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# Chapter 5

## The cognitive psychology of developmental dyslexia

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### Introduction

This chapter reviews some of the work undertaken at University College of North Wales concerning the cognitive psychological description of developmental dyslexia. Tim Miles started this programme of research and 17 years later he continues to inspire hundreds of other students, psychologists, teachers, parents and children who all share a concern with developmental dyslexia. His researches address not only theoretical aspects of the disorder but also clinical and applied issues concerning remediation and education, and his training in linguistic philosophy ensures that no one associated with him can rest in a false security of woolly language and fuzzy definitions (Miles, 1957, 1961). Comparison of hundreds of individual cases has allowed him to see the syndrome pattern in the apparent labyrinth of diverse presenting symptoms (Miles, 1978, 1983). The Dyslexia Unit at University College of North Wales was set up to research and develop effective remedial teaching programmes, to train teachers, and to ensure a local provision for the assessment and education of dyslexic children (Miles, 1970; Miles and Miles, 1975, 1990). Tim has urged us that people, science, scholarship, and, particularly, dyslexia really do matter.

Tim first wrote on developmental dyslexia in a 1961 article 'Two cases of developmental aphasia' which reported detailed clinical case studies of two children, Brenda and Michael. In this chapter I will briefly illustrate the major issues and approaches introduced in that article and then review how these have progressed over the subsequent three decades.

The four major issues concern the following:

1. Developmental dyslexia as a syndrome – a specific deficit in reading

I express grateful thanks to my co-workers, Alan Baddeley, Gordon Brown, Suzanne Cataldo, Barbara Large, Tim and Elaine Miles.

- and spelling which occurs despite high intelligence and which is commonly associated with other difficulties in symbolic processing.
2. The similarities between developmental dyslexia and acquired disorders of language.
  3. The understanding that can be gleaned from analyses of the spelling mistakes of dyslexic individuals.
  4. The possibilities of successful remediation given the proper choice of method.

The importance of these themes is indexed by the large amounts of work that have addressed them since that date. I argue here that:

- the most general information processing deficit in developmental dyslexia lies in phonological processing; developmental dyslexic subjects resemble acquired surface dyslexic subjects but are even more similar to younger children of equivalent reading ability;
- an understanding of the development of reading can only come from longitudinal investigations of development itself;
- such studies demonstrate typical sequences of interactive growth of related skills;
- a key stage in the development of reading is the acquisition of an alphabetic strategy and we can trace the evolution of this skill from implicit phonological awareness through explicit phonological awareness to spelling and hence to reading itself.

## A cognitive psychological description of specific dyslexia

Miles (1961) showed that his two case histories demonstrate specific dyslexia, i.e. a failure to read and spell *despite high intelligence* 'as opposed to an ordinary manifestation of dullness or stupidity' (p. 63). Furthermore, their literacy problems were not the only symptoms:

to say that a child suffers from dyslexia is not, as some have supposed, simply a high-faluting way of saying that he is weak at reading; it is to link such weakness with comparable weakness in brain-damaged adults, and to recognise the existence of a specific syndrome.

(p. 49)

Thus the children had other difficulties concerning, for example, letter reversals and, particularly, short-term memory (Michael's poor reverse digit span and difficulty in repeating polysyllabic words). It was emphasised that these associated difficulties were predominantly concerned with symbolic rather than concrete processing:

I am not of course suggesting that there is any failure of integration when *things* lie side by side, but only when *symbols* lie side by side.

(p. 68)

How have these claims fared over subsequent investigations?

By the late 1970s it *appeared* that there were a wide variety of other difficulties associated with dyslexia. The then-current knowledge of dyslexia, reflected in reviews of hundreds of individual studies (e.g. Critchley, 1970; Vernon, 1971; Gibson and Levin, 1975) suggested a host of problems. Critchley's (1970) index is illustrative with its coverage of dyslexic subjects' perceptual problems, weak cerebral dominance, a constellation of minor neurological signs and clinical manifestations and maternal and socioeconomic correlates. Admittedly these were presented alongside an emphasis on language problems and the similarities with aphasia, but nevertheless it was still easy to reach the jaundiced conclusion that those with developmental dyslexia differed from normal readers in just about every assessed respect if investigators looked hard enough (Ellis and Large, 1987). These reviews arose predominantly from studies using *ex post facto* bivalent designs with little or no attempt to look for differential abilities. The investigations had been performed by different investigators, with children of different cultures, education, age and socioeconomic background, and they had involved radically different numbers of subjects. They had taken place over the previous 50 years when educational practices had been changing. It was quite possible therefore that these reviews constituted a nomothetic generality which, from a heterogeneous population, reflected none of the individuals studied.

By the end of the 1970s there began to appear more analytical and theoretically focused meta-analyses. Vellutino (1979) marshalled a strong case that just about all of the published experiments demonstrating the difficulty of those with developmental dyslexia used measures which involved some element of *verbal* processing; Ellis and Miles (1981) and Miles and Ellis (1981) analysed experimental, psychometric and clinical correlates of developmental dyslexia and argued that they all reflected problems with processing words as symbols (thus returning to the original etymological characterisation of *dyslexia* as a 'lexical encoding deficiency'); and Frith (1981) editing the 1981 special issue of *Psychological Research* on dyslexia concluded that dyslexic subjects' major problems with verbal processing arose because of a core deficit in phonological processing.

This will be illustrated with details of cross-sectional studies, studies from University College of North Wales and an in-depth longitudinal investigation.

### Cross-sectional studies

When two letters of the same case are presented simultaneously and the child has to report whether they are the same (OO) or different (OB), dyslexic and control children do not differ either in the speed or

in the accuracy with which they can perform this task. Nor are the dyslexic children or poor readers slower than age-matched controls when the letters, though different, are visually confusable (OQ, RP, EF, CG) (Ellis, 1981a,b). It appears unlikely, therefore, that dyslexic children have difficulty in dealing with the visual characteristics of letters as such. In contrast, when two letters of different case have to be adjudged the same (Gg) or different (Gw, Gd) on the basis of name characteristics, the dyslexic children are reliably slower and more error-prone than age-matched controls. It thus seems that dyslexic children have no extra difficulty in dealing with the visual aspects of letters as such, but that they show an impairment when the task demands the access and analysis of phonological features. This dissociation is similarly demonstrated in the study of Done and Miles (1978), who presented dyslexic subjects and age-matched controls with arrays of digits and afterwards made the correct digits available and asked the children to place them in the original order. At this task, where the stimuli were nameable, the dyslexic children scored considerably lower than the controls, but when non-verbal nonsense shapes were used as stimuli in place of digits the differences were minimal. Finally, when both groups had been given Paired Associate Learning, where names were learned for the nonsense shapes, the performance of the controls again became significantly superior.

This deficit in phonological access is confirmed in the wide range of demonstrations of dyslexic children being slow in naming letters, objects, colours, digits, pictures, non-words and words (Ellis and Miles, 1981) and their difficulties in verbal short-term memory, which are often taken as symptomatic of the syndrome.

These findings underpin the now modal view of developmental dyslexia as a deficiency in phonological processing: developmental dyslexic children are specifically impaired on tasks requiring perception, access or analysis of phonological material and they evidence no dramatic disability to function with concrete or visual material (Spring and Capps, 1974; Vellutino, 1979; Ellis and Miles, 1981; Frith, 1981; Miles and Ellis, 1981).

## **A longitudinal study**

If we want to understand *developmental* dyslexia then we must do so directly. Only when the same persons are tested repeatedly over time does it become possible to identify developmental changes and processes of organisation within the individual. Cross-sectional studies which compare different groups of people at different stages of acquisition must always come a poor second when small but reliable changes with age are to be detected, where teaching methods and teachers change with time and where we do not wish to make the false assumption that

the abilities of a younger cross-section were necessarily present in the older cross-section at a previous time. They also fail us with regard to the determination of causality: a cross-sectional study may show an association between two phenomena, but only a longitudinal investigation can determine which came first.

At Bangor we embarked on a study of the first three years of reading development in the same children using a longitudinal differential design (Ellis and Large, 1987, 1988). The longitudinal nature of the study allowed a meaningful analysis of the changing nature of individual children's reading skill and the determination of which skills promote reading development and which benefit from it. The differential design allowed not only the determination of which skills are associated with reading, but also their relative importance.

A cohort of 40 children was assessed for their abilities on 44 variables; besides the full Wechsler Intelligence Scale for Children (WISC; Wechsler, 1976) there were a variety of measures of reading, spelling, vocabulary, short-term memory, visual skills, auditory-visual integration ability, auditory/language abilities, language knowledge, and rote knowledge and ordering ability. The children were assessed on these measures each year, from 5 to 8 years old. In the first of our reports (Ellis and Large, 1987) we extracted three groups at age 8 on the basis of reading and IQ scores. Group A showed a specific reading disability (high IQ, low reading), group B were good readers of similarly high IQ, group C showed a more generalised reading deficit in that they were at the same level as group A in reading but their IQ scores were low. The data were then searched retrospectively to describe the development of these patterns of ability from the very beginnings of reading acquisition.

The children with specific reading retardation differed from their better-reading peers in terms of the relatively few variables that concerned phonological segmentation, short-term memory and naming. The children with generalised reading disability differed from their better-reading peers in almost every respect, but the strong discriminators concerned phonological processing. The children with specific reading disability differed from those with generalised reading disability in terms of intelligence and abilities that involve visual processing. These patterns of ability were broadly replicated at each age from 5 to 7 years old.

From the wide and varied test battery there were few tests which discriminated between the children with specific reading disability and their age- and IQ-matched controls, and they all concerned phonological processing, short-term memory or some aspects of accessing the articulatory equivalents of visual material. The most important discriminators were the rhyming tasks that require implicit use of phoneme segmentation and which had previously been demonstrated to be reliable discriminators between dyslexic and adequate readers in group studies

(Snowling, Stackhouse and Rack, 1985), and to be reliable predictors of later reading difficulty (Bradley and Bryant, 1983). The next strongest discriminator was auditory digit span, a most common finding in the developmental dyslexia literature (see Vellutino, 1979; Ellis and Miles, 1981; Jorm, 1983; Ellis, 1990, for reviews). Next came other tests of short-term memory for verbal material (auditory sentence span, auditory word span) and of phonological processing (sound blending, phoneme segmentation). We additionally found that the rate at which children can access the articulatory equivalents for colours discriminated between the groups, and we confirmed the typical WISC profile of dyslexic children where they had problems with the Digit Span, Comprehension, Information and Coding subtests (Spache, 1976). The only discriminator which was not of a phonological type was visual serial ordering which squeezed in at the bottom of the list, a suitable placement because of the dispute over whether visual encoding problems fall out of group studies as being associated with dyslexia: some affirm this to be the case (Benton, 1962; Ingram, 1971), some deny (Yule and Rutter, 1976; Ellis, 1981a,b), some find it to be dependent on spatial frequency with the deficiency only in the transient subsystem (Lovegrove, Martin and Slaghuis, 1986), and some reinterpret the 'visual' tasks to involve implicit verbalisation strategies (Vellutino, 1979), but most would agree that such problems are negligible when compared with short-term memory and phonological processing deficiencies.

None of the other tests, the larger part of the battery, significantly discriminated between these groups – the children with specific reading problems did not seem to show reliable patterns of problems of visual processing (on tests of visual closure, picture completion, letter search, coding, block design, object assembly or picture arrangement), nor syntactic skills, nor rote knowledge and ordering.

Tim's earlier claims in this regard have thus stood the test of time: the developmental dyslexic children were really quite different from both their normal reading-ability peers and those with general reading retardation – see also Ellis (1994), and the commentary by Stanovich (1994). Furthermore, there is a characteristic pattern of associated difficulties all concerning phonological processing, suggesting that a core problem in this area may underlie the various presenting symptoms of developmental dyslexia (Frith, 1990).

## **Relationships between developmental and acquired disorders of language**

Miles (1961) also saw that the language problems of developmental dyslexia might be enlightened by comparison with other acquired disorders:

our understanding of these [developmental dyslexic] disabilities in children can be helped by an examination of the whole group of aphasic disabilities in adults.  
(p. 49)

The term 'dyslexia' is applied both to the difficulty a child may experience in learning to read and to reading problems resulting from brain damage in previously normal adults. Research on acquired dyslexia has recently undergone an intensive period of theoretical development and has led to a number of agreed categories of dyslexia, each having a characteristic pattern of reading errors, a different pattern of sensitivity to the characteristics of the material read and a concomitant description in terms of deficit in information-processing routes in models based on the analysis of normal adult reading (Coltheart, Patterson and Marshall, 1980; Patterson, 1981; Patterson, Marshall and Coltheart, 1985). For example, deep dyslexics have more difficulty reading orthographically regular non-words than real words, function words than content words and low-imageability words than highly imageable words, but they are largely unaffected by word length or orthographic regularity. Surface dyslexic subjects show the converse in that they are largely unaffected by lexicality, parts of speech or imageability, but are affected by word length and spelling regularity. Most current models of reading suggest that an isolated word may be read aloud by either of two routes. Those words that are in the reader's sight vocabulary may directly access both the word's phonological representation and its meaning. These will be read rapidly and accurately. In the case of words that are less familiar, reading is assumed to proceed via the application of either grapheme-to-phoneme translation rules or analogies between groups of letters in the word being read and similar groups of letters in known words. Deep dyslexic patients are assumed to have the former direct route relatively less impaired than the grapheme-to-phoneme or analogy-based route. Those with surface dyslexia, on the other hand, are assumed to be capable of using the grapheme-to-phoneme route, but to be impaired in the operation of the whole word route; hence, the use of their relatively automatic sight vocabulary is impaired but the ability to sound out words and non-words is relatively intact. When we compared developmental and acquired dyslexic subjects (Baddeley et al., 1982; Baddeley, Logie and Ellis, 1988), we found that people with developmental dyslexia were more akin to those with surface dyslexia, with both groups being susceptible to the effects of spelling regularity, somewhat susceptible to word-length effects, and insensitive to the content-function word distinction. On the other hand, our subjects with developmental dyslexia were clearly highly susceptible to the lexicality effect, being much better at reading words than non-words, an effect which is not said to be prominent in the pattern of reading disability exhibited by people with surface dyslexia. The pattern of results for those with

developmental dyslexia was very similar to that of normal, younger children of an equivalent reading age.

People with developmental dyslexia and young children resemble people with surface dyslexia in having a poorly developed sight vocabulary, and thus having to rely more extensively on the indirect rule-based route. They differ from them in that adults with acquired dyslexia have previously had a fully developed reading system and their grapheme-phoneme route is well developed, extensive and automatised. The system of people with developmental dyslexia has simply not yet developed and their phonological deficits slow and restrict their reading through this rule-based route; hence their exceptional difficulties with novel words.

## The role of spelling in reading development

It is interesting that Miles (1961) identified that dyslexic children's spelling errors might hold a clue to the nature of their problems:

[Brenda's] spelling, despite its oddity, is nonetheless not unintelligent spelling, . . . her spelling is an attempt to put onto paper the written symbols for tongue and lip positions and movements, not the written symbols for words as such.

He explained spelling errors like 'kach' for *catch*, 'disdons' for *distance* by pointing out that 'there are no tactile-kinaesthetic cues for distinguishing a soft *c* from an *s* nor a hard *c* from a *k*, and, more generally, that many of the spellings are "phonetically intelligible"' (p. 57).

The importance of this observation has been reinforced by subsequent studies which have shown that analysis of children's spelling throws light both on the normal development of alphabetic strategies of reading and on the difficulties that developmental dyslexic children have at this stage of literacy development.

The idea that children's misspellings reflect a developing sense of phonetic properties of words was pioneered by Read (1971, 1975, 1986) who found evidence that young inventive spellers used a system of grouping sounds together according to shared phonetic features. Thus they might represent a particular vowel sound in their spelling by substituting a letter whose *name* shared a salient phonetic feature with the sound. Read's exhaustive studies of invented spellings attuned further research to the analysis of misspellings in an attempt to uncover a developmental sequence for spelling that reflects a heightening awareness of the internal sound structure of words, and this has led subsequent researchers to categorise developmental strategies in spelling. Henderson and Beers (1980) analysed samples of children's creative writing and assigned each error to a category according to the completeness of phonetic information mapped by the misspelling. They



charted movement from pre-phonetic to phonetic stages of spelling. As a result of their work and that of Gentry (1982), it is now generally agreed that children move through distinct stages of spelling, namely precommunicative, semi-phonetic, phonetic, transitional and correct spelling. It is the first three of these developmental stages that are relevant to the question of how phonological awareness plays a role in children's early spelling. Pre-communicative spellings are characterised by the strategy of randomly selecting letter strings to represent words. Although at this stage children can produce letters in writing, their spellings reflect a complete lack of letter-sound or letter-name knowledge. Semiphonetic spellings contain a partial mapping of phonetic content. Phonetic spellings contain a complete description of the sequence of sounds in pronunciations.

Theoretical analyses which assign spelling a major role in the development of phonological as well as reading skills include Elkonin (1973), Chomsky (1977), Lewkowicz (1980) and Ehri and Wilce (1987). Frith (1985) suggested a theoretical framework within which spelling and reading interact to advance the learner towards increased proficiency in each ability. In her model, spelling plays a fundamental role in the movement from a visual, or logographic, reading strategy to an alphabetic approach: alphabetic spelling is the pacemaker for the use of an alphabetic strategy in reading. Early spelling practice involves dividing spoken words into phonemes and representing these phonemes with letters. In this way experience in spelling words affords the opportunity for making comparisons between the phonetic information in individual letters and sounds as they are embedded in the spoken word. Through repeated practice in spelling, the child may come to appreciate the subtle relationship between a symbol in the written word and its corresponding sound in the context of the spoken word. The discovery of this relationship is the key to alphabetic insight. The crux of the problem is 'knowing how to combine the letters into units appropriate for speech' (Lieberman and Shankweiler, 1979, p. 141). Early efforts in spelling may provide the opportunity to experiment in a very concrete way with the properties of this abstract concept. As children struggle to decompose words into individual phonemic units, they commonly experiment with various articulatory rehearsals of word parts and they search for distinguishable articulatory units that correspond to letter-sound units. This process of their separating sounds in a word through consciously monitoring their own articulations may serve a dual purpose: it may both help the development of phonological awareness and enhance knowledge of the alphabetic principle.

Cataldo and Ellis (1988, 1989; Ellis and Cataldo, 1990) adopted a longitudinal design to measure directly these early sequences of interactive development in reading, spelling and phonological awareness skills. We elucidated the early causal relations among these three vari-

ables by following the development of each skill in a group of children as they moved from preliteracy through the beginning stages of learning to read and spell. In this study the early interactive development of reading, spelling and phonological awareness was charted in a group of 28 children during their first three years in school. During this time the children were tested at four intervals in reading and spelling real and nonsense words, phoneme segmentation and auditory categorisation. A test of phoneme segmentation was given as a measure of explicit phonemic awareness and a test of auditory categorisation was taken as a measure of implicit phonological awareness. The majority of the sample had only begun to attend school when the initial assessments were taken at the beginning of the school year in which their mean age was 4;6 years. The children were re-tested at the end of their first school year, at the beginning of the second year and finally at the beginning of the third school year. Exploratory (LISREL – Joreskog and Sorbom, 1984) causal path analyses were used to investigate the contribution of each ability to the subsequent growth of skill in word recognition, spelling and phonological awareness. The patterns of interaction among these three abilities provided a preliminary framework for mapping the early stages in the acquisition of literacy.

By broadening the phonological awareness–reading paradigm to include spelling, we were able to see a clear picture of the early interaction among these abilities. There were three measured phrases of development. Phase 1 spanned the children's first year in school. Phase 2 charted the development from spring of the first school year to autumn of the second year. Phase 3 looked at development from the beginning of the second year in school to the beginning of the third year. The phase 1 pathweights from spelling to reading real words and nonsense words identified spelling as an important contributor to the early formation of reading. This pattern of influence was repeated much more strongly in phase 2 with high pathweights from spelling to reading real words and nonsense words. The pronounced influence of spelling on reading contrasted with a negligible contribution of reading to spelling in both phases 1 and 2. Implicit phonological awareness initially predicted early attempts to read as well as to spell but lost its influence on both reading and spelling in the following two phases. In contrast to the diminishing predictive power of implicit phonological awareness, explicit phonological awareness consistently predicted spelling in all three phases, this influence increasing with phase. Explicit phonological awareness only emerged as a strong predictor of reading in phase 3.

This early interactive sequence describes the pattern of growth from pre-alphabetic to alphabetic stage reading (Frith, 1985). Although implicit knowledge of the sound properties of words helps children forge initial connections between the printed word and its pronunciation, spelling

acts as a mediator for the use of explicit phonological awareness until the child begins alphabetic stage reading by directly applying explicit phonological awareness to reading. Our data suggested that, as children practise spelling, so they develop proficiency in the use of the alphabetic principle and apply this knowledge to the task of reading. In the beginning, as spelling begins to take form, the beginner relies on a phonological strategy based on a perception of the overall sound content of words. In turn, these early endeavours in spelling contribute to an awareness of the general sound properties of words. In the next stage, children begin to demonstrate proficiency in spelling with increasingly complete phonemic descriptions and a more analytical approach to pronunciations. This progression from holistic to analytical phonological strategy is analogous to the movement from semiphonetic to phonetic spelling proposed by Gentry (1982). Recognising that children's misspellings provide valuable insight into the formation of spelling ability, we also explored the relationships among different groupings of misspellings and different levels of phonological awareness.

We classified misspellings in five categories that reflect increasing insight into the phonetic structure of the word. It was a hierarchical classification of spelling errors based on work by Henderson (1980), Gentry (1982) and Morris (1983). The most rudimentary spelling skill, first letter strategy, preserves only the information for the initial letter. Closer approximations have both boundary sounds intact. The highest level of informed error are partial-sequential and sequential errors where only the middle phoneme is in doubt: the representation of consonant sounds is 'safer' than vowel sounds in that consonant sounds are more reliably 'matched' to letters on a one-to-one basis than are vowel sounds.

Our analyses showed that when young children in this age band made a spelling error which bore any phonetic resemblance to the target, it was more often the case that only information for the initial consonant was preserved. The next most typical responses were those where both boundary sounds were correct (either with or without an incorrect intervening vowel). By the time the children were at the beginning of year 3, the total numbers of errors had declined. Errors which fell into this hierarchical classification system became predominant (54% at the beginning of years two and three versus 23% at the beginning of year 1) – the children did indeed move from being pre-communicative to semi-phonetic spellers. And this progression was also found within the semi-phonetic stage: the lowest phonemic content errors (first letter intact) declined with age and higher-order errors (sequential and partial-sequential), which preserved more of the phonetic content, came to the fore.

In conclusion, it is clear that Tim was right to identify spelling as an

important clue to the nature of reading and reading disability. It is an important clue for researchers of these phenomena, but even more, it is important to the very children who are learning to be literate. Although implicit phonological awareness is the precursor of early developments in spelling, reading and explicit phonological awareness, it is the growth of *explicit* phonological awareness that allows the acquisition of alphabetic spelling. Awareness of rhyme and alliteration is not sufficient for accurate spelling; rather the child has to be able explicitly to segment the sounds of a spoken word, to strip it apart sound by sound and then look for the graphemes that represent these sounds. In turn, spelling makes this ability relevant to the child for the first time, both phonological awareness and spelling grow through practice and the alphabetic insight is gained. This insight is then available to allow its application in reading and the child shifts from a logographic to an alphabetic strategy of reading – see also Frith (1985) and Ehri and Wilce 1987).

Dyslexic children's problems with phonological analysis and awareness makes this passage very difficult for them, as Frith (1985, p324) says: 'Classic developmental dyslexia is the failure of alphabetic skills'. Hence children with developmental dyslexia need special remedial teaching which concentrates on phonological awareness. Although he did not use these terms, Tim's interventions concentrated on exactly these processes, as we will see in the next section.

## Remedial teaching

Tim's description of the teaching programmes for Brenda and Michael reads as follows:

The main problem was that of vowels. To start off, Brenda was required to make five columns in an exercise book; the first was headed by the word 'bag', the next by the word 'beg', and the third, fourth, and fifth by the words 'big', 'bog', and 'bug'. Each column had a 'noise', which was its vowel sound with the consonants removed... Brenda was required to make the 'noises' for each column in turn, concentrating on the tongue movements and the vibration of the vocal bands as she did so. The 'noise' could easily be associated with a particular letter, and thus any word with the same 'noise' as, say, 'bag' would necessarily have to have the same letter, viz. *a*, as its vowel. 'Cat', 'ham', etc. would go in the 'bag' column; 'cot', 'dog', etc. would go in the 'bog' column, and so on. The consonants were left in the main to look after themselves, since apart from *f* and *v*, etc., the phonetic distinction between them is not difficult.

The next stage was to introduce a new set of 'noises'. The 'noises' chosen were the long *a*, the long *i*, and the long *o* and the three columns were headed by the words 'tame', 'time', and 'tome'. Brenda was required to pay attention to the contrast between the *ae* 'noise' (short *a*) and the *ei* 'noise' (long *a*), and was told that when the long vowel occurred an *e* was necessary at the end. Thus 'mate' carries a final *e*, 'mat' does not... In general the purpose was to give her

rules to follow whenever this was possible, rather than present her with the formidable task of remembering every word of the language by heart.

(Miles, 1961, pp. 56–57)

Such remedial teaching continued over about a year with her form mistress reporting 'steady (although not spectacular) progress in spelling' (Miles, 1961, p. 58).

This approach is clearly heavily influenced by 'phonic' methods (Flesch, 1955; Daniels and Diack, 1956; Downing, 1973). Did Tim back the right horse when he chose such an intervention? This question relates to *The Great Debate* (Chall, 1967) concerning the 'best' ways of teaching reading, at the core of which vie methods based on 'whole language', 'look-and-say', 'phonics', spelling and meaning. Over the decades each has ascended and waned in almost predictably recurrent cycles. It is a huge question and the debate still rages. However, since 1961 there have been a number of findings which suggest that, again, Tim was correct.

There is now an accumulation of evidence from evaluative studies of differing teaching methods that phonic and spelling-pattern training is particularly effective. Chall's (1967) exhaustive meta-analysis of the studies performed between 1910 and 1965 concludes that:

1. A code (phonics) emphasis tends to produce better overall reading achievement by the beginning of the fourth grade than a meaning emphasis, with greater accuracy in word recognition and oral reading from the very beginning, and better vocabulary and comprehension scores by mid-second grade. With a code emphasis the child seems initially to read more slowly because of the greater emphasis on accuracy; however, by the third or fourth grade when he is more fluent his rate is equal to, or may ultimately exceed, that produced by a meaning emphasis.
2. Systematic-phonics programmes that rely on direct teaching of letter–sound relationships are as successful as, or perhaps more successful than, programmes that rely on 'discovery' – the so-called linguistic approaches that do not teach letter–sound correspondences directly.

For the particular case of children with specific reading disabilities we find, similarly, in Bradley and Bryant's (1983) training study that when children who were backwards in reading at 4 and 5 years old were trained on sound categorisation (very similar in method to that of Miles (1961) described above) they showed markedly greater improvements in reading over the next two years than those who were given semantic categorisation training. However, those children who were given sound categorisation and, with the help of plastic letters, were additionally taught how each common sound was represented by a

letter of the alphabet, showed even greater improvement. Furthermore, less than 10 hours of such training spaced over two years led to these superiorities in reading being sustained through until the children were 13 years old (Bradley, 1989). We can conclude from these results that phonic training is particularly effective for individuals who are retarded in reading, and, furthermore, training in sound categorisation is even more effective when it is linked to spelling and involves an explicit connection with the alphabet.

A perennial question in clinical and educational psychology concerns whether training for individuals with a particular information-processing deficit should attempt to remedy that deficit directly or whether it should play to individuals' strengths, helping them to circumvent their weaknesses by capitalising on other skills. It is becoming clear that, at least for those with developmental dyslexia, their problems with reading stem from underlying phonological problems and these are best countered by reading tuition which helps them to acquire phonological awareness and analysis skills.

## Conclusions

This brief review has confirmed the phonological deficits in developmental dyslexia. It has shown how reading changes in nature as it is learned and that an important early stage in its development is the adoption of an alphabetic reading strategy. It has traced the precursors of the phonological knowledge that forms the foundations of grapheme-phoneme reading back through spelling, through explicit phonological awareness and in turn to its source in implicit phonological awareness. It has confirmed that the reading and spelling development of developmental dyslexic children is limited by their prior failures to acquire this knowledge. Furthermore, it has demonstrated Tim Miles's keenness of insight in identifying these over 30 years ago as important areas of research.