Reading and language in children
Exposing hidden def icits

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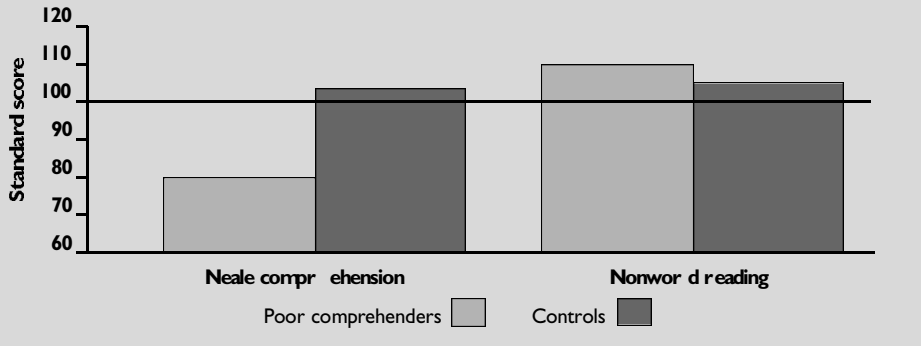
THERE'S no doubt that learning to read is a complicated business. The first lesson children must learn is that English is an alphabetic language – letters and groups of letters map on to pronunciations in a systematic way. This is not easy, particularly in a language such as English where the relationship between orthography (print) and phonology (sound) is only quasi-regular. Young children must surely be bemused to learn that the words *beat*, *street*, *ski*, *theme* and *thief* all contain the same vowel pronunciation, that *steak* and *teak* look very similar yet sound very different, and that despite looking different and having distinct meanings *weak* and *week* have identical pronunciations.

Nevertheless, most children 'crack the code' and within the first couple of years of schooling, basic decoding skills are well in place. These skills are vital: one only needs to see those children who fail to crack the code struggle with reading to understand this immediately. However, there is a lot more to reading than decoding. The ultimate goal of reading is to understand what has been written. Although the ability to decode individual words is a crucial first step, it is no guarantee that adequate comprehension will follow.

Generally, there is a strong association between decoding and comprehension: children who are good at decoding tend to have good comprehension, and children who are poor at decoding tend to have weak comprehension. But for some children the two sets of skills develop out of step. In dyslexia, a developmental disorder affecting 3–10 per cent of children, decoding is slow, effortful and error prone; yet their actual comprehension of what they have read can be impressive (see Snowling, 2000a, for a review). In contrast to children with dyslexia, approximately 10 per cent of children in mid-childhood are poor comprehenders: despite having well-developed decoding skills, they are poor at understanding what they have read (Nation & Snowling, 1997; Yuill & Oakhill, 1991). It is these poor comprehenders that I have focused on in my research.

FIGURE 1 Who are 'poor comprehenders'?

Control children have average-for-age reading comprehension (the horizontal line shows the population average). In addition, they are at least average-for-age at reading nonsense words such as *twamket*, *stansert* and *hinshink* (as measured by the Graded Nonword Reading Test: Snowling *et al.*, 1996). Children in the poor comprehender group have comprehension skills that fall well below the expected levels, but are matched to the control children for age and nonword reading. Arguably, nonword reading is the purest measure of decoding skill, so adopting this methodology allows us to be sure that poor comprehenders and control children do not differ in their ability to decode or 'sound out' written words.



Hidden reading impairments

Unlike the case for dyslexic children, poor comprehenders' difficulties often go unnoticed in the classroom, and they seldom come to the attention of specialist professionals. Yet they are an important and interesting group of children to study for a number reasons. If – as our data suggest – a substantial minority of children have comprehension impairments that tend to go unnoticed in the primary school years, the development of early identification and intervention programmes must surely be desirable.

Turning to more theoretical concerns, a number of studies have attempted to understand the nature and causes of reading comprehension failure. Unfortunately, most studies have included children who are poor at both reading comprehension and decoding. As a consequence, the results are difficult to interpret as poor reading comprehension is confounded by inadequate decoding skill. In a series of papers published over the last 20 years Jane Oakhill and colleagues have addressed the cognitive and linguistic processes that contribute specifically to the comprehension component of reading by studying children who have selective weaknesses in comprehension despite adequate decoding skill (Cain & Oakhill, 1999; Oakhill, 1982, 1984; Yuill & Oakhill, 1991).

Building on Oakhill's approach, Figure 1 describes how we screen and select poor comprehenders and control children from regular mainstream classrooms based on their performance on the Neale Analysis of Reading Ability (NARA-II: Neale, 1997). In this reading test, children read aloud short passages of text, they are then asked questions to assess their literal and inferential understanding of the text.

As mentioned above, we find that

approximately 10 per cent of children aged between 7 and 10 years are poor comprehenders. In addition to the discrepancy between reading comprehension and decoding, their impaired understanding is also out of step with their general cognitive ability, which is usually well within the normal range (although approximately 20 per cent do have more general cognitive weaknesses: see Nation *et al.*, 2001, for details).

Consistent with Yuill and Oakhill's (1991) observations, the vast majority of children in our studies are never identified as having any reading difficulties; many are considered to be among the better readers in their class. Yet their difficulties are wide-ranging: they have particular problems with aspects of text processing, such as integrating information gleaned in one sentence with information learned earlier or later in the passage, and with 'filling out' text by incorporating information from general knowledge (e.g. inferring that a parcel was posted abroad as it had strange and unfamiliar stamps). They also show a range of metacognitive difficulties, including problems with comprehension monitoring (i.e. recognising that their comprehension has broken down and taking corrective action, such as re-reading part of the text) (for reviews see Stothard, 1994; Yuill & Oakhill, 1991). Neither are their difficulties transient: in our longitudinal sample 78 per cent of poor comprehenders originally tested at age 8–9 years still had significant comprehension impairments when tested later at age 13–14 years; a further 13 per cent continued to have milder weaknesses with reading comprehension.

Hidden language difficulties

Very clearly, poor comprehenders have reading difficulties. But are their difficulties restricted to reading comprehension? Evidence suggests not. Oakhill (1983) found that poor comprehenders were also poor at listening comprehension, a finding since replicated many times (e.g. Nation & Snowling, 1997; Stothard & Hulme, 1992). We have extended these findings by showing that poor comprehenders also have relative weaknesses in oral vocabulary and word knowledge, and with aspects of grammatical processing (Nation & Snowling, 1998a, 2000).

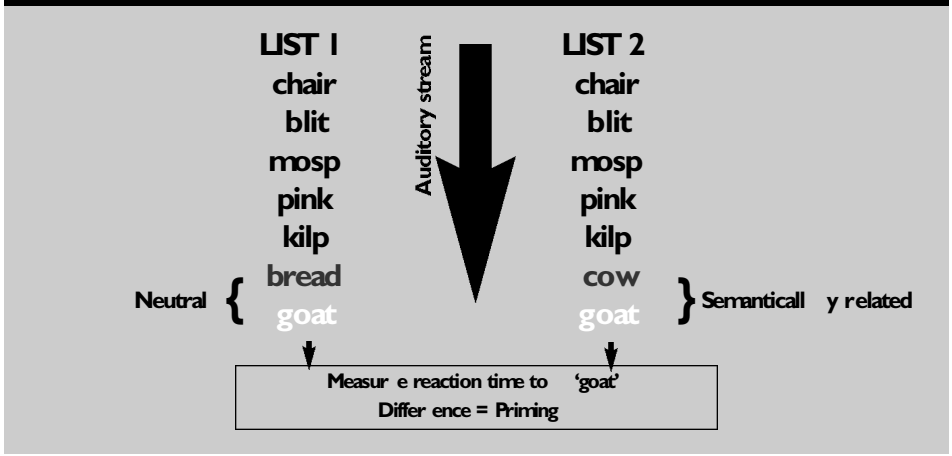
In addition to these group differences there seems to be quite a lot of individual variation: for some poor comprehenders, spoken weaknesses are fairly mild; but for others, the degree of language impairment is striking. Some recent work by Paula Clarke and myself illustrates this point nicely. We gave 25 poor comprehenders and 25 control children matched for age and decoding ability a battery of seven different standardised language tests that measure a variety of different aspects of spoken language (including vocabulary, verbal reasoning, comprehension and figurative understanding). Most of the controls were not impaired on any of the measures; none were impaired on three or more measures. In contrast, none of the poor comprehenders were within normal range across all seven measures, and half of the sample were below average on three or more of the measures. Clearly, some poor comprehenders do have quite severe and wide-ranging deficits with aspects of language processing.

We also have evidence of differences in spoken language processing by poor comprehenders. One study involved using a semantic priming paradigm (Nation & Snowling, 1999). The standard semantic priming effect is that participants are faster at processing a word if they have previously encountered a semantically related word (see Meyer & Schvaneveldt, 1971). For example, people are faster at responding to the word *nurse* if they have recently encountered *doctor*. While the precise theoretical explanation of semantic priming continues to be debated, it is generally assumed that experiencing a word automatically activates those words that are related in meaning, and that this partial activation facilitates faster or more accurate processing if the word is subsequently encountered. This is an interesting technique to use with poor comprehenders, as it allows us to probe their semantic knowledge in a more implicit way by asking whether, on hearing a word, they activate semantic information in the same way as normally developing children do. Figure 2 describes how we went about doing this with 8- and 9-year-old children.

The answer to the question of whether poor comprehenders show normal semantic priming is complex and seems to depend on the nature of the semantic relation probed. Following Moss *et al.* (1995), we distinguished between items that are semantically related in different ways. For those items that are related through belonging to a common semantic category (e.g. *cow–goat*, *red–green*), control children showed the same effects as normal adults: they were approximately 50 milliseconds faster in the related condition relative to the neutral condition. In stark contrast, the poor comprehenders responded at the same speed in both conditions: they showed no semantic priming whatsoever. For those items that were semantically related by virtue of having a more instrumental or functional relationship (for example *broom–floor*, *shampoo–hair*), both groups of children showed a similar magnitude of semantic priming.

FIGURE 2 Measuring semantic priming in children with poor language comprehension

An auditory lexical decision paradigm was used in which children heard a list of words and had to decide whether each one was a real word or a nonsense word (Nation & Snowling, 1999). In the following example they would press 'yes' for *chair*, *pink*, *cow* and *goat* and 'no' for the other items. Unknown to the child (who is just hearing a very long list of words) a few of the words are primed by a semantically related word. In the second list here the word *goat* is preceded by the word *cow*. If children are sensitive to the fact that *cow* and *goat* belong to the same semantic category, they ought to be faster at responding to *goat* when it follows *cow*, relative to when *goat* follows the word *bread*.



Clearly, we need some explanation of why poor comprehenders show normal priming in some conditions but not in others; but for present purposes, we can conclude that poor comprehenders do not necessarily activate semantic information in the same way as normally developing children. This is an important finding as it shows that poor comprehenders have deficiencies in online language processing, even for highly familiar words that are well within their spoken vocabularies. Although we do not know exactly how these online processing differences relate to text or discourse comprehension, it seems likely that slow or inadequate activation of semantic information will have a detrimental impact on real-time language understanding.

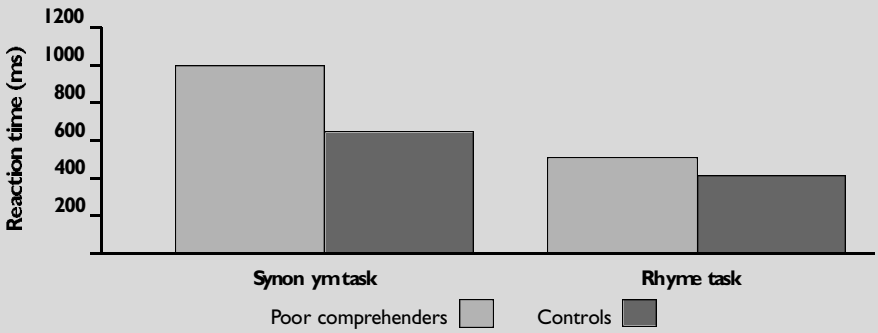
Why do these impairments remain mostly hidden?

An obvious question emerges from these conclusions: if poor comprehenders do have problems with language – and in some cases, wide-ranging and severe difficulties – why do their problems go relatively unnoticed and seldom come to

the attention of specialist teachers, speech therapists or psychologists? A number of factors are probably relevant here, but I think the main answer to this question lies in the fact that poor comprehenders' problems with language are not pervasive: in some aspects of language processing, they are perfectly normal.

Perhaps the most obvious index of a child's language proficiency is his or her speech. Most children with specific language impairment have obvious speech difficulties at some point during development (Bishop, 1997), and many dyslexic children have subtle weaknesses with aspects of speech perception and production (Snowling & Stackhouse, 1996). In contrast, poor comprehenders are equivalent to normally developing children in terms of phonological skill, as measured by tasks such as phoneme deletion (where the child has to say a word after removing one of the sounds, e.g. *bice* without the *b* is *ice*) and spoonerisms (where the child swaps the initial sounds of words, e.g. *paddington bear* becomes *baddington pear)* (Cain *et al.*, 2000; Stothard & Hulme, 1995). They also perform normally on speech-processing tasks such as nonword repetition (Marshall, 2000) and they show the typical pattern of phonological effects in short-term memory (Nation *et al.*, 1999).

FIGURE 3 Comparing semantic and phonological processing in poor comprehenders and controls



We have tried to make a direct comparison between children's phonological skills and their semantic skills by devising tasks that are equivalent in terms of task demands. For example, in the judgement tasks, illustrated in the photograph (left), children hear two words over headphones. In the semantic version of the task, they decide whether two words have similar meanings (are synonyms); whereas in the phonological task, they decide whether or not the two words rhyme.

Summary data from this experiment (Nation & Snowling, 1998a), collapsed across various conditions, are shown in Figure 3. In the semantic task there was a substantial difference between the two groups, with the poor comprehenders being much slower than the control children. They were also more error prone, making on average 21.3 per cent errors compared with less than 10 per cent for the controls. In the phonological task, however, the poor comprehenders performed just as well as the control children, both in terms of speed and accuracy.

Taken together, these findings show that poor comprehenders have normal phonological skill. On the plus side, these strengths in phonological processing no doubt fuel the development of good reading accuracy and decoding. More negatively, it may be these very strengths in speech and phonology that mask poor comprehenders' difficulties with the broader, more general aspects of language processing, just as their obvious strengths in word reading and decoding mask the difficulties they experience with reading comprehension.

From hidden language to hidden reading difficulties?

An important question concerns how children's spoken language proficiency shapes the development of written language. Given that reading is heavily parasitic on spoken language, inasmuch as written language is a visual representation of speech, it is perhaps not suprising that children with spoken language weaknesses tend to go on to have literacy problems (Snowling *et al.*, 2000). From this perspective it is tempting to speculate that poor comprehenders' weaknesses in aspects of spoken language are causally related to problems with reading comprehension. However, at this point in time causal connections are far from clear, and this hypothesis awaits thorough testing from longitudinal and training studies. Nevertheless, we can make predictions concerning which aspects of reading development may be particularly sensitive to underlying weaknesses in language comprehension.

People are usually faster and more accurate at recognising words when they are in context (e.g. Stanovich *et al.*, 1981). When children read, they generally read meaningful text and thus are able to capitalise on top-down semantic support to facilitate word recognition. If poor comprehenders are poor at understanding context, does this mean that they benefit

less from sentence-level constraints than normally developing children?

To address this question we asked poor comprehenders and control children to read words in two conditions (Nation & Snowling, 1998b). In the isolation condition, children simply read a word as it appeared on a computer screen. In the context condition, they first heard a sentence frame that offered supportive but not constraining context. For example, they may have heard 'I went shopping with my mother and my' before the word *aunt* appeared on the screen. If children benefit from context, they should be faster and more accurate at reading in the context condition than in the isolation condition. This is exactly what happened. All children performed better in the context condition, but the relative improvement was far greater for the control children: the poor comprehenders showed only very modest gains with context. Put simply, these findings suggest that if a poor comprehender cannot read a word when it is presented out of context, putting it into context does not help them very much.

The failure of poor comprehenders to benefit greatly from contextual facilitation also has knock-on implications for the development of other aspects of reading. The English language is renowned for its many irregularities, and it is not surprising that young children find words such as *eye*, *chaos*, *choir*, *daughter* and *enough* difficult as they do not obey 'sounding-out' principles. Studies have shown that putting an irregular or exception word into a meaningful context increases the chances that it will be read correctly (e.g. Adams & Huggins, 1985). For example, a child may read the isolated word *island* as 'izland', but read it correctly when it's presented in the sentence 'They rowed the boat to the island'. This semantic bootstrapping strategy may be one way that children learn the correct pronunciation of exception words (Nation & Snowling, 1998b).

Potentially therefore, poor comprehenders' reduced sensitivity to context may limit their opportunities to learn about the pronunciations of irregularly spelled words. If this was the case, poor comprehenders should be less skilled at reading irregular words than children to whom they are matched for decoding ability (nonword reading).

To test this hypothesis, we asked poor comprehenders and control children to read aloud words that varied in regularity and frequency (Nation & Snowling, 1998a). The words were presented one at a time on a computer screen, without context, and we measured the speed and accuracy of reading responses. As the two groups were matched for nonword reading ability, we were confident that they had equivalent decoding skill, and indeed there was no group difference in the regular word condition. However, the poor comprehenders were considerably slower and less accurate at reading exception words, especially low-frequency exception words, than decoding-matched controls. This demonstrates, in line with our predictions, that poor comprehenders are worse at reading exception words than would be expected, given the level of their decoding ability.

At first sight, these findings seem difficult to explain. It is not obvious how or why a language comprehension problem should exert an influence on the visual recognition of words presented in isolation. One way to think about how individual differences in spoken language impact on reading development is from the perspective offered by connectionist models (see Plunkett *et al.*, 1997). In their influential connectionist model Plaut *et al*. (1996) proposed that reading development is best characterised by a division of labour between a phonological pathway (consisting of connections between phonological and orthographic representations) and a semantic pathway (connections between semantic representations, phonology and orthography), shown schematically in Figure 4.

Their simulations suggest that in the earliest stages of reading development, resources are devoted to establishing connections between orthography and phonology (akin to basic decoding or 'sounding-out'). As a function of normal development however, the semantic pathway becomes increasingly important, especially for the efficient reading of exception or irregular words, words not handled so well by the phonological pathway alone.

With this framework as a backdrop it is possible to speculate on how children's spoken language ability influences the way in which their reading systems are established. For example, dyslexic children with impaired phonological skill are thought to come to the task of learning to read with poorly specified phonological knowledge in the spoken domain. As such they find it difficult to forge adequate connections between orthography and phonology, and consequently these children find decoding very difficult (Harm & Seidenberg, 1999; Snowling, 2000b).

Poor comprehenders have no such difficulty: their strong phonological skills allow them to develop an efficient and well-specified phonological pathway. Although connections between orthography and phonology provide the essential foundations of word recognition, the simulations of Plaut *et al*. show that skilled word recognition benefits from meaning-level input, via the semantic pathway, especially in a language such as English where the mappings between print and sound are only pseudo-regular.

WEBLINKS

Association for Speech and Language Impaired Children: *www.afasic.org.uk*

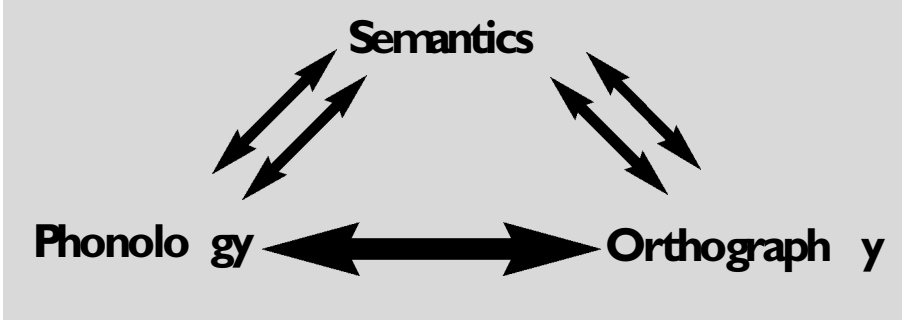
British Dyslexia Association: *www.bda-dyslexia.org.uk*

Centre for Reading and Language at the University of York: *www.york.ac.uk/res/crl*

I CAN (educational charity for children with speech and language difficulties): *www.ican.org.uk*

Oxford study of Children's Communication Impairments: *epwww.psych.ox.ac.uk/oscci*

FIGURE 4 Schematic outline of the 'triangle' model of reading dev elopment (Plaut et *al., 1996)*



We suggest that as poor comprehenders have relative weaknesses with the broader meaning-based aspects of language processing, this may constrain the development of the semantic pathway. Consequently, poor comprehenders develop a reading system that relies less heavily on the semantic pathway than children whose reading systems are underpinned by good meaning-based language skills. The clear prediction following on from this is that such children should be good at decoding but relatively poor at dealing with exception words – exactly the pattern of reading behaviour we observed in poor comprehenders. In this way we can begin to see how relative weaknesses in aspects of spoken language can impact upon aspects of written language development.

Future directions

Our studies of children with poor reading comprehension have revealed that such children also tend to have difficulties with spoken language. Their language difficulties are not pervasive however; from a theoretical perspective, their combination of strengths in the phonological domain alongside weaknesses in other aspects of language processing has allowed us to address the question of how subtle language weaknesses influence reading development. But many challenges and questions remain. We know very little about poor comprehenders' early language development. Were they late to talk? Were they ever referred for speech and language therapy? Positive answers to these questions might suggest that earlier in development, the children did have more obvious language impairments that have since resolved, leaving only residual deficits that are revealed on close inspection.

Similarly, we know little about the later development of poor comprehenders. Although an eight-year-old with impaired reading comprehension may go unnoticed in a busy classroom, this seems unlikely later in development when so much of the curriculum is dependent on reading comprehension. At all ages, research needs to be directed at specifying in more precise psycholinguistic terms the nature of language processing in these children, and how this impacts developmentally.

A final issue concerns heterogeneity. Undoubtedly, language comprehension is a very complex task and the reasons why children fail to understand are likely to be many and varied. Some children may have genuine language impairment; some may have poor attention or have language difficulties that are a consequence of a more pervasive developmental difficulty, while others may potentially suffer from lack of environmental input. An important job of future research is to begin to tease apart these different routes to poor comprehension.

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