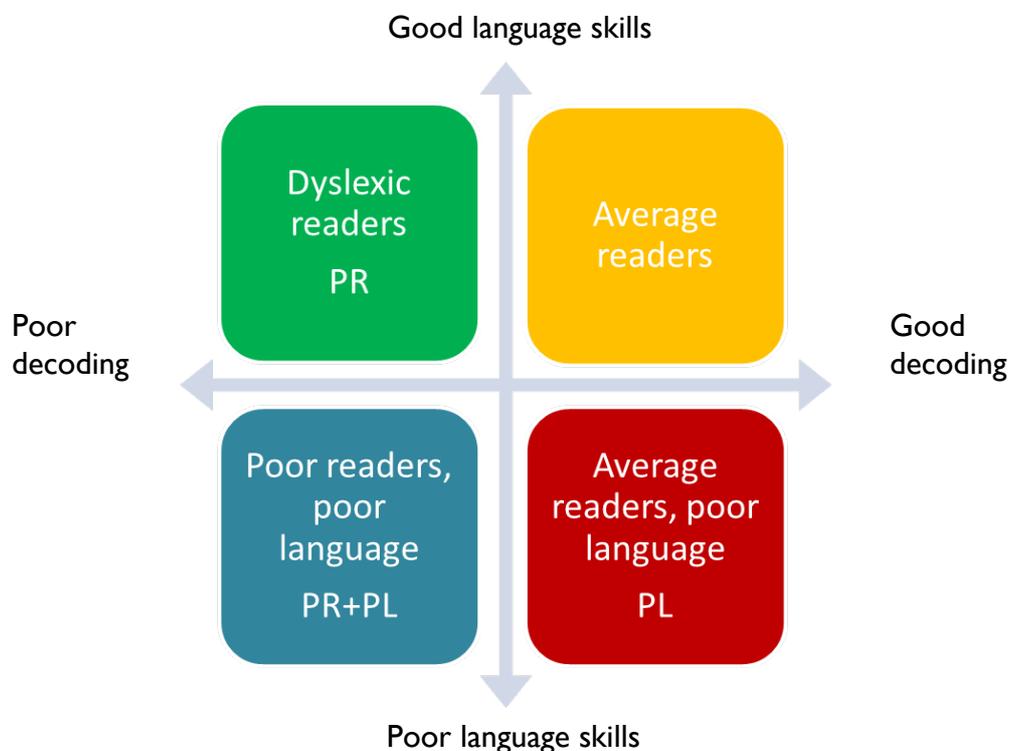


Figure 2. Impact of decoding and language skills on reading

The government-commissioned Rose Report 'Identifying and Teaching Children and Young People with Dyslexia and Literacy Difficulties' (2009) noted poor literacy to be associated with educational failure, emotional and behavioural problems in the school years, reduced earning potential, increased risk of unemployment and social exclusion in adulthood. For these reasons, there has been considerable interest in understanding the underlying causes of dyslexia, improving identification and developing effective interventions.

To date, this research has focused on dyslexia among children and adults with normal hearing. Yet, given the genetic basis of dyslexia in the hearing population, it is likely that a proportion of deaf readers are dyslexic and indeed teachers often suspect this is the case. One challenge is how to differentiate deaf children who are poor readers due to limited exposure to key pre-reading experiences from those who are dyslexic. The challenge is compounded by the lack of information about typical reading profiles among deaf children and adults. How do you decide if an individual child's profile of skills is uneven or discrepant if you do not know the typical profile of skills for any one age group?

The development of standardised assessments has played a key role in the recognition of dyslexia in recent years, as well as in the identification of other poor readers. Standardised assessments enable us to compare an individual child's test performance with others of the same age and also inform the design of interventions for hearing children with reading difficulties. However, there are no comparable tests in the UK for deaf children and no normative data. The research described in this Briefing Paper is a first step towards redressing this balance.

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## **Deafness and deaf children's reading**

Recent estimates suggest that there are 44,000 children with a permanent hearing loss in the UK (CRIDE 2012) and over 90% come from families with no experience of deafness. Approximately a quarter of affected children have a severe-profound degree of loss that significantly impacts their access to spoken language. Of these, an estimated two thirds use spoken language as their preferred form of communication.

Because of their hearing loss, deaf children have difficulty hearing the speech sounds that make up spoken language (i.e. phonology), upon which written language is based. Although many rely on lipreading (or speechreading) to support their understanding of spoken language, this is only partially successful. In addition, deaf children often struggle to understand language that is not specifically addressed to them and therefore cannot benefit from incidental learning. As a consequence of their impoverished input, deaf children can have speech that is difficult to understand and levels of language and literacy development markedly below their hearing classmates, despite a normal range of intelligence. A variety of factors, such as when deafness was identified, the degree of deafness, the benefit obtained from hearing aids or cochlear implants, the preferred form of communication, etc., contribute to further differences among deaf children.

Despite these factors, deaf children seem to follow essentially the same route to reading as hearing children. This is especially true of oral deaf children, i.e. those who predominately use spoken rather than sign language. Phonological skills play a central role in reading for both groups although, unlike hearing children, many deaf children develop their phonological skills by combining information obtained through listening with hearing aids and cochlear implants with information obtained from observable lip-patterns.

In recent years, the earlier diagnosis provided by the UK Newborn Hearing Screening Programme and more widespread use of cochlear implants at younger ages have offered better outcomes. Now,

many deaf children have improved access to spoken language and more intelligible speech. Higher levels of achievement have been reported at the early stages of learning to read and among certain groups of deaf children, e.g. those with cochlear implants and those who communicate orally. However, significant gaps in reading levels between deaf and hearing children are still reported for a large proportion of deaf children, gaps which widen as children get older.

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## Research study

A research study was set up to investigate reading and dyslexia among oral deaf children, since these children most closely follow the route to reading taken by hearing children. The research team comprised Dr Rosalind Herman, Professor Penny Roy and Dr Fiona Kyle from City University London. In this Briefing Paper, the analyses of our data are summarised and we suggest some implications for improving reading attainment in oral deaf children.

The main aims of the research were:

1. To investigate the suitability of literacy and dyslexia-sensitive tests developed for hearing children for oral deaf children
  2. To collect data from a representative sample of 80 oral deaf children in their final year of primary school (age 10-11 years)
  3. To compare deaf children to hearing children with and without dyslexia
  4. To identify key predictors of literacy skills in deaf children in comparison with the hearing dyslexic sample
  5. To find out whether some deaf children have particular literacy difficulties similar to those found in dyslexia.
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## A representative sample of deaf children

Children aged 10-11 years (average age 11 years) in Year 6, their last year of primary school, were identified as the target group. By this age, children would be expected to have established reading skills and if not, teachers urgently need to know since transfer to secondary education is imminent. Although a diagnosis of dyslexia is possible at a younger age among hearing children, this would not be possible given the reading delays that many deaf children experience.

Eighty-two children with a severe-profound level of deafness and who used spoken language to communicate were recruited from all parts of the UK. All children were reported to be deaf from or shortly after birth, i.e. they were prelingually deaf. This sample size represents a significant proportion of oral deaf children in the UK within this age group and is larger than samples included in other studies. Moreover, the sample is highly representative of the population of severely-profoundly prelingually deaf children in the UK.

All children who could attempt the test battery were encouraged to do so. Three children were excluded: two because of poor levels of speech intelligibility and one child who could not comply

with the literacy measures. This left a final sample of 79 children. There were approximately equal numbers of girls and boys and children came from a range of backgrounds in terms of parental education and ethnicity. The majority attended resource units for deaf children within mainstream schools; some were in mainstream schools unsupported and a small minority attended schools for deaf children. All children had attended an English speaking school since Year 1 and used English as their dominant language. Almost two thirds of the children used one or more cochlear implants (one child used one digital aid and one cochlear implant); the remainder used digital hearing aids. Speech intelligibility ratings varied within the group: 96% had at least average intelligibility.

Further background information was obtained from parents on family history of hearing, language or reading difficulties and family reading habits and from teachers on school communication approaches.

## Hearing children with dyslexia

Twenty hearing children with identified dyslexia completed the same test battery for comparison with the deaf participants. Compared to our deaf participants, the hearing dyslexic sample was less representative. Children attended either mainstream schools or specialist dyslexic units and schools in London, Yorkshire and the East and South-East of the England only. There was a similar range of social backgrounds as in the deaf group, but a disproportionate number of fathers were educated to degree level or above. The age range was also wider (8-11 years), with an average age of 10 years, i.e. a year younger than the deaf participants. There were approximately equal numbers of girls and boys.

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## Test battery

Tests selected were known to measure skills related to reading and dyslexia in hearing children. Additional tests targeted skills known to be important to reading in deaf children only. The test battery covered the following skills (full details are provided in the Appendix):

- Nonverbal skills
- Literacy skills (reading words<sup>1</sup> & non-words, reading rate & comprehension, spelling)
- Phonological skills
- Naming speed & fluency skills
- Language skills (expressive vocabulary)
- Speech intelligibility<sup>2</sup>
- Speechreading skills<sup>3</sup>

The phonological skills tested included:

- Matching words that rhyme (rhyme awareness)
- Generating words that rhyme (rhyme fluency)
- Generating words that start with the same sound (alliteration fluency)
- Recall of digits forwards and backwards
- Manipulating sounds within words<sup>4</sup>
  - Spoonerisms, e.g. fun with a 'b' gives 'bun;' 'riding boot' gives 'biding root'
  - Phoneme deletion, e.g. say 'reindeer,' say it again but don't say 'rein'; say 'afford,' say it again but don't say 'a'
- Naming speed for pictures and digits<sup>5</sup>

<sup>1</sup>The single word reading test was taken from the BAS II (Elliott, Smith & McCulloch, 1996). These norms, available at the time of data collection, were used to make comparisons between our measures, as the other tests used were also standardised at that time. However, the BAS3 norms published in 2011 are used when commenting on deaf children's reading achievements.

<sup>2,3</sup> Test skills known to be significant for deaf children's reading.

<sup>4,5</sup> Tests known to be discriminating in hearing children with dyslexia.

Deaf children were tested in school by a researcher skilled in communicating with deaf children. Instructions were delivered in spoken English. Sign support or British Sign Language was used according to teachers' recommendations to help children understand what was required. For some tests, additional practice items were included. Following these adjustments to the test procedure, all children were able to attempt the full test battery.

Children responded using spoken English. As many deaf children have poor speech intelligibility, responses were filmed to check for scoring accuracy. In addition, a proportion of children's responses were scored separately by an independent person to check scoring reliability. Scoring reliability was high for all measures with the exception of accuracy in reading aloud. For this measure, some deaf children's speech difficulties made it difficult to reach agreement between independent scorers. Therefore, this measure was not included in subsequent analyses.

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### Deaf children's test scores

Unlike the findings of some other studies, we found no differences between children using cochlear implants and those using digital hearing aids on any of our measures. For subsequent analyses, a single combined group of implant and hearing aid users was used (although we return to the question of benefit obtained from cochlear implants below).

Overall, deaf children achieved lower scores than would be expected for hearing children based on the test norms. Scores on some of the phonological tasks (phoneme deletion, recall of digits forward) and the vocabulary measure were particularly poor for all deaf children. There were some exceptions: on the non-verbal, semantic fluency and naming speed tasks, deaf children's scores were within the expected range for hearing children. Scores for speechreading were somewhat above the norms for deaf children.

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### How do deaf and hearing dyslexic children compare?

In common with the deaf group, hearing children with dyslexia found many of the literacy tasks challenging; in particular, spelling was more difficult for some hearing dyslexic children than reading. More deaf children than hearing children with dyslexia had below average scores on non-word reading, but the difference was less marked than for single word reading. In terms of reading age equivalents, the deaf group were 2 years below and the dyslexic group were 1 year below on single word reading. Both groups were 18 months below on the spelling task.

However, there were differences between the deaf and dyslexic groups. Whereas the dyslexic children's scores for vocabulary and reading comprehension were as expected for their age, two thirds of the deaf children had below average scores on these measures. Figure 3 shows the percentage of test scores that were below average in the deaf and hearing dyslexic groups.

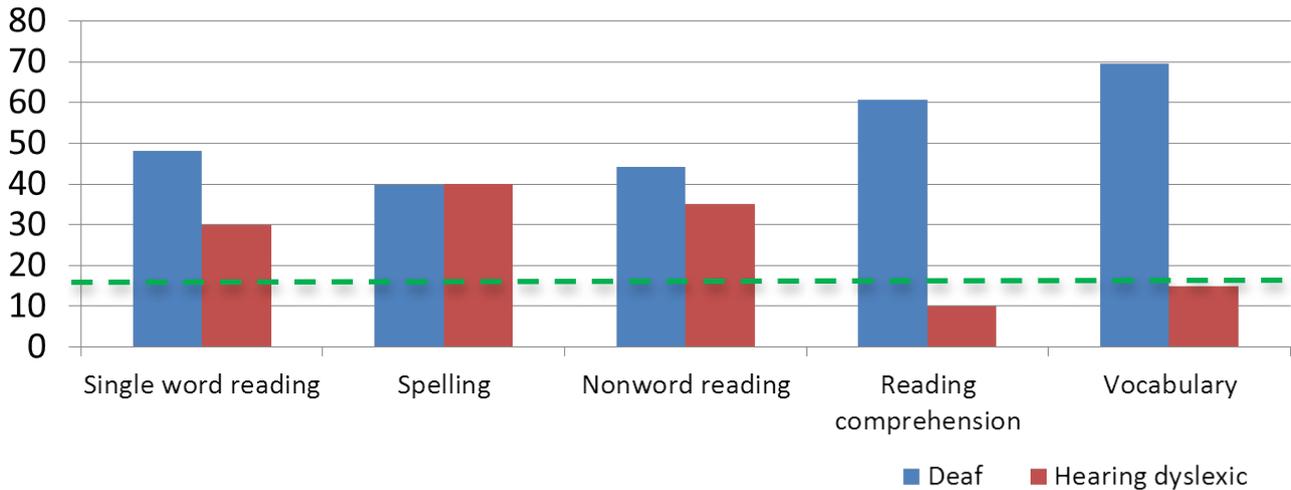


Figure 3. Percentage of below average literacy and language scores for deaf and hearing dyslexic children

### Proportion of average, poor and extremely poor readers in each group

Based on test scores for single word reading, deaf and hearing dyslexic children were divided into average (average scores) and poor (below average) readers. There were many more average readers among the hearing dyslexic children than among the deaf children. In the hearing dyslexic group, 70% were average readers, with test scores within the average range for hearing children, and 30% were poor readers with below average scores (see Figure 4).

In the deaf group, 52% were average and 48% were poor readers (although see conclusion for discussion of new reading norms). Among the poor readers, a small number of children (6%) achieved extremely low scores (less than two standard deviations below the mean,  $<-2SD$ ). No equivalent group was found among the hearing dyslexic group. However, as no statistically significant differences were found between the poor and extremely poor deaf readers in key measures other than single word reading, these groups were combined.

For both deaf and hearing dyslexic children, the average readers achieved higher scores than the poor readers on some but not all of the measures. Three phonological measures failed to differentiate average and poor readers in the deaf group only: recall of digits forward, alliteration fluency and sequencing days of the week. Some measures, e.g. speechreading, rhyme awareness and letter sound knowledge did not differentiate average and poor readers in the hearing dyslexic group only.

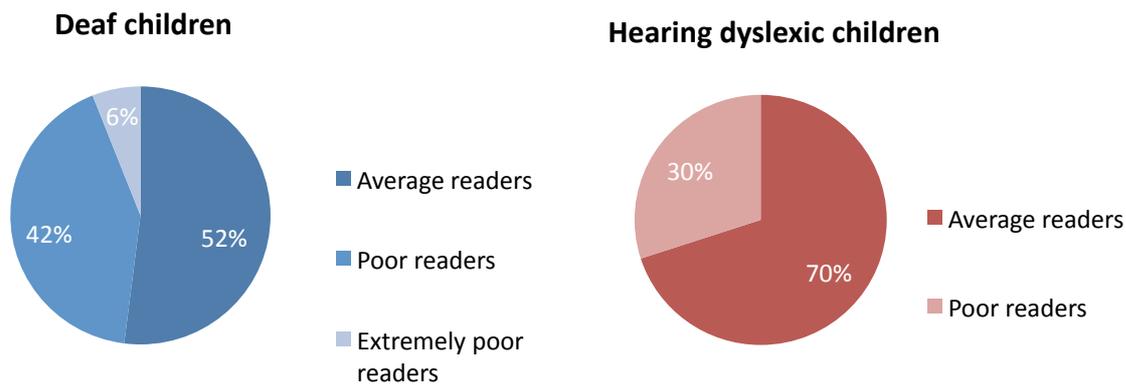


Figure 4. Average, poor and extremely poor readers in the deaf and hearing dyslexic groups

### Profiles of average and poor readers

In Figure 2, we presented the different reading profiles for decoding and language skills. Using single word reading as the measure of decoding skill and vocabulary as the measure of language (vocabulary scores were highly related to reading comprehension scores), Figure 5 presents the distribution of deaf and hearing dyslexic children according to these same profiles (*note*: we acknowledge the limitation of using this type of profiling in view of the continuous nature of children's scores). From this, we can see that the majority of the dyslexic children in our reference group were average readers with decoding and language skills within the average range. None of the dyslexic group had poor language only (PL). Half of the poor dyslexic readers (15%) fit the pure dyslexic profile of poor readers (PR) due to weak decoding alongside average language skills. The other 15% had weak decoding in addition to weak language skills, i.e. poor reading and poor language (PR+PL). This varying profile fits in with the view of dyslexia as being along a continuum of reading difficulty.

In contrast to the dyslexic children, a significant proportion of average deaf readers were found to have poor language (PL). Although currently reading at an average level for single words, these children could be considered at risk of future reading problems because of their language difficulties, as are the PR+PL children. Only 30% of deaf children were reading at age level with appropriate language skills.

Within the large number of poor deaf readers (48%), all showed weak decoding and language skills (PR+PL). Taking non-word reading as a measure of decoding skills, rather than single word reading, had very little impact on the distribution of average and poor readers across profiles in either group. Based on this analysis, no deaf children fit the pure dyslexic profile of average language and poor decoding skills. However, we will see later that other measures identified different profiles of phonological deficits amongst the poor readers.

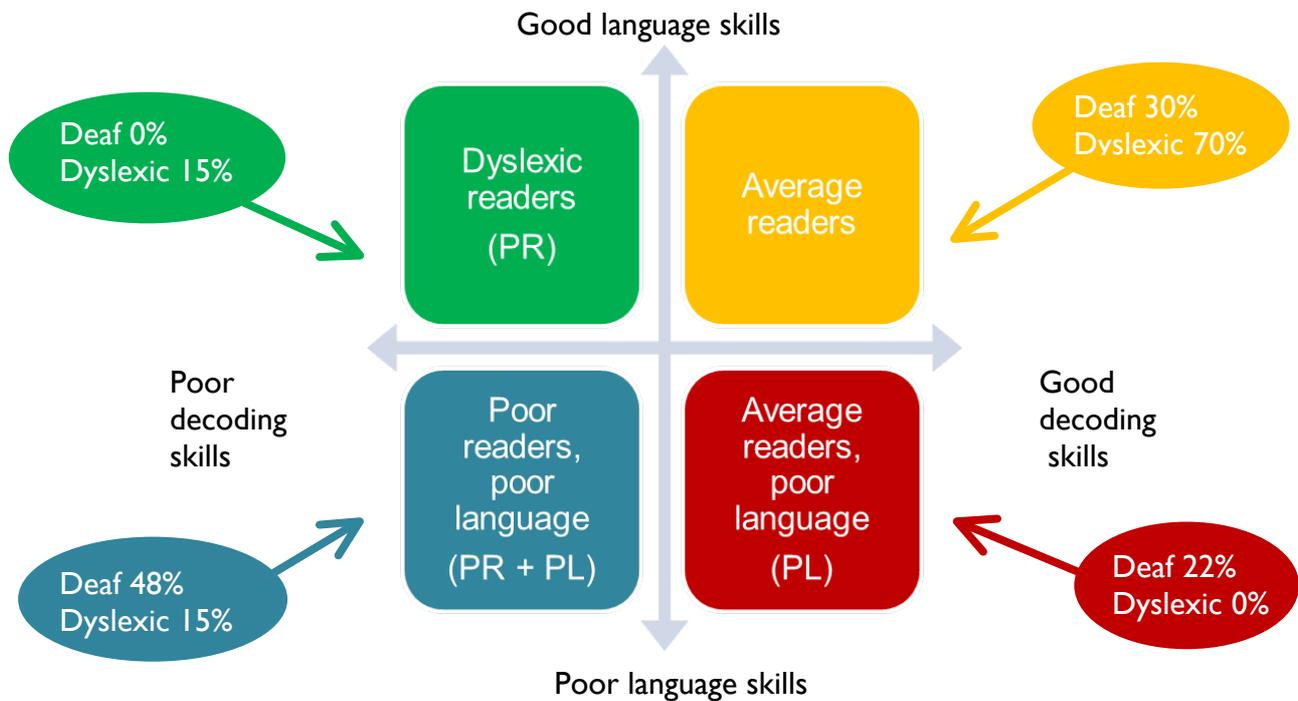


Figure 5. Distribution of average and poor deaf or dyslexic readers according to decoding and language skills

### Exploring the profiles of deaf readers in relation to literacy and vocabulary measures

Figure 6 shows the literacy scores (single word reading, non-word reading, spelling, reading rate, reading comprehension) and vocabulary scores for the three groups of deaf children identified above according to their decoding and language scores (i.e. average readers, PL and PR+PL). As we would expect, the average literacy scores of the PL and average readers were in the average range (with the exception of vocabulary for the PL group). However, the PR+PL group's scores were consistently below average. Reading comprehension in the PR+PL group was in line with decoding skills; vocabulary scores were significantly lower. Most of the observed differences were large and statistically significant.

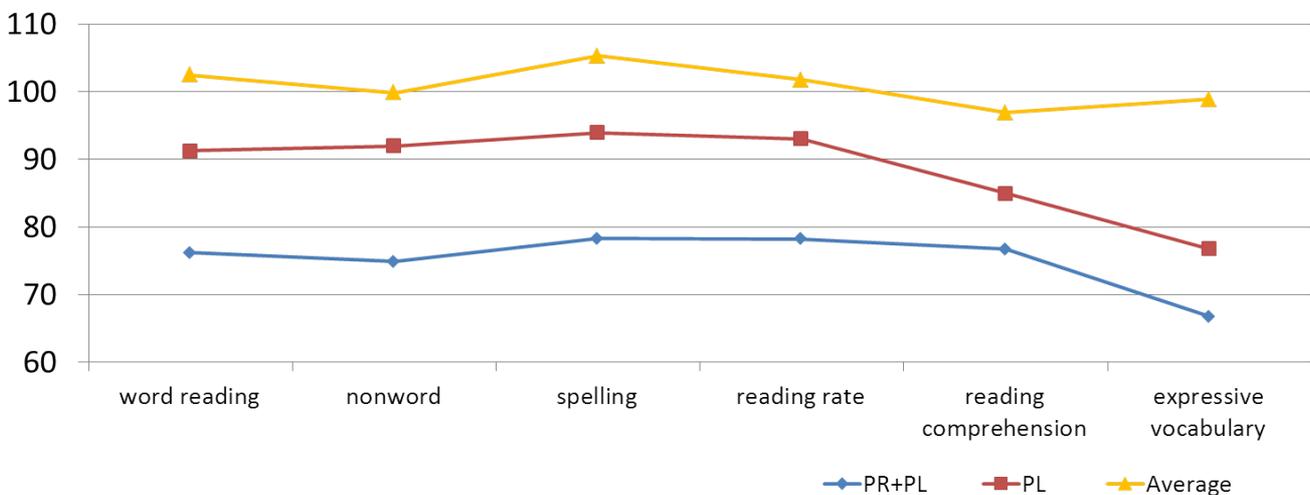


Figure 6. Mean literacy scores for deaf children according to decoding and language profile

## Phonological measures

Figure 7 shows the deaf group's performance on the phonological measures. Differences between the PL and average deaf readers were apparent on many of these measures, although these were less marked than those found on the literacy tests (see above). However, in the main, differences were not statistically significant and were explained by vocabulary.

In contrast, differences at all levels of phonological processing were evident between the PR+PL and PL groups. The PR+PL group was significantly poorer at phonological tasks that involved manipulation (spoonerisms, phoneme deletion) and also at tasks that did not involve manipulation (rhyme fluency, rhyme awareness). Of interest, scores for naming speed for digits for the deaf group as a whole were in the expected range, but the PR+PL group were still significantly lower than PL group. The large differences observed between average and poor readers were not fully explained by vocabulary.

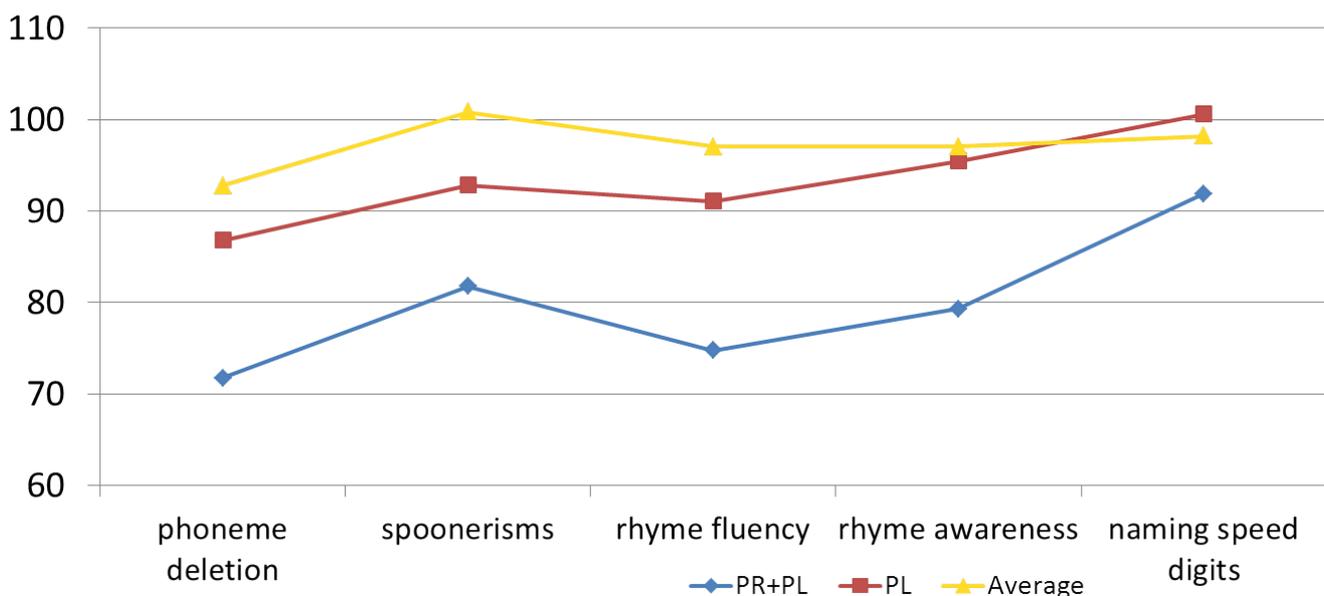


Figure 7. Mean phonological test scores according to decoding and language profile

## Were measures equally effective for deaf and hearing dyslexic children?

Many of the tests identified average and poor readers in both deaf and hearing dyslexic groups. However, a few tasks were only effective in one or other group. Some measures only presented challenges to the deaf children, e.g. rhyme tasks. In all cases, these test scores were uniquely associated with vocabulary in the deaf sample. In contrast, the measure of short-term verbal memory (recall of digits forward), known to be affected in dyslexia, was only sensitive in the hearing dyslexic group, despite the fact that many deaf children were very poor at it. Additionally, over half of the hearing dyslexic children (compared with less than 10% of the deaf group) found the speechreading task difficult, but there was no relation between their speechreading skills and literacy performance.

Further analysis revealed the main difference between the deaf and hearing dyslexic group to be the key role of vocabulary for reading and spelling for the deaf children. Even when reading entirely unfamiliar words (non-words), vocabulary played a small role in the deaf group. Speech intelligibility measures were only taken for the deaf children. Intelligibility ratings related both to phonological and literacy outcomes.

Of interest, the profile of phonological deficits associated with poor literacy at this age was strikingly similar for deaf and hearing dyslexic children. In line with previous evidence, tasks involving the manipulation of sounds (e.g. phoneme deletion, spoonerisms) were particularly significant for reading, and naming speed for digits was significant for spelling. Deaf children's specific difficulties with the rhyme tasks were fully accounted for by their problems with vocabulary and the key phonological tasks significant for both deaf and hearing children.

The type of spelling errors the children made was also informative (see Figure 8). We found that children varied in the proportion of phonetic errors they made (e.g. lepered for 'leopard'). Almost all the hearing dyslexic group made mainly phonetic errors, indicating they were using a phonological route to reading and spelling. Roughly equal proportions of the deaf sample made mainly phonetic errors, mainly non-phonetic errors, or a 'mixed' pattern of phonetic and non-phonetic errors.

For the deaf group, phonetic or mixed errors were associated with better reading and spelling. Mainly non-phonetic errors (e.g. cuircle for 'circle') were found almost exclusively among the poorest spellers and readers in the deaf group. For these children, there is little evidence that they are using a phonological route to literacy. However, a small group of deaf children who were poor readers made mainly phonetic errors, like the hearing dyslexic children.

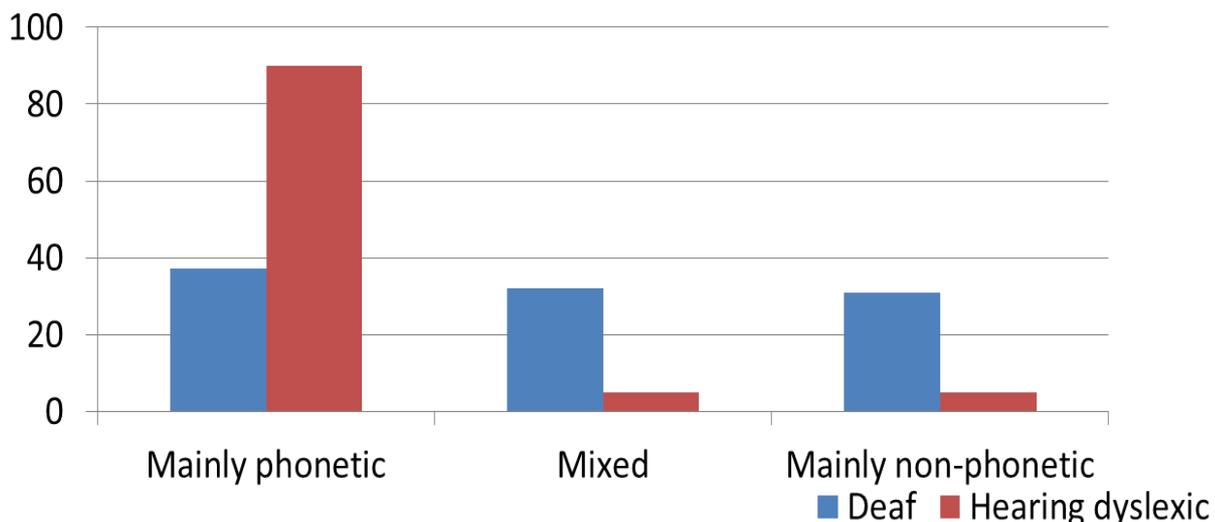


Figure 8. Spelling errors in deaf and hearing dyslexic children

### A 'deaf dyslexic' profile?

As shown above, most deaf children with poor reading skills had below average phonological skills. In addition, among our bottom 6% of extremely poor readers, many children were getting the lowest possible scores across most, if not all of the measures, including vocabulary. Can we conclude that all these children showed a dyslexic profile? In order to make a decision about dyslexia using the model of dyslexia we have followed, we need to be sure that children are using a phonological route. In cases where children's scores are at floor, this is not possible. For such children, responses to a phonological intervention would be informative.

Close inspection of children's profiles of performance across a number of measures was helpful in identifying strengths and weaknesses. We noted previously that deaf children's performance on the naming speed task did not differ from that of the hearing norms. This makes it a potentially useful measure to identify deaf children with specific reading difficulties. In addition, we saw that some children had higher scores on spoonerisms than the phoneme deletion task, and that the type of spelling errors the children made was indicative of their use of the phonological route to reading. Furthermore, whilst *all* poor readers in the hearing dyslexic group had very low non-word reading scores ( $< -1.5SD$  below the mean), this was not the case amongst the poor deaf readers. Just over two thirds of the poor deaf readers had very low non-word reading scores, a sixth had borderline scores ( $\geq -1.5SD < -1SD$ ), and a sixth had non-word reading scores in the average range ( $\geq -1SD$ ).

Using non-word reading, spelling error strategy, phonological skills and naming speed measures, we can identify distinct profiles within the group of poor deaf readers according to their strengths and weaknesses. The most clear cut cases will be those children who show deficits on all of these measures. However, as we found with our hearing sample, some children with deficits in one or more of these areas, will be diagnosed with dyslexia.

Figure 9 presents the risk factors for dyslexia using the four measures. Risk of dyslexia in poor deaf readers increases among children with low non-word reading scores, who make phonetic spelling errors and have deficits in either phonological skills or naming speed or both: the greater the number of risk factors, the higher the likelihood of dyslexia.

Measure	Risk present yes/no
Non-word reading: low	
Spelling strategy: phonetic/mixed pattern of errors	
Spoonerisms and/or phoneme deletion: low (vs both scores at floor)	
Naming speed: low	

Figure 9. Risk factors for dyslexia among poor deaf readers

A cut-off of  $< -1.5SD$  on the non-word reading test was taken as all the poor readers in the hearing dyslexic group achieved scores lower than this. Of the poor readers in the hearing dyslexic group, 33% had 4, 50% had 3 and 16% had 2 risk factors. Of the poor readers in the deaf group, 10% had 4, 18% had 3 and the remainder had 1, 2 or no risk factors.

We have identified a small number of deaf children who appear to have a dyslexic profile in line with that of poor readers in our hearing dyslexic sample. Does this mean that they, out of the entire group of deaf children, are most in need of specialist dyslexia intervention? Perhaps surprisingly, these children were not among the poorest readers in the sample. In our view, both they and all poor deaf readers, including those with 1 or no risk factors, are equally in need of intensive support. Moreover, as was evident among the poor readers in the hearing dyslexic group, children with dyslexia can present with different profiles.

## The role of vocabulary in deaf children's reading

A proportion of the average deaf readers in our sample had average language skills. However, some average readers and all poor deaf readers had weak expressive vocabulary skills. Our study, in line with other studies, has shown the key role of vocabulary in deaf children's literacy skills. Although vocabulary was the only language measure used in this study, it is widely acknowledged that vocabulary and wider language skills are associated.

We noted at the outset that learning to read involves two skills: decoding and language. The extent to which they are separable is debated. Our research shows these skills to be particularly closely related in 10-11 year-old oral deaf children. Other research has shown that this relationship is there from the early stages of learning to read. The evidence from our data and others suggests that the very limited exposure to early language experienced by most deaf children impacts on vocabulary development, speech perception and speech production, with consequences for the development of phonological representations and word learning efficiency. This is similar to the consequences of impoverished language input that has been observed in children from socioeconomically disadvantaged backgrounds. The interdependency of these early skills has longer term implications, not only for language, but also for the development of reading skills (see Figure 10).

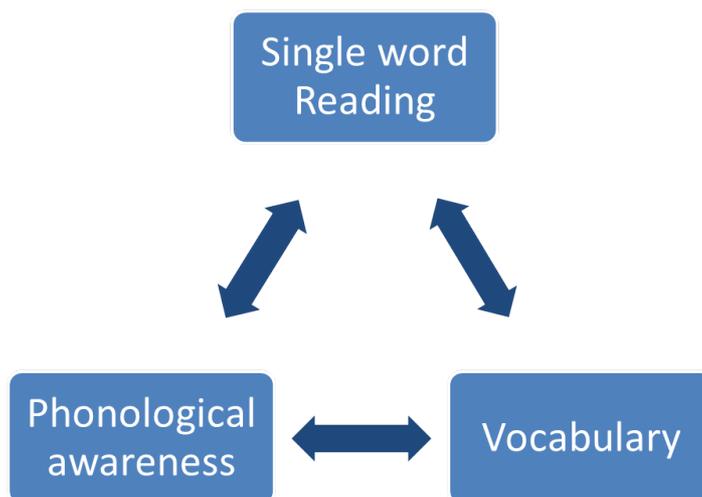


Figure 10. Relation between reading, phonological awareness and vocabulary

Although use of cochlear implants was not related to different outcomes from those of children with hearing aids, there was a small negative correlation between age of implant and literacy outcomes. Our findings show very early use of cochlear implants to be protective of literacy skills. None of the 13% of children who had been implanted at 18 months or younger (most were less than a year) had below average scores on literacy, although nor were they among the best readers in the group. The child with the lowest performance in this group had social factors that may have compromised their vocabulary and reading.

## Conclusions and implications of findings

Our research has established that it is possible to use reading and dyslexia-sensitive tests developed for hearing children successfully with oral deaf children. Our findings have implications for the skills needed by professionals who work with deaf children, in order to ensure that testing is effective in achieving valid scores, and also significant implications for reading interventions with deaf children.

Using the 1996 BAS II norms that were available when our data was collected, our study found that just over half of the oral deaf children tested were reading at an average level for their age. With the publication of new norms for the BAS3 in 2011 came the opportunity to reanalyse our data. From this new analysis, only 29% of our deaf group emerged as average readers, indicating a much larger proportion to be poor readers than previously, and the number of poor readers among the hearing dyslexic group also increased. This finding reveals the lack of any significant progress in reading made by deaf children and hearing children who are poor readers in comparison with their classmates in recent years. For deaf children, this is cause for concern, in view of advances in earlier identification of deafness and developments in hearing technology. Even children in our study with cochlear implants displayed a range of reading performance, suggesting that provision of cochlear implants can lead to intelligible speech, but this does not guarantee good reading.

Our original analyses showed that all poor deaf readers had language difficulties alongside their poor literacy and phonological skills and a significant proportion of the average readers also had impaired language. We have shown that language is a key predictor of literacy, along with phonological skills.

Our results highlight the continuing challenge that faces a significant proportion of oral deaf children in learning to read. We found a minority of deaf children with a dyslexic profile, but many others also have reading difficulties, with both poor language and weak phonological skills. Furthermore, a substantial group of children who may be considered average readers are at risk of developing reading problems because of poor language. Identifying the severity and nature of deaf children's reading difficulties provides an important step towards assessing individual needs and monitoring progress in response to interventions.

In 2009, the Rose Report stated that every child should have the opportunity to succeed in reading to ensure success in education and in life. The report further states the need for quality intervention for all children with reading difficulties. The report does not include deaf children at any stage and this is cause for concern. We have identified a large proportion of deaf children with reading difficulties at least as severe as the problems faced by hearing children with dyslexia; indeed, some of our deaf sample present with difficulties that are more severe, with many displaying poor letter knowledge, one of the more basic prerequisites for reading. And yet, unlike for hearing children with dyslexia, there are no specific reading interventions routinely offered to support deaf children's reading.

From our analysis, we have found that *many* deaf children have underlying phonological deficits comparable to dyslexia. For a small minority, their phonological skills are at such a basic level, it is impossible to tell whether or not they are dyslexic. The Rose Report notes that for some children, response to intervention is the way to confirm a diagnosis of dyslexia. It is our view that interventions designed for children with dyslexia may also benefit deaf children, and for very poor deaf readers, their response to intervention may be revealing about the nature of their reading difficulties. Our findings suggest there is an urgent need to implement individualised, intensive interventions known to be effective with hearing dyslexic children for deaf children who are poor readers. Additionally, the language problems faced by the majority of deaf children must also be

addressed. Early and ongoing support is needed to develop the language skills which underpin literacy and to tackle their phonological deficits.

We have seen that poor reading is not an inevitable outcome for every deaf child, since some deaf children do succeed in becoming good readers. Research has shown repeatedly that many deaf children continue to fail at reading. Changes in recent reading test norms indicate that hearing children are now reading better than previously; the same cannot be said for deaf children. With a proper understanding of their reading deficits and appropriate support, the outlook for deaf children can and must change.

## Acknowledgements

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## Appendix: Test battery

Target	Test
Nonverbal skills	British Abilities Scales II (BAS II) Matrices, Pattern Construction
Speech intelligibility	Speech Intelligibility Rating Scale
Speechreading skills	Test of Child Speechreading
Vocabulary	English One Word Picture Vocabulary Test
Reading skills: decoding	BAS Single Word Reading Test
	Dyslexia Portfolio Non-Word Reading Test
	York Assessment of Reading Comprehension (YARC) Letter-Sound Knowledge Test
Reading skills: rate and comprehension	YARC Passage Reading Test: Reading Accuracy, Reading Rate, Reading Comprehension
Spelling skills	BAS Single Word Spelling Test
Phonological skills	Phonological Assessment Battery (PhAB): Naming Speed Test Fluency Test: Alliteration, Rhyme, Semantic (non-phonological) Rhyme Awareness Test Phoneme manipulation tasks: Spoonerisms, Phoneme Deletion Test (Dyslexia Portfolio) Recall of Digits Forwards and Backwards (Dyslexia Portfolio)
Sequential organisation skills	Recall of Sequences: days of the week, months of the year