Chapter 1

What is Dyslexia?

Reading is a skill that is highly valued by society and in most communities holds the key to education. In evolutionary terms, however, written language is a relatively new acquisition. Writing systems evolved as ways of representing spoken words in a more permanent form for the purposes of communication across time and place. The ways in which different writing systems do this varies. In this book, we will be solely concerned with alphabetic orthographies that represent speech in writing at the level of the single speech sound or phoneme (in fact we will focus primarily on English). Learning to read in these orthographies is a complex task requiring the translation of written symbols, or graphemes, into speech forms, or phonemes. This mapping process engages a number of different brain mechanisms that are specialized for other purposes. It is the smooth interaction of these systems that brings about fluent reading and spelling performance.

In spite of the complexities of written language, the majority of children who are given appropriate instruction learn to read with relative ease. However, a substantial minority of children have specific difficulty acquiring literacy skills, and these difficulties can be considered 'unexpected' because they occur in otherwise bright and able children who master other tasks well. These children are sometimes called dyslexic, and current estimates suggest that between 3 and 10 per cent of the population are so affected.

Terminology in the field of reading difficulties is often unclear and inconsistent. While there is no doubt that intelligent individuals with severe reading and spelling problems exist, they have been described in ways that vary widely. Terms such as reading disabled, reading impaired, reading disordered and retarded reader add confusion to what some would prefer to call plain 'poor reading'. Reading

disability carries the connotation of a persisting handicap, while reading impairment perhaps suggests a milder deficit. The term reading disorder implies that reading is developing not only slowly but in an atypical fashion, and retarded reader suggests the affected person is globally impaired. In fact, the plethora of terms listed here are all used loosely with little regard for the implicit meaning they carry. It is only the use of the term 'dyslexia' to describe these problems that has been controversial since its inception. The controversy centres around whether dyslexia can be differentiated from other forms of reading problem. Before discussing definitions of dyslexia, let us begin by examining the case of JM, a dyslexic child with a very clear profile of difficulties. Such children are typically of above average intelligence, with significantly delayed literacy development. In addition it is often the case that reading and spelling strategies are different from those of normally developing children. We first saw JM when he was 8 years and 5 months old (Snowling, Stackhouse and Rack, 1986) and we subsequently followed his progress into adulthood. His case provides an excellent illustration of how a specific cognitive deficit can constrain reading development and pose a life-long problem with literacy.

JM: Case History

JM's birth and early development had given no cause for concern. He was born into a supportive family in which there was a history of reading and language problems. JM was late in starting to talk and his motor milestones were also delayed. His first words appeared at around 2 years and, although he could make his wishes known, he was difficult to understand. Some of the time he used immature speech forms for his age, and at other times he used combinations of sounds that were unacceptable in English. He was referred for speech therapy at 3, when the therapist wrote that his speech (more formally, his phonological system) was characterized by 'both delay and disorder'. However, the therapist was in no doubt that his language comprehension was good and his vocabulary development was proceeding along normal lines.

JM responded well to speech therapy and was soon discharged to nine-monthly review. There were no further concerns about his

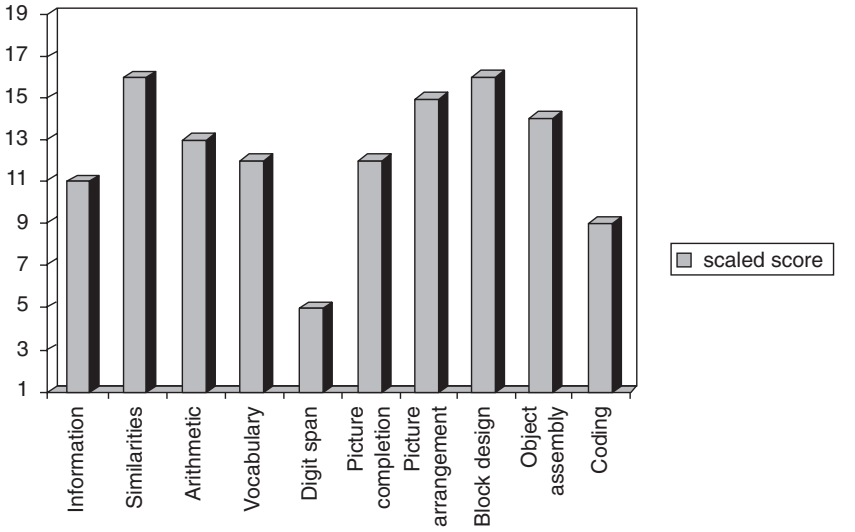

Figure 1.1 Graph showing JM's performance across the sub-tests of the WISC-R in scaled scores. In the normal population, sub-test scores have a mean of 10 ($SD = 3$)

development until, towards the end of infant school, it became apparent that he was not learning to read at the rate to be expected given his seeming intelligence. When he was 7 years old, he was seen by an educational psychologist, who found him to be of high IQ; but it was some time before his problems were properly acknowledged. His parents' concerns led them to seek a second professional opinion when he was just beginning his fourth year in school. Their worries were affirmed. He was indeed dyslexic, and he presented with a clear-cut profile of strengths and difficulties.

In order to ascertain the degree of discrepancy between JM's expected and actual reading skills, he was first administered a test of intelligence, the Wechsler Intelligence Scale for Children – Revised (Wechsler, 1974). On this test, he gained a full scale IQ of 123, placing him within the superior range of intelligence. His profile across the various sub-tests of the scale can be seen in figure 1.1. Sub-test scores can range from 1 to 19 and 10 is average; JM's performance was average or above on all but one sub-test. Indeed, he obtained superior scores on four tests; his excellent performance on Block

Design and Object Assembly, both constructional tasks, indicated well-developed spatial abilities. His verbal reasoning skills, as measured by his ability to sequence pictures to tell a story (Picture Arrangement), and his performance on Similarities, a test of tapping verbal concepts, were also excellent. In contrast, he showed a deficit on Digit Span, a test of verbal short-term memory, and his performance on Coding, a timed task involving copying, was poor relative to his own average.

Although JM displayed some specific verbal weaknesses, there was no significant discrepancy between his Verbal and Performance IQ (the Digit Span score is not included in the calculation of Verbal IQ). Vocabulary development and arithmetic were comfortably above average and, despite some difficulty retrieving names, such as those of cities or famous people, his general knowledge was average for his age. More of a problem had been learning common sequences such as the days of the week, months of the year and the alphabet sequence, none of which JM could yet recite.

JM's expected reading level for an 8-year-old with his IQ was around the 9-year level, and his expected spelling level was at least age appropriate. However, he only achieved a reading age of 7 years 5 months for single word reading, and of 7 years for reading accuracy when required to read text aloud. His spelling skills were even further behind at the 6½-year level.

The Development of Reading, Spelling and Phonological Skills

A more significant indication of JM's difficulties came from the strategies that he was using to read and spell. In reading, he relied exclusively upon a small sight vocabulary, and he made many visual errors, such as reading *saucer* as 'supper' and *thirsty* as 'twenty'. When he could not recognize a word he tried to sound it out, but without success. Indeed, he was unable to pronounce letter strings presented as 'nonwords' and even his knowledge of single letter-sounds was insecure. Some of his many confusions included thinking that *q* was [u], *d* was [t] and *b* was [p].

JM's prose reading strategy was ingenious. He relied heavily upon context, often substituting semantically acceptable words, for example, he read the word *Saturday* as 'Sunday' and the phrase *they shouted*

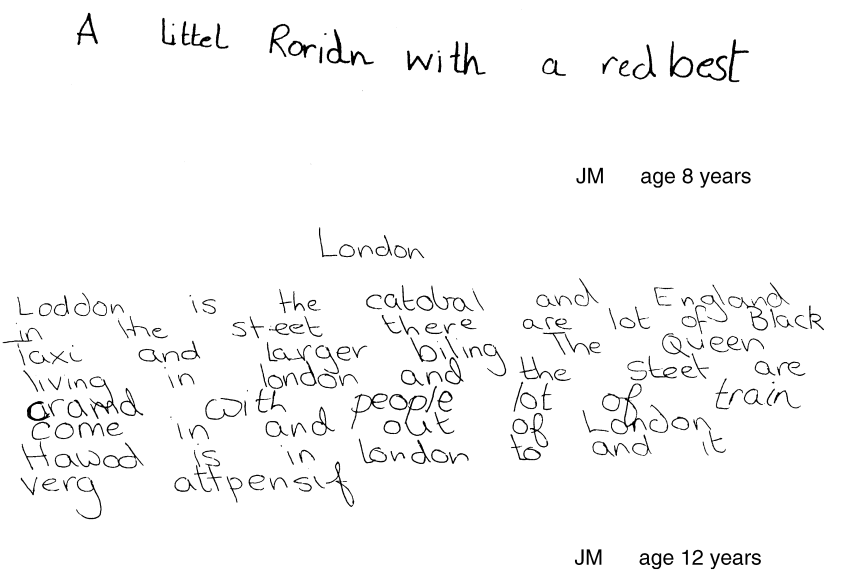

Figure 1.2 Samples of JM's free writing at 8 and 12 years

with delight as 'there were shouts and screams.' Spelling was by far his weakest area. His spelling attempts seldom portrayed the sound sequence of the word correctly and therefore the majority of his attempts were difficult to decipher. He had considerable difficulty in segmenting the speech sounds of words he was asked to spell, and often assigned the letter of a phonetically similar segment: for example, he spelt *cut* as 'khad'; *dot* as 'tond'; *peg* as 'beg'. When asked to write a short story he produced a single sentence and said it was: *I saw a little robin with a red breast.* His sentence is reproduced in figure 1.2 together with some free writing he produced four years later at the age of 12 years.

What was the cause of JM's problems with literacy? Could it be that he had difficulty in retaining the visual images of words in memory so that each must be read anew and effortfully? This did not seem a likely explanation. For one thing it did not explain JM's small but effective sight-vocabulary or the striking dissociation he showed between his ability to read familiar words and his more or less complete inability to read nonwords. Furthermore, JM had excellent

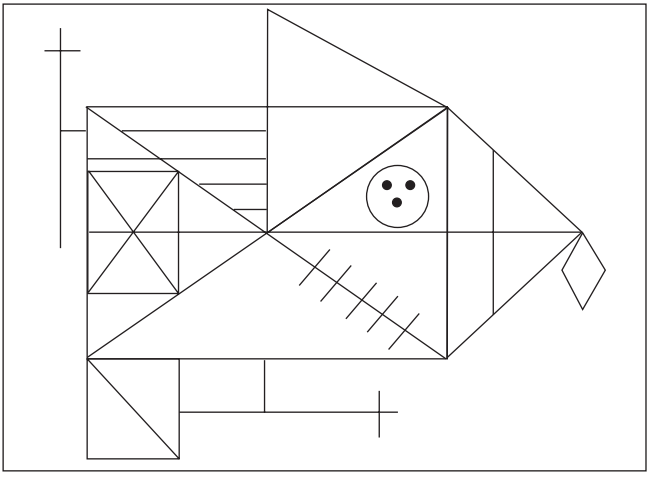

Figure 1.3 Rey Osterrieth Figure. JM could copy this from memory without difficulty

visual memory, as demonstrated by his ability to reproduce almost perfectly the complex Rey Osterrieth Figure after a delay of 30 minutes (figure 1.3).

In contrast, JM had poor auditory skills. He performed below age norms when required to discriminate between pairs of phonetically confusable words presented auditorily (for example *pin – bin*), and he also had difficulty with phonological tasks that required him to reflect on the sound sequence of words. Although he could segment words by syllable, he could not analyse them at the level of single speech sounds or phonemes, and he performed at chance level on a rime oddity task in which he had to decide which of four words sounded the odd one out, for example, *sun*, *bun*, *tin*, *run*. In addition, subtle speech problems marred his performance on a test of sound blending where he synthesized *p-o-g* to make 'bog' and *g-l-e-b* to make 'cleb'.

Taken together, these phonological processing problems seemed a likely cause of JM's slow literacy development. Since learning to read in English requires children to associate the letters of printed words with the speech sounds of spoken words, a child like JM with a

Table 1.1 JM's spellings of a set of three-syllable words at ages 8, 10 and 12 years

Target	*Age 8*	*Age 10*	*Age 12*
umbrella	unenprl	unbrl	unberller
adventure	afveorl	addfch	venter
cigarette	sikeoleg	cigeragg	citterlit
membership	meaofe	membship	menbership
understand	unenstand	understant	unstand
instructed	inthder	intrmu	interdie
refreshment	refent	reafrestmint	refeashment

significant degree of difficulty with the analysis and organization of speech sounds was likely to have problems. In the face of these difficulties JM had tried to learn to read by different means, memorizing the pronunciations of sight words without an appreciation of the links between their sound segments and the spelling patterns they contained.

Soon after this assessment, JM transferred to a special school for dyslexic children. Here he was offered specialist teaching on an intensive basis in a small class. The teaching he received involved highly structured reading activities coupled with a multisensory approach to the development of spelling (looking, saying and writing words that are being taught). This school placement made a great difference to JM's morale and self-esteem, but even with the extra support his reading development was slow. When seen four years after his initial assessment, JM had progressed by roughly half the average rate in reading and somewhat less in spelling development (Snowling and Hulme, 1989). Moreover, the pattern of his reading and spelling impairment had changed little. At 8 years, JM had been unable to read aloud nonwords that he was shown. His ability to decode such novel words had improved by the time he was 12 years old, but only to the level expected of a 7-year-old. His spelling errors remained difficult to decipher, being primarily 'dysphonetic'. In particular, his spellings of multisyllabic words were often a long way from the sound structure of the target word (see table 1.1), and it was not uncommon for the

phonological 'skeleton' of the word to be distorted by reducing a consonant cluster or dropping an entire syllable.

In addition to the problems that JM had on auditory and phonological tasks, he also had some subtle yet persisting speech difficulties. In particular, he had significant difficulty repeating multisyllabic words and nonwords. These repetition problems led us to believe that JM had a severe deficit in the way speech sounds and sequences were represented in his mind. Another way of stating this is that he had a problem at the level of 'phonological representation'. One consequence of this was his limited ability to store verbal information in short-term memory. Another was his failure to set up mappings between phonemes and letter sequences in words. JM also had word finding difficulties and it was not unusual for him to have difficulty recalling the names of words he used often. Among JM's naming errors on a picture naming task were 'terescope' for *microscope*, 'harmonicum' for *accordion* and multiple attempts for *aquarium*: 'fish tank, ack aren, fisharian, ackareen'.

The Development of Compensatory Strategies

One of the important questions that JM's case raises is how, in the face of poor phonological skills, dyslexic children learn to read. As will be argued later, there are likely to be different ways in which dyslexic children meet this challenge. Their strategies are likely to be related to the severity of their phonological deficit and their proficiency in other areas. JM had very severe phonological difficulties. In contrast, his memory for visual information was excellent and his good vocabulary indicated that his semantic skills were good. Could it be that he had learned to read by relying on a visual approach, making use of semantic skills to 'bootstrap' the process? JM's reading comprehension had always been better than his decoding skills suggested, so this was at least a plausible idea.

To investigate the reading strategies that JM had at his disposal, we asked him to decode sets of nonwords that we knew he would find difficult. We began by assessing his performance on nonwords that sounded like words, such as *breth*, *munth*, *burds* (so called pseudohomophones). Half of these nonwords were constructed to be visually similar to words by changing a single grapheme (*cake* → *caik*;

clown → *klown*); half were visually dissimilar to words in that they differed by two graphemes (*kaik*; *kloun*). This manipulation of visual similarity made little difference to the performance of a group of normally developing readers, who read similar numbers of visually similar and dissimilar nonwords correctly. In contrast, JM read more of the nonwords that were visually similar to words than those that were dissimilar. This finding suggested he was using a visual approach to reading (Hulme and Snowling, 1992).

We next provided a context in which to read these nonwords by presenting them after a semantic clue word or 'prime'. For example, the nonword *sawce* was presented after *tomato* and *snease* after the prime *cough*. JM's performance improved significantly when he was provided with a semantic prime. However, this manipulation had a much smaller effect on the reading of the younger controls. Indeed, placing the nonword in context brought JM's performance close to the ceiling of the test – he could have done no better. Thus, our hypothesis that JM had learned to read by building up a visual memory store of words, bootstrapped by semantic context, received some support from this demonstration. This idea is consistent with the view that learning to read is a highly interactive process to which a child will bring all of their spoken language skills, most particularly their phonological and semantic abilities.

Orthographic Development in Dyslexia

Another question that might reasonably be asked was what was the longer-term outcome of JM's dyslexia? To answer this question, we carried out a further assessment of his literacy skills when he was 15 years of age (Snowling, Hulme and Goulandris, 1994). We were interested in the nature of JM's reading system now that he was coming to the end of his specialist educational placement. In particular, we wished to assess the accuracy, consistency and speed of his word reading, and his ability to decode novel words.

We asked JM to read 112 words varying in frequency and spelling–sound regularity, each presented on a computer screen so that we could time his responses. He did this twice on two occasions, separated by a period of 12 months. We also asked him to read 25 computer-presented nonwords of one and two syllables (for example,

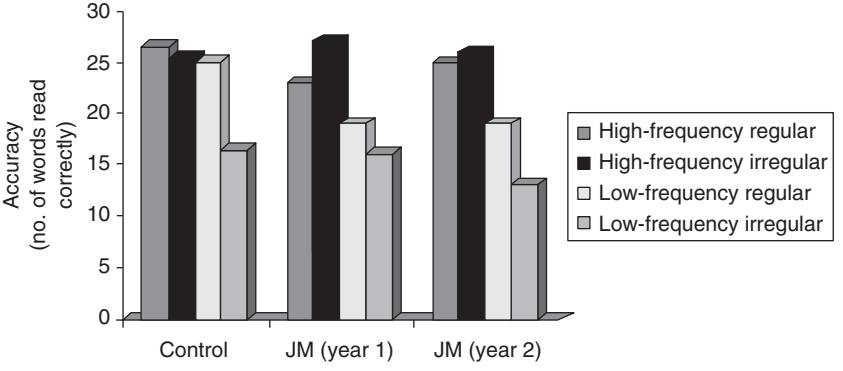

Figure 1.4 Performance of JM when reading regular and irregular words of high and low frequency, at two points in time, compared with RA-controls

ner, *resords*) and 12 more complex nonwords (for example, *balrid*, *etmung*). On all occasions, his performance was compared with that of normal readers who, like JM, were reading at the 10-year level.

JM's ability to read words was similar to that of younger children of similar reading age (RA-controls). In contrast, his ability to read nonwords was severely impaired on both occasions. He was able to read only nine of those he was shown and it took him between 4 and 14 seconds to decode each one. In contrast, all but one of the control children were at ceiling on this test and their response times were generally under 1 second.

Figure 1.4 shows his performance when asked to read high- and low-frequency words. For simplicity, we will focus here on the data from year 1. JM's ability to read familiar words (high frequency in their occurrence in English) did not differ from that of controls, confirming he was well matched to the control group. On low-frequency words, normal readers showed a regularity effect, reading regular words containing consistent sound–spelling correspondences (for example, *gap*, *mar*) more easily than irregular items (for example, *chasm*). Unlike them, JM did not show this advantage. He read both types of word equally well (or badly).

What does this absence of a regularity effect suggest? As will become clear later, it is unusual for a child not to find it easier to read regular than irregular words, even if they are dyslexic. The fact that JM could

read regular words only as well as irregular words indicates that his reading was not sensitive to the consistencies of spelling–sound correspondences. It also lent credence to the idea that he had been learning to read by building up a vocabulary of word-specific associations between printed words and their pronunciations.

What about the consistency of his reading from one occasion to the next? We reasoned that if JM had been learning words on a word-by-word basis, then it was likely that his memory for these words would be more global than if they had been learned following the application of phonologically based decoding strategies. To our surprise, this was not the case. JM was just as consistent in his responding as were younger controls. It seemed that his memory for the visual forms of words he knew (orthographic representations) was sufficiently well specified to support the word recognition process.

Another way of testing the integrity of JM's orthographic skills was by assessing the speed and automaticity of his reading responses. It has sometimes been argued that dyslexic children fail to automate the reading skills they possess (Nicolson and Fawcett, 1990; Yap and van der Leij, 1994). Again we did not find this to be the case for JM, whose reading of high-frequency words was just as fast as that of controls. The distribution of his reaction times to words he could read correctly is shown in figure 1.5, where it can be seen that the majority of his responses were made within 1 second of the presentation of the word.

Our findings on both the consistency and the automaticity of JM's reading of familiar words forced us to conclude that, even though he had set up an orthographic system using atypical reading strategies, it was remarkably efficient in its operation and a noteworthy demonstration of the self-righting tendency of development. Even if JM had not been able to develop mappings between the phonemes of spoken words and the letter strings of printed words, it appeared that he had been able to establish connections between orthography and phonology at a somewhat coarser level, possibly involving word-specific links. Scrutiny of his reading errors provided some support for this hypothesis. Twelve of the words on the word reading test provoked a large number of errors among the normal readers. In each case, we were able to identify the most typical error response provided by the control group. For *chasm* this was [chasum]; for *bough* it was '*bow*' and for *aisle* it was [ay-sl]. In marked contrast, JM's reading errors included

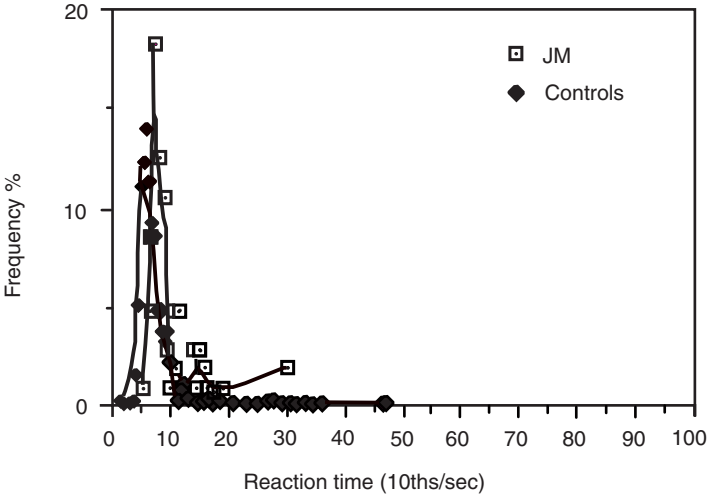

Figure 1.5 Reaction time distribution for JM's reading of high-frequency words, showing automaticity when compared with controls

chasm → 'charm', *bough* → 'brought' and *aisle* → 'alas'. Whilst his word recognition system served him well for high-frequency words and words in context, it was error prone and of course it was not conducive to spelling accuracy.

JM left school still with significant writing difficulties, and his written work in no way reflected his underlying ability. At least in part his persisting difficulties reflected the fact that it is harder to draw upon compensatory strategies for spelling than for reading. The only such tactic that we could discern in JM was a tendency to use syllabic segments as a way of analysing the spoken forms of words. For example, at 13 years, he spelled *uniform* → 'youofrom', *tomato* → 'tomanto' and *wilderness* → 'wilonest'.

It is fortunate, and a testament to JM's own efforts, that his literacy skills were sufficient to allow him to go on to higher education. At university he studied Psychology. This was no mean feat; in spite of his superior intelligence, he struggled with the demands of his degree course. JM graduated successfully three years later, and since then he has turned his attention to a vocation working with young people. By his own admission, he does not enjoy reading, he has prob-

lems with spelling and the pronunciations of certain words still trip him up. When we last saw him he was 24 years old and he had compensated for his reading problem; his reading was at the average level for the population (a standard score of 93). However, he remained unable to decode nonwords (he read only two out of 15 correctly on a graded test) and he had persisting difficulties with phonological awareness tasks. Like most adult dyslexics, his spelling was poor and although his mistakes were now more phonetic in their form, he still committed some that were difficult to decipher, for example, he spelled *biscuit* → 'bistic', *puncture* → 'pinshire' and *inspect* → 'insipate'. It is to his credit that none of these problems had prevented him from successfully negotiating the world of work.

In summary, JM has been presented here as a classic case of developmental dyslexia. He is a bright young man who has always understood spoken language well and is an excellent communicator who expresses his ideas clearly in oral language. However, he has experienced severe and persisting phonological processing deficits. These are seen as the cause of his problems in learning to read and spell. The reading and spelling skills he has developed seem to reflect an excessive reliance on memorizing words as wholes and using meaning and context whenever possible to compensate for his inability to decode. He could never (and still cannot) read nonwords and, even as an adult, the phonetic structure of his spellings is often inaccurate. With his case as backdrop to our discussion, we now turn to consider formal definitions of dyslexia.