A SYSTEMATIC COMPARISON

OF THE

DEVELOPMENTAL AND ACQUIRED DYSLEXIAS

BY

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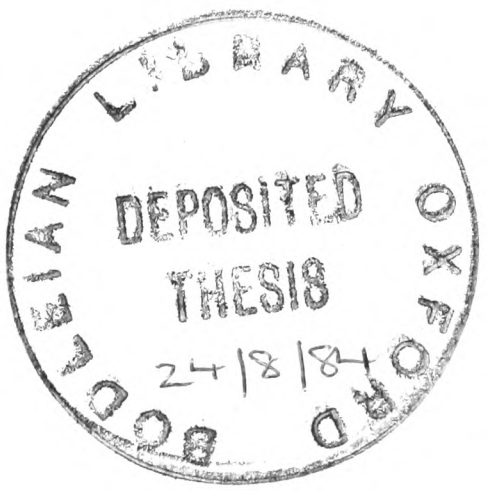

A SYSTEMATIC COMPARISON OF THE DEVELOPMENTAL AND ACQUIRED DYSLEXIAS

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Traditional approaches to the investigation of the developmental dyslexias have involved cognitive or peripheral impairments which are correlated with the reading disorders. These studies have examined the average performance of groups of developmental dyslexics. By contrast, recent studies of the acquired dyslexias have analysed the pattern and nature of the reading deficits themselves. The variation between patients has necessitated the employment of a single case study methodology.

The objective of this thesis is to investigate the developmental dyslexias in the same manner as these recent studies of acquired dyslexia. That is, detailed case studies of the natures of the reading disorders of children with developmental dyslexia are presented. These case reports include investigation of the ability to read non-words; qualitative and quantitative analysis of reading errors; investigation of the effects of different linguistic dimensions upon reading performance; investigation of spelling in relation to the same variables. The experimental materials involved in these investigations include a number of newly constructed tasks. The error analysis, although based on the categories used with the acquired dyslexias, newly introduces the category of 'valid' errors.

Two cases of developmental surface dyslexia are described. One is analogous to classical cases of acquired surface dyslexia, the other to the 'pure' case recently reported by Bub et al (1984). The reading of both children is significantly influenced by spelling-to-sound regularity. Reading errors are predominantly neologistic and many are valid. There is no significant incidence of semantic, derivational, visuo-semantic, or visual+semantic errors. There is homophone confusion. Spelling is phonological. Performance on rhyme tasks is good. In the discussion of surface dyslexia, an expanded representation of the phonological route is incorporated into the reading model. The system proposed operates upon orthographic units of varying size and selects from a number of potential translations. Cases of surface dyslexia are interpreted in terms of the model.The origination of 'visual' errors in surface dyslexia is also discussed.

Four cases of developmental phonological dyslexia are described. The reading performance of these children differs significantly from surface dyslexia. Non-word reading is impaired in comparison to word reading. Reading errors are predominantly paralexias : visual, derivational, or visuo-semantic. Spelling-to-sound regularity does not significantly influence reading performance. Function word reading is impaired in isolation and/or in text. Reading of reversed typed words is impaired and performance on rhyming tasks is poor. The mode of reading acquisition for these children and the limitations of the resultant skills are discussed. Spelling patterns differ between cases and indicate that the phonological route for spelling may develop despite impairment of the phonological route for reading.

The existence of these two distinct subgroups of developmental dyslexia indicates that semantic and phonological routes to reading may develop in relative isolation from each other. The appropriate remedial strategies for the subgroups are discussed. Researchers that use a group study approach to the developmental dyslexias should accordingly be aware that averaging across subgroups may render the data uninterpretable.

Finally, two cases of children who read without phonology are presented. They are unable to pronounce non-words. Most words read correctly are of high frequency and imageability. Individual letter transcoding and function word reading are impaired. Visual, derivational and semantic errors are in evidence. The reading of these children resembles acquired deep dyslexia although the incidence of semantic errors is very low. But, in one case the rate of semantic errors is significantly above chance and within the range spanned by acquired cases. The absence or rarity of pure developmental deep dyslexia is discussed in relation to strategies for the acquisition of reading.

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PUBLICATIONS

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Temple,C.M. (in press) Surface Dyslexia in a child with epilepsy. Neuropsychologia.

Temple,C.M. (in press) New approaches to the developmental dyslexias. In F.C.Rose (ed.) Progress in aphasiology. Rayens Press. New York.

Temple, C.M. (in press) Surface Dyslexia : Variation within a syndrome. In K.E. Patterson, J.C. Marshall and M. Coltheart (eds.) Surface Dyslexia. Lawrence Erlbaum. Hillsdale . New Jersey.

"The complex processes involved in vision proceed smoothly and harmoniously during health in the region of the unconscious cerebration, but when disease disturbs the delicate mechanism of the brain, there are revealed to us glimpses of its intimate workings, a knowledge of which we would not aquire otherwise. It is for this reason that we have studies at such length the symptoms of acquired word-blindness, the knowledge of which will enable us to interpret and explain the phenomena of the congenital form. An adequate knowledge of the former condition is an essential preliminary to the proper understanding of the latter. It is the absense of this necessary and fundamental knowledge which has given rise to much of the ambiguity and vagueness which characterise many recent accounts of this condition."

(Hinshelwood 1917)

GENERAL INTRODUCTION

It is nearly a century since the term "congenital word-blindness" was introduced (Morgan 1896) to refer to cases of reading disability which occur developmentally as a selective impairment and without recognisable etiology. The name was taken from the term "word-blindness" which had been coined in 1877 by Kussmaul to refer to acquired disorders of reading consequent upon brain damage. Kussmaul noted that "a complete text-blindness may exist, although the powers of sight, the intellect and the powers of speech are intact." From the first suggestion of congenital word-blindness as a clinical entity, similarities were conjectured between it and acquired word-blindness. In both conditions word without letter blindness was discovered (Dejerine 1892, Kerr 1897) and, Fisher (1910) speculated that a congenital aplasia of the angular gyrus, a structure known to be damaged in many cases of aquired word-blindness, might underly problems in learning to read. Hinshelwood (1917) was particularly concerned with the similarities between the two groups of disorders. He made the connection explicit by stating "without an adequate knowledge of (acquired word-blindness) congenital word-blindness cannot be properly understood." However most later researchers were not concerned with such comparisons and systematic investigations of the developmental reading disorders in the light of acquired disorders of reading did not resurface until the 1970s.

During the twentieth century many different terms have been employed to refer to the condition which Morgan (1896) and Hinshelwood (1900,1917) called "congenital word-blindness". Among these were strephosymbolia (Orton 1928), specific dyslexia (Hallgren 1950), constitutional dyslexia (Skysgaard 1942), congenital symbol-amblyopia (Claiborne 1906), congenital typholexia (Variot and Lecomte 1906), specific reading disability (Bender and Schilder 1951), congenital alexia (Stephenson 1907), developmental

alexia (Orton 1937, Chance 1913), bradylexia (Claparede 1917), analfabetia partialis (Wolff 1916), amnesia visualis verbalis (Witmer 1917), congenital dyslexia (Hinshelwood 1917) and primary reading retardation (Rabinovitch et al 1955). In current publications the term developmental dyslexia is generally employed, although some prefer terms which they consider less emotive : specific reading retardation and specific reading disability.

Despite the proliferation of terms for congenital reading disorders, there is still debate over the definition which is to be employed for such disorders. The World Federation of Neurology defines "specific developmental dyslexia" as a "disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence and sociocultural opportunity. It is dependent upon fundamental cognitive disabilites which are frequently of constitutional origin." (Critchley 1970) The vagueness of such a definition by exclusion is discussed elsewhere (e.g. Rutter 1980). One of the important contributions of Rutter et al (1976) was to point to the distinction between specific reading retardation and reading backwardness. Reading backwardness is part of more general intellectual backwardness and scholastic failure. Specific reading retardation is an unexpected failure which occurs despite normal intelligence. In an attempt to formalise what should be considered specific difficulty in learning to read Rutter and Yule (1973) proposed a more precise and operational diagnosis. This employed a regression equation ; using a child's chronological age and intelligence to predict expected reading attainment, Where observed reading attainment differed from predicted reading attainment by more than two standard deviations, the child could be termed dyslexic.

At the turn of the century Hinshelwood (1900, 1902, 1904, 1917) presented detailed accounts of individual case studies of "congenital word blindness". Orton (1925, 1926, 1928) working in the 20s and 30s was also concerned

with the analysis of individual cases. But the most prevalant mode of investigation of these disorders was to conduct group studies comparing a large number of dyslexic children with a large number of 'normal children', on a specific task. The tasks employed in almost all of these studies are not reading tasks per se. Rather they measure a skill or ability the investigator considers important for effecient reading. Frequently, differences are found between the performance of the dyslexic children and the performance of the control children. Such studies have led to vast proliferation of theories of the underlying cause of dyslexia, in which the quest is to locate one specific underlying cognitive or peripheral impairment that accounts for the disabilities.

There are at least two major problems with these studies. Firstly, all the studies prior to 1979 (and many since) use control children of the same chronological age as the dyslexic children but not of the same reading age. Differences in performance may then be a consequence of differences in reading skill rather than a cause thereof.

Secondly, group studies assume a degree of homogeneity which seems unwarranted. There is a limitation to the amount of information which may be obtained with group studies if the group involved is not homogeneous with respect to the factor under investigation. Group studies assume that developmental dyslexia is a single syndrome.

Since the early 60s a number of researchers have pointed out that developmental dyslexics do not all display similar patterns of disability (Birch 1982, Johnston and Myklebust 1967, Myklebust and Johnston 1962, Boder 1970, 1971, Ingram et al 1970, Mattis et al 1975, Denkla 1979). These researchers have stressed the multiple syndrome nature of developmental dyslexia. Despite this knowledge, there have been few attempts to pursue a detailed analysis of the different syndromes that comprise the developmental dyslexias.

One disappointing aspect of the dominant group study approach has

been that the results have been of little benefit to the remedial teacher who must deal individually with a child's reading difficulty; group studies have also been of little help in establishing theoretically sound explanations for the types of disorder manifested.

By contrast, in the investigation of the acquired dyslexias case studies have been more prevalent. Furthermore, significant advances have taken place, in the past decade, resulting from the convergence of modern information processing theory and pathological data. That is, the pattern of breakdown of visual language skills consequent upon brain damage in adult life had been interpreted in terms of cognitive models of the normal reading process.

A particularly significant model in cognitive psychology (from which many of the models described later have derived) is that of Morton (1969, 1979). In this model, he postulated the existence of so-called 'logogens', or abstract units of word recognition. Each unit corresponds to an individual word (or morpheme) and underlies the perception and production of this word. The logogens are grouped together in a 'logogen system', a type of internal dictionary. The functional mechanism of the logogen is taken from biological models of cellular action. The units of the logogen system have thresholds of activation. Sensory stimulation summates with the resting potential of all units that are responsive to the physical properties of the stimulus, until one logogen reaches threshold. The firing thresholds are inversely correlated with the frequency of occurrence of the respective words in the language. When a logogen reaches threshold, the word is recognised and transmitted to the cognitive system for assignment of lexico-semantic features ; that is, to be assigned 'meaning'. In this model, phonological recoding (analysis of the sound pattern of the word) is not essential to the attainment of meaning.

The early model of Morton has since been expanded and complicated both by himself and by others. In these subsequent models, there is a

an unfortunate proliferation of technical terms and a penchant by researchers to rename what has already been named.

Nevertheless the convergence of information processing theory and pathological data has successfully resulted in the description and explanation of a number of different acquired disorders of reading. Some of these disorders result form peripheral impairments ; three of the disorders have been called the "central dyslexias" (Shallice and Warrington 1980). Most investigations of the acquired dyslexias have involved the central dyslexias and it is these disorders which have been most fruitful in elucidating our models of reading. These three central dyslexias are surface dyslexia, phonological dyslexia, and deep dyslexia.

In 1973 Holmes suggested in her doctoral thesis that some developmental dyslexics exhibited a pattern of reading performance very similar to that of acquired surface dyslexia. This claim was not further investigated in the seventies, although towards the end of the decade there was some discussion of putative parallels between reading disorders in adults and children. Jorm (1979) suggested that developmental dyslexics resembled acquired deep dyslexics. Ellis (1979) refuted this claim but encouraged the discussion of parallels stating :

" In the field of acquired dyslexia, studies of heterogenous groups of patients have been far less informative than intensive case studies of particular interesting and theoretically-relevant individuals. The present author is of the firm opinion that real advances in the understanding of developmental reading difficulties will only occur if the same approach is adopted".

Recently Masterson (1983), in her doctoral thesis, has extensively investigated the parallels between some developmental dyslexics and patients with acquired surface dyslexia. The current study is concerned with children with dyslexias which may form analogues to the three central acquired dyslexias : surface, phonological and deep dyslexia. The objective is to investigate the developmental dyslexias in the same manner as in recent studies of the acquired dyslexias, that is, detailed case studies of children with developmental dyslexia are presented. The case studies investigate each child's reading.

First, an account of the test material and proposed error analysis is given. Then, each of the central dyslexias is investigated in a separate section with its own introduction that takes the form of a review of the literature on the acquired disorder : the first case; the integral features of the disorder; the variation between the cases reported in the literature ; and theoretical explanations that have been posited to account for each disorder. The case studies are then presented. In particular these include investigation of non-word reading, analysis of reading errors, investigation of the effects of linguistic dimensions upon reading performance, investigation of the effects of reversed typescript and handwriting upon reading and investigation of spelling.

In the section on surface dyslexia, two developmental case studies are presented. One is similar to the chidren who have been studied by Holmes (1973,1978), Masterson (1983) and Coltheart (1982, Coltheart et al 1983). The other child is analogous to the more unusual case described by Bub et al (1984). In the section on phonological dyslexia four individual cases are presented : two ten-year old boys and two seventeen-year old girls . In the section on deep dyslexia, two final cases are presented. For these children

the similarity with the acquired disorder is less complete.

Most of the discussion sections are placed directly with the account of each disorder. This somewhat unconventional organisation is intended to fascilitate clarity of exposition by integrating the description and interpretation of syndromes within their respective sections. After a summary with final conclusions, the thesis ends with some future perspectives.

EXPERIMENTAL MATERIAL

In the forthcoming chapters detailed descriptions will be presented of the reading and spelling performance of n children. In assessing these skills a standard set of tests were used. Rather than repeatedly describing these for each case study, this chapter will describe the experimental material : rationale, construction and testing procedure. Where possible every test described in this chapter was given to each child. In some cases time constraints limited the number of tests which could be administered. In others, tests clearly beyond the capacity of the child were omitted. For a few cases additional tests were administered and these are described in the relevant case presentations. The test materials and tasks employed are summarised in Table 1. Some were designed and used by other researchers and clinicians; the remainder are newly constructed.

BACKGROUND MATERIAL
****

To assess general intellectual ability the Wechsler Intelligence Scale Children - Revised, was administered. The test consists of five verbal and five performance sub-tests, and provides verbal, performance and full scale IQ measures. Raven's Progressive Matrices (coloured or standard, according to age) were also administered, giving further measures of intellectual ability. The vocabulary subtest of the WISC provides a measure of the child's ability to express the definitions of words he hears. As an additional vocabulary measure the Peabody Picture Vocabulary test was administered. This test requires the child to select from one of four picture alternatives a target word spoken by the tester. The test provides a measure of receptive vocabulary without requiring expressive skills. Digit span, traditionally considered to be low in both acquired and developmental dyslexia, was assessed both forwards and backwards. To

Background Tests

Wechsler Intelligence Scale for Children - Revised
Ravens Progressive Matrices
Peabody Picture Vocabulary Test
Neale Analysis of Reading
Schonell Single Word Reading
Schonell Single Word Spelling (written and oral)

Non-word Lists	Tasks Employed
Temple 3 letter	Reading, Spelling, Lexical Decision
Temple 5/6 letter	Reading, Spelling, Lexical Decision
Coltheart Non-word	Reading, Lexical Decision
Coltheart-Patterson homophonic	Reading
Temple homophonic	Reading

Word Lists	Tasks Employed
Coltheart *et al* (1979)	Reading (Scores used to investigate regularity. Responses used in error analysis.)
Stanovich and Bauer (1978)	Reading (Scores used to investigate Regularity. Responses used in error analysis.)
Marshall Derivational	Reading (Responses used in error analysis.)
Temple	Reading, Spelling, Reading own spellings. (Scores used to investigate regularity, frequency, imageability and length. Responses used in error analysis.)
Handwritten subset of Temple	Reading
Reversed type subset of Temple	Reading
Function words	Reading
Temple homophones	Reading, Spelling
Nelson Adult Reading Test	Reading (H.M. and J.E. only)

Rhyme Fluency

Auditory Rhyme Pairs

Letters

Upper case and lower case	Naming, Sounding, Matching
Letter names and sounds	Spelling
Subset of letters	Tail direction, orientation, rhymimg

Table 1 Summary of Test Material

measure reading age, the Schonell single word reading test and the Neale Analysis of Reading tests were given, The Schonell test is single word reading and the Neale test is text reading. Spelling age was determined from the Schonell single word spelling test (written response). The test was also given with oral responding for comparison.

NON-WORD MATERIAL : 'BALANCED' WORDS AND NON-WORDS

****

LISTS

Temple 3-letter (newly constructed)

The first list contained 28, three-letter , consonant-vowel-consonant stimuli. Fourteen were words and fourteen were non-words, derived from the words by altering one letter. The stimuli were : cat, jat, dog, dop, fox, fex, pen, gen, leg, lig, sun, sut, hat, het, lip, fip, dig, vig, man, mab, red, ked, cup, tup, van, zan, hot, mot.

Temple 5/6-letter (newly constructed)

The second list was constructed in a similar way to the first. It contained 30 five-or six-letter stimuli. They did not conform to any particular consonant-vowel pattern. Half were words and half were non-words derived from the words by altering one letter. The stimuli were : flower, klower, paper, faper, doctor, doptor, insect, inlect, butter, sutter, carrot, barrot, brown, trown, apple, upple, lemon, gemon, horse, lorse, glass, plass, truck, trock, fence, fince, pencil, hencil.

Coltheart non-word (unpublished)

The third list contained the fifty short stimuli from the unpublished lexical decision task of Coltheart. These comprise twenty-five very frequent words, varying in length from three to six letters and twenty-five matched non-words derived as described above. The stimuli on this list are : house, gouse, boy, doy, hand, pand, school, schoom, church, charch, floor, floon, girl, garl, money, doney, room, foom, face, fape,

man, mun, eye, ede, road, poad, car, cag, street, streed, woman, moman, book, boak, child, chold, city, cimy, food, foop, table, toble, fine, fime, door, noor, water, nater, head, and heam.

TASKS

A. Reading

For each preceding list (and all subsequent lists) the stimuli were typed individually, in lower case lettering (IBM courier 20) onto separate cards. The cards were then randomised and presented individually for reading aloud. Each child was informed that approximately half of the stimuli were words and the other half were non-words. Examples of non-words similar to those on the cards were given. The children were told that they should try to pronounce the non-words even though they were meaningless and might sound strange.

B. Spelling

The stimuli on the Temple 3-letter and the Temple 5/6-letter lists were also orally dictated, in random order, for written spelling. Once again, the children were informed that half of the stimuli were meaningless, but that they should nevertheless try to write them down.

C. Lexical Decision

The cards for the three lists which had been used in the reading test, were presented individually in random order in a sebsequent session, for lexical decision. The children were told that these were stimuli which they had already read and that some were words and some were non-words. They were requested not to read the stimuli aloud but simply to say 'Yes' or 'No' to each stimulus item, indicating whether or not they thought it was a real word.

Some acquired dyslexics find it easier to read non-words homophonic with real words than those that are not homophonic. To investigate this

phenomenon two lists containing only non-words were employed.

NON-WORD MATERIAL : CONTAINING HOMOPHONIC NON-WORDS

****

LISTS

Coltheart-Patterson homophonic list (Patterson 1982)

The words contained on the Coltheart-Patterson list were selected from the set published in Coltheart, Davelaar, Jonasson and Besner (1977). They were chosen by Patterson (1982) for use with her patient A.M. The list contains forty non-word stimuli. Half are homophonic with real words (e.g.waid) and half are not (e.g. flure).

On the Coltheart-Patterson list homophonicity is often confounded with visual similarity to a real word. It has been suggested that this may account for the homophone effect in some cases of acquired dyslexia (Martin 1982). A new list was therefore constructed which contained non-words (homophonic with real words) for which the degree of visual similarity to real words was varied.

Temple homophonic list (newly constructed)

The list contained 48 non-words. Half were homophonic with real words and half were not. Of the 24 that were homophonic with real words, half were visually highly similar to their word counterparts (e.g.shoo) and half were only slightly visually similar to their counterparts (e.g. riste). Homophonic and non-homophonic stimuli were matched so that each of the homophonic non-words differed from a non-homophonic non-word by only one letter. The non-homophonic stimuli were : fide, niste, loze, voor, polemm, vissil, scuge, antor, phogo, heeb, spoo, scort, rond, goom fich, flere, sheb, pume, etum, skoe, grele, opil, glud, dorde. The homophonic stimuli with high visual similarity were : shoo, flore, heer,

grene, solemm, skie, shef, ankor, scowt, wond, roze, moov. The homophonic stimuli with lower visual similarity were : blud, korde, otum, fite, tume, woom, scule, wissil, wich, apil, riste, and pholo.

TASKS

Reading

The stimuli on the preceding two lists were used only for reading aloud. No explicit strategy instructions were given. The children were requested to read all the stimuli aloud. They were told that none of the stimuli were words but that some might sound like words when they were read aloud while others would not.

WORD MATERIAL

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LISTS

Coltheart, Besner, Jonasson, and Davelaar (1979) Regularity List

This list consists of 78 words. Half have regular spelling-to-sound patterns (e.g.distress) and half are irregular (e.g. yacht). The two sublists are balanced for number of letters, part of speech, number of syllables and word frequency.

Stanovich and Bauer (1978)

This list comprises 100 words. Half are regular and half are irregular. The two groups are balanced for word frequency and length in letters.

Marshall Derivational List (unpublished)

This list was constructed by Dr John Marshall and consists of 24 base verbs and their nominals e.g. decide and decision and 24 base adjectives and their nominals e.g. true and truth. The stimuli on the Marshall list are given in the appendix.

Temple Word List (newly constructed)

This list comprises 160 words of varied imageability and word frequency

A pilot study showed that all the words were well within the auditory vocabularies of ten year old dyslexics. A sublist contains 80 words balanced for the above variables. This sublist is henceforth referred to as Core 80. The words in Core 80 were balanced with the aid of the Medical Research Council psycholinguistic database (Coltheart 1981)

Core 80

Within Core 80 there are forty words of high frequency (Kucera and Francis 1967, frequency$>$80) and forty words of low frequency (Kucera and Francis 1967, frequency$<$20). These two groups are balanced for imageability, length in letters, regularity and part of speech. Imageability was determined from the "IMAG" rating in the M.R.C. psycholinguistic database (Coltheart 1981). This rating was obtained from merging three sets of imageability ratings : Paivio et al (1968), Gilhooly and Logie (1980) and the Colorado Imageability norms (Toglia and Battig 1978). Regularity was determined on the basis of the rules outlined by Wijk(1966). Three researchers in the Neuropsychology Unit were also asked to rate the words considered for inclusion in the categories regular and irregular. Words for which there was disagreement were eliminated.

Within Core 80 there are forty words of high imageability (IMAG$>$400), and forty words of lower imageability (IMAG$<$400 and for all but two words IMAG also$<$300). These two groups of words are balanced for regularity (as determined above), frequency (Kucera and Francis 1967), length in letters and part of speech.

Two subsets of thirty long words (6-9 letters) and thirty short words (3-5 letters) can be taken from Core 80. These are balanced for regularity, imageability and frequency (determined as above).

Two subsets of twenty-six regular and twenty-six irregular words can also be taken from Core 80. These are balanced for frequency, imageability and length.

The full list of 160 words contains a variety of orthographic and spelling-to-sound features. It may be subdivided into 16 mutually exclusive categories. There are 10 words containing a vowel which is lengthened by a terminal 'e' and the corresponding ten words created by the removal of terminal 'e' e.g. hope and hop There are ten 3-letter words which when read in reverse order are also words (e.g. god). There are ten words containing the letter c where it receives the phonetic translation /k/ and ten where it is pronounced /s/, e.g. strict and deceit. There ten words containing the digraph ch where it is pronounced /tʃ/ (e.g.peach) and ten where the h is silent add the digraph is pronounced /k/ (e.g.echo). There are ten words containing silent gh (e.g.bright) and ten words with other silent letters (e.g.debt). There are ten words containing the letter g pronounced /dz/ rather than /g/ (e.g.angel).There are ten words containing the letter j pronounced /dz/ (e.g.join). There are ten words containing the digraph sh (e.g.shone) and ten containing the digraph ss (e.g.stress). There are ten words containing the digraph th pronounced /ð/(e.g.the) and ten where it is pronounced /θ/ (e.g.thin). Finally there are ten words containing the cluster tion (e.g.station)

The stimuli on the Temple word list and those that comprise Core 80 are detailed in the appendix.

TASKS

A. Reading

The four word lists described above were presented for reading aloud. Stimuli were individually typed on separate cards in lower case. The responses to these four lists were used for the error analysis for each child. The error categories used are outlined in the next section. The responses to the first two lists (Coltheart et al 1979; Stanovich and Bauer 1978) and the regularity portion of Core 80 were used to assess regularity effects. The other subdivisions of Core 80 were used to assess

the effects of frequency, imageability, and length.

B. Spelling

The stimuli on the Temple list were also individually dictated for written spelling. These spelling responses were used for the spelling analysis.

C. Reading of Misspellings

In a later test session the written spellings were returned to the child who made them and presented for rereading. This experiment thus assesses whether the written code employed by the child was more beneficial to him/her than conventional spelling.

D. Reading with reversed or handwritten stimuli

The first 25 Core 80 words were presented for reading aloud in three ways : in handwriting, in reversed lower case (e.g. egral) and in reversed upper case (e.g. EGRAL).

LIST

Function word (Newly constructed)

This list comprises 32 common,short function words. No stimulus was more than four letters in length : in, on, at, of, he, she, yet, and, so, I, me, when, if, but, them, to, by, you, for, from, the, us, that, with, as, or, not, it, our, this, his, and my.

TASK

Reading aloud

LIST

Temple Homophones (newly constructed)

This list is composed of forty words : twenty pairs of homophonic words. Each words had a regular spelling-to-sound pattern. No words were included which had ambiguous consonants or vowels, or silent letters. Each word was of high frequency and familiar to children. The twenty pairs

are : road-rowed, tyre-tire, steel-steal, deer-dear, peace-piece, groan-grown, mail-male, dye-die, heel-heal, cheep-cheap, current-currant, rows-rose, sail-sale, thrown-throne, hair-hare, bored-board, flew-flu, bye-buy, aloud-allowed, stare-stair.

TASKS

A.Reading

The forty words were presented in random order for reading aloud. After reading each word, the child was requested to define it.

B.Spelling

In a later test session the stimuli were orally dictated for written spelling. After each word, a sentence containing the word was given in order to differentiate it from its respective homophone. Each child was requested not to start writing until the full sentence had been heard, e.g. " Sail, we went to sail our boat up the river...sail ", "road, our house stands near a busy road....road". (The full list of sentences is given in the appendix).

LIST

The Nelson Adult Reading Test (Nelson and O'Connell 1978)

There are two sections to this test. The first consists of 50 irregular words of declining frequency and familiarity. An early word is ache and a late word is syncope. The second section contains 20 long regular words (9-14 letters in length). These are also of declining frequency ranging from adventurously to shibboleth.

TASK

Reading aloud (Given to H.M. and J.E. only)

RHYMING TASKS
****

Rhyme Fluency

As a preliminary to this test, a straightforward one minute oral fluency task was given for the categories "animals" and "things". This task was employed partly as an introduction to the harder rhyme fluency task and partly so that if any differences emerged in the performance on rhyme fluency, then standard fluency scores could indicate whether this was attributable merely to general differences in overall fluency levels.

The rhyme fluency task was used to investigate the segmentation and synthesis of sound. A target word was spoken aloud and the child was required to produce as many words as possible which rhymed with it. Common names were permitted. One minute was allotted to complete the task per item. The target stimuli were : duck, shop, nine, pen, cold, ring, stitch, hate, bone, fear,wool, and crab.For comparative purposes, the total number of rhymes produced by each child and the mean per word were calculated.

Auditory Rhyme Pairs

For each target word in the fluency task, four paired stimuli were produced. The pairs were named in relation to the sounds which they held in common with the target stimulus, where the number 1 indicated the first sound in the words, the number 2 indicated the central sound in the words and the number 3 indicated the last sounds in the words. The first pair P23 rhymed : duck-stuck, shop-crop, nine-line, hen-pen, cold-fold, ring-sing, stitch-rich, hate-late, bone-phone, wool-pool, fear-beer, crab-stab. The second pair P13 shared initial and terminal sounds with the target but differed in the middle : duck-deck, shop-ship, nine-nun, hen-hymn, cold-killed, ring-rung, stitch-starch, hate-hat, bone-bin, wool-will, fear-four, crab-crib. The third pair P12 shared initial and middle sounds but differed in the terminal sound : duck-dull, shop-shone, nine-knife, hen-head, cold-

comb, ring-rip, stitch-still, hate-hail, bone-bore, wool-woof, fear-feed, crab-cram. The fourth pair consisted of phonologically unrelated words: duck-wine, shop-fear, nine-stitch, hen-wool, cold-hate, ring-fear, stitch-crab, hate-duck, bone-shop, wool-nine, fear-hen, crab-cold.All the pairs were randomised. Each pair was then spoken aloud and the child was required to say whether or not the two stimuli in the pair rhymed.

LETTERS
****

Two decks, in letraset, (.5cm-1cm tall,.3cm-.6cm wide) of the 26 letters of the alphabet were constructed : one in lower case and the other in upper case. Letters from each set were presented on individual cards, in random order, in two conditions. In the first, the child was directed to name the letters. In the second, the child was directed to "sound" the letters. Preliminary practice and explanation ensured that the latter task was understood. A letter matching task was also conducted. The 26 upper case letters were spread randomly over a table surface so that the child could see them all. The lower case letters were presented individually and the child was required to select the matching upper case letter. After selection the upper case letter was replaced on the table. The names of all the letters were orally dictated for written spelling, as were the letter sounds.

A further set of lower case letters was assembled. There were two tokens each of the following : w, v, x, i, a, u, o, n, p, y, q, b, k, d, and e. For each of these letters the child was required to say whether: a) the tail went up or down, or there was no tail ; b) in relation to the tail, the letters faced right or left, or neither if there was no tail ; c) the sound of the letter rhymed with 'c'. Task (a) was completed for each child, then task (b) and finally (c).

ERROR ANALYSIS
****

In 1966 Marshall and Newcombe published a case study of a patient with acquired dyslexiq. In their analysis they set a new trend by discussing the type of error that the patient made when reading aloud. errors were grouped into different categories on the basis of the relationship between the stimulus and response. This psycholonguistic approach has since been adopted by many researchers.

This section will outline the error analysis that is used in the following chapters. The analysis is very similar to those that have been used with researchers working with patients with acquired dyslexia, and includes some of the categories first proposed by Marshall and Newcombe(1966). The major new category introduced here is the class of "valid" but erroneous responses. The error taxonomy is subdivided according to whether the erroneous response is a word (paralexias) or a non-word (neologism).

A. PARALEXIC RESPONSES

SEMANTIC

An error in which both target and response have semantic features in common, yet share fewer than 50% of their letters in common, e.g. black → "white"; angel → "god"; Niagara → "Falls"

DERIVATIONAL

An error in which the base lexical item is read correctly but an affix is dropped, added or substituted e.g. child → "children"; mourning → "mourn"; disbelief → "belief". The term derivational is not used in its strict linguistic sense. 'Morphological'is a more appropriate name to assign as the errors involve both derivational and inflectional morphology but in the interests of consistency with the adult literature the name 'derivational' is retained.

VISUAL

An error in which the response contains at least 50% of the letters

in the target, or the target contains at least 50% of the letters in the response where the mutual letters have their order preserved, e.g. table → "gable", boutique → "bouquet", harness → "harvest" . It should be noted that in some of the literature on acquired dyslexia the definition of a visual error is not as strict as this.(It should also be noted that the name does not necessarly imply that the errors are of peripheral visual origin.)

Some of the errors defined below as valid paralexias could also be classified as visual paralexias. For the cases presented in the later section on phonological dyslexias there are few errors where there is such overlap. These few errors are listed with the visual paralexias but are noted and relisted after them. For the cases presented in the section on surface dyslexia valid paralexias are more prevalent. They are listed separately from the invalid visual paralexias.

VALID

Valid paralexias are those where a rule system has been applied to determine the pronunciation of the word. When a rule involves the most common translation of grapheme to phoneme (here grapheme is defined as the written representation of a single phoneme), the error has been called previously a regularisation,e.g. sweat → "sweet", dead → "deed". The category valid also includes errors where the rule system is based upon translations of graphemes to phonemes which are not the most usual (called irregularisations by Masterson,1983), and errors where the rule system is based upon the translation of orthographic units larger than the grapheme. The translations must be appropriate for more than one English word in order to qualify as valid. In terms of analogy theory (to be outlined later) valid errors are those for which an analogy is transparent.Examples of valid errors include :

like → "lick" (translation of i as in give,live)
pure → "purr" (translation or ure as in enclosure)
phase → "face" (translation of ase as in base, chase)

VISUO-SEMANTIC

An error in which the response shares a substantial number of semantic features with the stimulus and, where the response contains at least 50% of the letters in the target (or the target contains at least 50% of the letters in the response) with the mutual letters preserving order, e.g. satirical → "sarcastic", county → "country", haggis → "bagpipe".

VISUAL+SEMANTIC

An error in which an implicit visual error is followed by a semantic error , e.g. Nigeria → "Falls" (via Niagara)

sheep → "dream" (via sleep)

shy → "blue" (via sky)

B. NEOLOGISTIC RESPONSES

VALID

Valid neologistic errors are those for which one may determine a rule system that applies to derive the pronunciation of the non-word. This rule system may be based upon frequent or infrequent conversions of grapheme to phoneme,or conversions of larger orthographic and phonological size. The conversion must be present in more tham one English word.

A valid neologism is thus akin to a valid paralexia except that the response is not a word, e.g.

hive → "hiv"/hɪv/ (ive translated as in give, live)

yacht → "yatcht"/jætʃt/

INVALID

A neologistic error that is not valid,e.g.

corner → "corper"/kɔpð/

fight → "figuth"/fɪgʌθ/

source → "scooch"/skutʃ/

SURFACE DYSLEXIA

INTRODUCTION
****

The First Description

The term surface dyslexia was introduced by Marshall and Newcombe (1973). They described the case of a 45 year old man , J.C. who had sustained as the age of twenty a severe penetrating missile wound to the left temporo-parietal region. Twenty-five years after injury neurological examination revealed a mild right hemiparesis. Tone was normal and symmetrical and plantars were flexor. Light touch, pin prick, joint position sense and vibration sense were intact in the extremities. Perimetry showed a right homonymous hemianopia.

J.C. had only very mild residual aphasic symptoms. These were not detectable upon conventional clinical testing but could be detected with more formal tests. There were mild difficulties on the Token Test, repetition of long sentences and naming of low frequency objects. Neverthless his spontaneous speech was fluent and grammatical. He had trained as an electrician prior to injury, and despite a severe reading and spelling deficit, he retained his electrical skills and worked successfully until retirement. The characteristics of this patients reading disorder follow.

J.C. made many errors which Marshall and Newcombe (1973) described as "partial failures of grapheme-phoneme conversion". The phonetic values of some letters are affected by the letters which surround them. J.C. had difficulty using this context of a letter within a word to achieve its pronunciation. Thus errors were made on ambiguous letters. For example, the letter c may be pronounced /k/ or/s/ dependent on letter context. J.C. made the error insect $\longrightarrow$ "insist" where one of the errors was the

pronunciation of c as /s/ instead of /k/; and the error incence → "increase", where one of the errors was the pronunciation of c as /k/ instead of /s/. The grapheme g also produced difficulty since it may be pronounced /g/ or /j/. Voiced consonants were sometimes pronounced in unvoiced form e.g. disease → "decease" and silent letters were assigned phonetic values e.g. island → "izland" /ɪzlænd/. The "rule of e" was rarely applied, e.g. bike → "bik" /bɪk/. Vowel digraphs which represent one sound were generally read as only one of the component letters, e.g. niece → "nice". In addition, consonant clusters provoked difficulty and there were stress errors. A quarter of J.C.'s responses were neologistic. With respect to linguistic dimensions, J.C. was mildly influenced by word concreteness, frequency and part of speech. Finally when questioned about the meaning of a word he had read in error, J.C. described the meaning of his response, e.g. begin → "beggin /bɛgɜn/ .....collecting money". A further surface dyslexic, S.T. was also described by Marshall and Newcombe (1973) and more extensive data on these two cases was presented by Holmes (1973).

Since this time a number of other adult cases have been described. The first references made to the known published cases of acquired surface dyslexia are given in table 2. There is some interesting variability within the patient group, but before discussing this, the salient characteristics of surface dyslexia will be described and some prominent explanatory theories summarised.

Integral Features

The integral features of acquired surface dyslexia are listed below in the order in which they will be investigated in the developmental cases.

1. Non-word Reading

   Some dyslexic populations (deep and phonological), have especial difficulty reading non-words,e.g.gip. In surface dyslexia non-words are not harder

1.	1943	Imura	
2.	1960	Luria	
3.	1971	Dubois Charlier	
4.	1973	Marshall and Newcombe	J.C.
5.	1973	Marshall and Newcombe	S.T.
6.	1975	Sasanuma and Morroi	M.U.
7.	1975	Warrington	A.B.
8.	1975	Warrington	E.M.
9.	1980	Shallice and Warrington	R.O.G.
10.	1980	Kremin	F.R.A.
11.	1980	Sasanuma	K.K.
12.	1982	Deloche, Andreewsky and Desi	
13.	1983	Shallice, Warrington and McCarthy	H.T.R.
14.	1983	Coltheart, Masterson, Byng, Prior and Riddoch	A.B.
		Eleven unpublished cases presented at the 1982 conference on Surface Dyslexia, Oxford, England.(Patterson et al 1984, in press)	
15.		Kay and Patterson	E.S.T.
16.		Kremin	H.A.M.
17.		Goldblum	B.F.
18.		Bub	M.P.
19 - 22.		Coltheart, Masterson and Byng	E.E.,C.I.T., K.M.,P.M.
23.		Sasanuma	S.V.
24.		Saffran	L.L.
25.		Newcombe and Marshall	M.S.
26.		Margolin, Marcel and Carlson	R.F.

Table 2 The first references to cases of acquired surface dyslexia

to read words.

2. Error Types

The reading errors of surface dyslexics are of a particular qualitative nature. Paralexic responses are usually smaller in number than neologistic responses. Both visual and valid paralexias are made. In contrast, semantic, derivational, visuo-semantic and visual + semantic paralexias are effectively absent. Many of the neologistic responses are valid, although in most cases there are also substantial numbers of invalid neologisms. In addition there are often stress errors.

3. Regularity

Surface dyslexics are especially sensitive to the regularity of spelling of the words they are trying to read. Words with regular spelling-to-sound patterns are read more easily than those with irregular spelling-to-sound patterns.

4. Length, Imageability and Frequency

Word length in letters or syllables appears to affect reading in surface dyslexia. Longer words are more prone to produce errors. The effects of rated imageability and (directional) frequency , if present, are not large, although both have been observed.

5. Function Words

Some dyslexics have especial difficulty reading function words, e.g. in, on, but. In surface dyslexia, function words are not harder to read then content words. Any difficulty reading function words arises from the irregularity of the spelling-to-sound patterns of some long function words, e.g. enough, although.

6. Homophones

Surface dyslexics show confusion in the comprehension of homophones,e.g. blue - blew, even when they are read aloud correctly.

7. Reversed typescript and handwriting

There are no reports of specific difficulty being encountered by surface

dyslexics , required to read material in reversed typescript.

8. Spelling

To date, all surface dyslexics have been found to be surface dysgraphics. That is, the pattern of their spelling performance and spelling errors mirrors that of their reading performance. Recently Hatfield and Patterson (1983) have extensively compared surface dyslexia to surface dysgraphia (which they call phonological spelling). Their conclusions will be presented later. ◇

Theoretical Interpretations

Three broad groups of theories have been proposed to account for surface dyslexia. The difference between them is best exemplified by the mechanism which they invoke for the reading aloud of pronounceable non-words. Group 1 theories consider that non-words are read by an abstract process of grapheme-phoneme conversion. Group 2 theories consider that they are read by a conversion system based upon orthographic units which may be larger than the grapheme. (Some writers use the word grapheme to refer to a single letter, but it is used here as it is used by Coltheart (1978) who defines grapheme as the written representation of a single phoneme. This definition will apply throughout the thesis).Both of these theories assert that the process of reading non-words is clearly separate and dissociable from a semantically-based mechanism of reading which may be used for reading real words. Group 3 theories consider that this separation is artificial : that there are not multiple routes to reading aloud. For these theorists, non-words are read by analogy with the pronunciation of real words. Theories which fall into each group are :

Group 1 : Marshall and Newcombe
Morton and Patterson
Coltheart

Group 2 : Shallice and Warrington

Group 3 : Marcel

Henderson

Glushko

To illustrate and clarify, one theory from each group will be outlined.

Newcombe and Marshall (1981)

One of Marshall and Newcombe's models of the reading process is given in figure 1. As they themselves have pointed out , it is very similar to other contemporary models and owes much to an original formulation of Coltheart (1978).In figure 1 visual word representations and oral word representations are equivalent respectively to the visual input logogens and output logogens of Morton and Patterson (1980). The figure shows three main routes by which a word may be read aloud. When reading occurs by route A, the semantic route, the following stages occur. After preliminary visual analysis , the word is either processed first into letter representations, or passes directly to visual word representations. An entry (logogen) is stimulated and reaches threshold. It then addresses the corresponding semantic representation, and this in turn accesses an oral word representation which is placed in the response buffer, and may then be spoken aloud. It is on this route that deep dyslexics and phonological dyslexics are considered to rely. The highly accurate performance of many phonological dyslexics suggets that the system may function with good efficiency, even when isolated from other routes.

Route C contains the grapheme-phoneme conversion system. Words read by this phonological route are parsed into graphemes. These are translated via an abstract set of grapheme-phoneme correspondence rules into phonemes which are then blended together. It was Coltheart (1978) who first explicitly invoked this mechanism. The response is held in the output buffer and then may be spoken aloud. It is considered that surface dyslexics are over-reliant on this method of reading due to impairment of the other reading routes that involve sight vocabulary. This over-reliance leads to

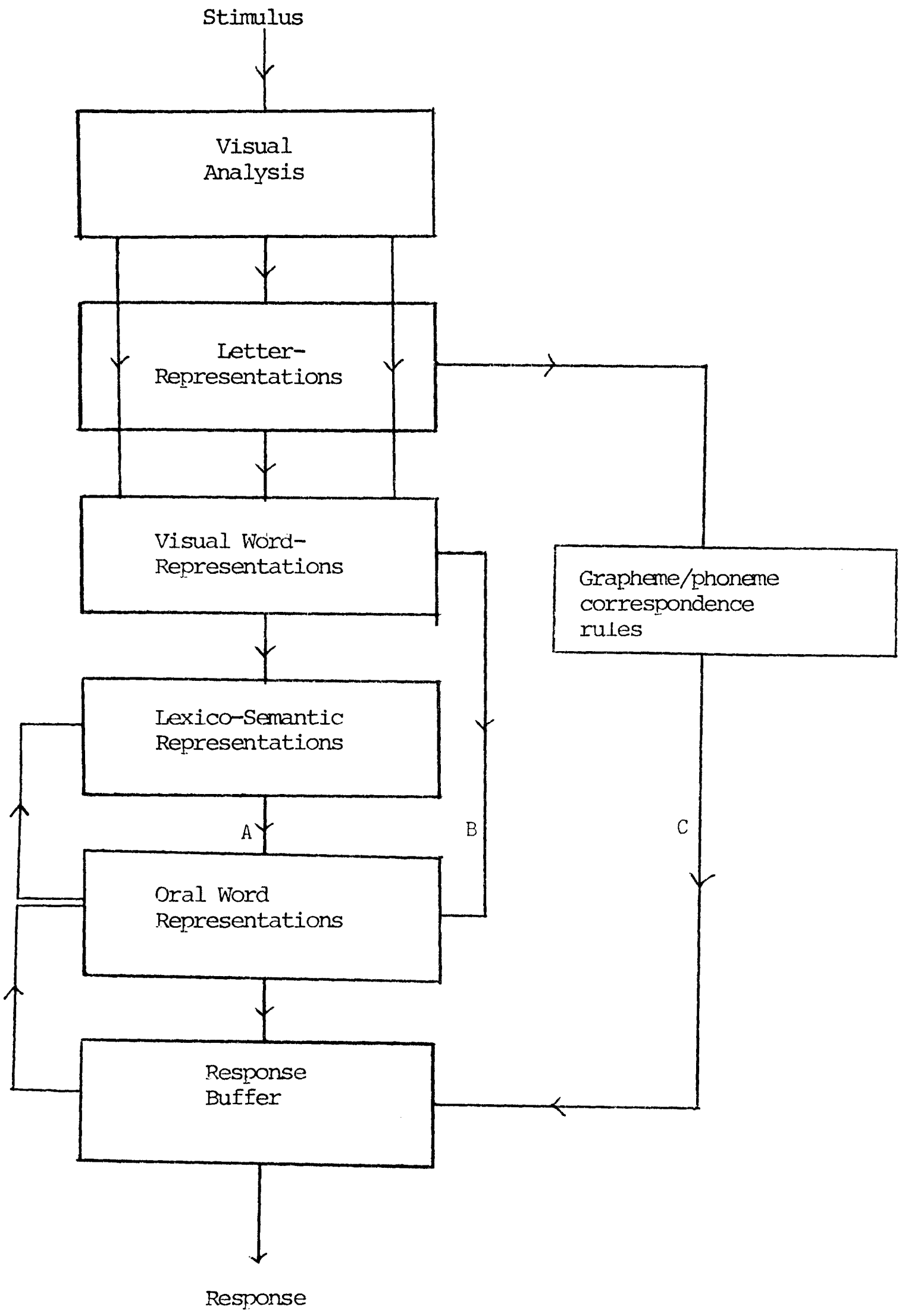

FIGURE 1

THE READING MODEL OF NEWCOMBE AND MARSHALL (1981)

erroneous reading of words with irregular spellings. However, reading of non-words and function words can be as good as reading content words. Since surface dyslexics do show instances of faulty grapheme-phoneme conversion it must be assumed that the grapheme-phoneme conversion system is itself damaged, unless one considers that such instances result from intrinsic instability. Marshall and Newcombe suggest that these errors result from "a partial failure of the grapheme-phoneme correspondence rules".

The third route, route B,has been added to the model specifically because of the patient of Schwartz, Saffran and Marin (1980). This patient could read aloud,accurately,a large number of both regular words (e.g. tooth, corn,) and irregular words (e.g. flood, great), yet she did not comprehend them. She was suffering from dementia. The stimuli had become meaningless to her yet she could still read them aloud. The initial absense of errors on highly irregular words indicated that reading did not result from the use of route C. Route B is called the direct route as it passes directly from input to output logogens.

With respect to the terminology used in education we may say that route A corresponds to a "look and say" method of reading. Route B corresponds to "barking at print" and route C corresponds to "sounding out".

If the surface dyslexic reads via route C, how does he/she decide upon their meaning? Marshall and Newcombe observed that their patient J.C. defined the words he read in terms of the erroneous response rather than in terms of the stimulus item. He may thus be deciding upon the meaning of the words he reads by the use of the feedback system illustrates on the left of figure 1. His functional impairment must therefore be before the box called semantic representations on route A.

Marshall and Newcombe's theoretical explanation has been criticised by Marcel (1980).He suggests that their explanation will not account for all the data of their first patient J.C. Marcel claims that there is evidence of lexical involvement in the reading of J.C. He states that concrete nouns

are read better than abstract nouns; Nouns are read better than adjectives which are in turn read better than verbs; High frequency words are read more easily than low frequency words; Errors tend to be nouns and tend to be more frequent than the target. However ,for J.C., imageability or concreteness effects are fairly mild. With respect to part of speech, in the 1973 paper J.C. read 16/20 nouns, 10/20 adjectives and 9/20 verbs. 1980 retest (personal communication Freda Newcombe) indicates that 14/20 nouns,10/20 adjectives,and 13/20 verbs are read. There is thus little evidence for a part of speech effect. Marcel also notes that only about one quarter of the errors were neologisms. Thus there was a strong tendency to produce words as responses. The emphasis here is misleading,since it is the production of a quarter of errors as neologisms which is unusual, and requiring explanation not the preservation of some word production skills. With more justification Marcel notes that failed or misapplied grapheme-phoneme rules, suggested by Newcombe and Marshall, cannot fully account for the data of J.C. For example, in the error incense $\longrightarrow$ "increase", an /r/ has appeared and an /n/ disappeared. In vowel digraphs often only one vowel is given a realisation e.g. violent $\longrightarrow$ "volent". Whole syllables are sometimes deleted or added.

Shallice and Warrington (1980, Shallice, Warrington, and McCarthy 1983)

Shallice and Warrington assume the lexically stored orthographic-to-sound correspondences are not limited to graphemes, as in the theory of Newcombe and Marshall. They suggest that there are correspondences for various sizes of orthographic unit. These include graphemes, consonant clusters, sub-syllabic units, syllables and morphemes. They postulate a visual-word form system which can detect letter groups of different sizes and then send information about them to corresponding units in the phonological system. Orthographic units could only exist in the word form system if the letter group corresponding to it actually existed in at least one English word. The units might be restricted to letter groups with functional

phonological or semantic correspondence .Letter groups with more than one possible pronunciation would have each distinct pronunciation represented by a separate correspondence rule. These correspondences could differ in strength. Correspondences for different units are achieved serially from left to right.

Finally, Shallice and Warrington assume that, as a result of neurological pathology, when the route is impaired larger units are affected more severely than smaller units. Increasing impairment leads to increased reliance on smaller and smaller units. In surface dyslexia, reliance is on orthographic units which are too small to cope effectively with the notorious irregularity of English orthography. (Shallice and Warrington's model also differs from that of Newcombe and Marshall in that they abandon the direct route and incorporate it into their expanded phonological route).

Marcel (1980)

The model of reading postulated by Marcel is given in figure 2. His model differs from those just described in that lexical processes are not separated from the other reading systems. There is only one mechanism for converting print to sound.

Letter strings are represented as individual letters in spatial order, irrespective of characteristics like upper/lower case. The visual input lexicon is specified for all known words and morphemes. They are coded in terms of a left-to-right description of letters in ordinal positions. This representation is not based on a whole-word gestalt description. Each address in the visual input lexicon has a connection to a semantic description and an entry or combination of entries in the output lexicon or what Marcel calls the aural-oral lexicon. In the second process the entry in the input lexicon first accesses a specification in the semantic system. Pronunciation is achieved as a whole but it has to be segmentable in order to account for blending errors in

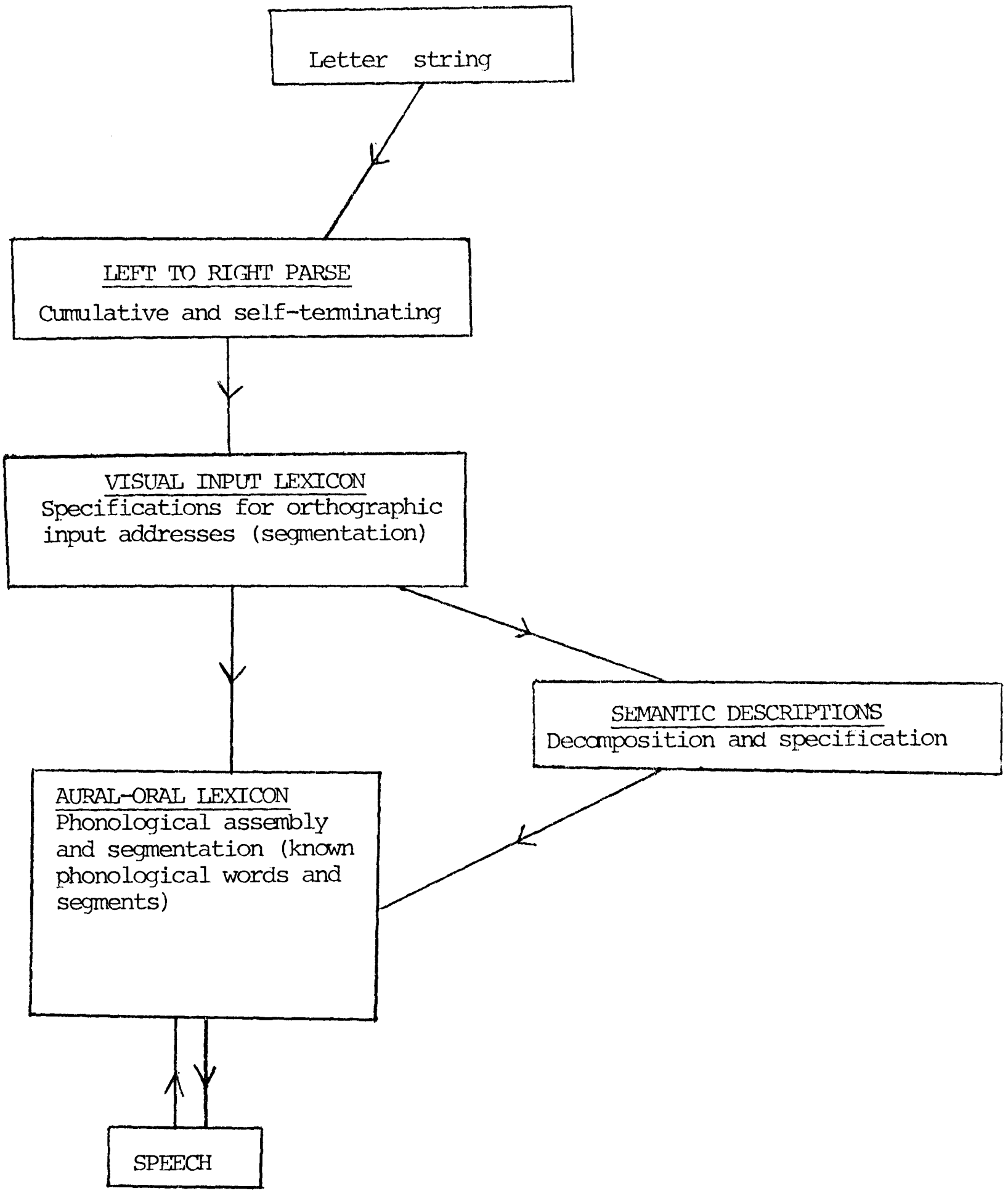

FIGURE 2

The Reading Model of Marcel (1980)

speech (Fromkin 1973).

The parsing of a letter string is achieved by two processes. The first mechanism is cumulative and exhaustive : as each letter is encountered in a left-to-right scan it is marked as a possible segment. Then as each new letter is encountered it is added to the previous letters and a series of ever larger segments is marked , with the previous bracketings remaining. The second mechanism is the operation of morpheme sensitive specifications in the visual input lexicon. The influence of these orthographic specifications is twofold. If the specification for a segment represented as a lexical address is met, then the criterial segment in the letter string is marked, but the bracketing internal to that segment is not overriden. In addition, lexical specifications can override or delete candidate bracketings. In the case of read, the potential bracketing of (re) would be overriden since -ad is not a segment which exists as a lexical address and the most satisfactory lexical "account" of the letter string is thus to treat is as (read). Thus context sensitivity consists of a) the bracketing of segments which correspond to morphemes; b) the later addition of letters can override previous bracketings; c) as more satisfactory analyses in terms of morphemes and words are yielded they override bracketings.

When a non-word is encountered the same mechanism is employed. It will be segmented by the parser and input-lexical specifications will mark those segments which occur in known words. The segments which are marked will activate all their potential pronunciations and that which is found in the greater number of words will 'win'.

Marcel considers, after studying the work of Doctor (1978), that the errors made by beginning readers are very similar to those made by aquired surface dyslexics. He accounts for both in his model by suggesting that, in the case of beginning readers, orthographic specifications in the input lexicon for some words have not yet been aquired and in the

case of surface dyslexia, specifications for some words have been lost. In addition, it is assumed that a strategy is adopted by the reader such that since the printed letter string is a word, what is pronounced should be recognised by the reader; that is, there should be an entry in the aural-oral lexicon. The lack of specification for a whole word will have two effects. Firstly , the pronunciation cannot be retrieved as a whole and must therefore rely on parsed segments. Secondly, primary bracketings in the parsing of the letter string will not be overriden by lexical knowledge, nor will later letters override previous bracketings. The eventual phonology will be affected by the most frequent phonology of the segments parsed in this way with the constraint that the result is an entry in the aural-oral lexicon. Marcel does permit that, in some cases, the result need not be an entry in the aural-oral lexicon, but he does not specify the circumstances in which this overruling is absent.

.By including the strategy that a response should be an entry in the aural-oral lexicon, Marcel can effectively account for all paralexic responses , in which there is even moderate resemblance between target and response. What is then of interest is the extent to which Marcel's theory can account for the neologistic responses made by surface dyslexics. Lack of overriding of letter segmentations can account for the removal of the effect of e and i on c and g ; the removal of the effect of final e on vowels preceding the consonant before the e ; removal of the effect of vowels in digraphs for synthesis to make diphthongs ; and the assignment of a phonetic value to silent letters. Since morphemic segments are not overriden one may also get errors of the sort island $\longrightarrow$ "izland" (is + land), begin $\longrightarrow$ "beggin" (beg + in). The retrieval of the most frequent pronunciation for a segment will account for a number of other neologistic responses, e.g. recent $\longrightarrow$ /rɪkɜnt/.

Thus Marcel's theory can account for more of the error responses of

surface dyslexics than the theory of Newcombe and Marshall (1981). It can account for all paralexic responses and all valid neologistic responses, in terms of the error classification outlined earlier. But, all three groups of theories fail to account for many of the invalid neologistic responses found in the error corpora of surface dyslexics. In none of the above theories is a phonological mechanism specified which would account for the errors : chair ⟶ "chaip"/tʃeɪp/, organisation ⟶ "organation" /ɔgɔneɪʃɔn/. (Some researchers would explain these errors, as emanating from a visual processing stage prior to phonological processing and would call them visual errors).

Patient Variability

Since the original description by Marshall and Newcombe (1973) , a number of surface dyslexics have been described whose pattern of deficit is crucially different from that of J.C. This has led to the suggestion that surface dyslexia is not one syndrome but a group of syndromes. Details of interesting cases of surface dyslexia who differ from J.C. are presented below.

1. M.P. (Bub ,Canceiliere, and Kertesz (1984)

Bub has described the case of a 62 year old, right-handed woman, the victim of a traffic accident. Computerised Tomography disclosed a shift, of approximately 1cm, of the mid-line structures to the right , with marked contusion of the left temporal lobe.Surgery was subsequently performed to relieve the temporal lobe herniation. The patient, M.P., has an acquired disorder of reading.When reading single words aloud almost her only error type is a valid error. She makes regularisation errors but she almost never makes invalid errors. When describing the error responses to irregular words of the patient M.P., Bub states " the incorrect pronunciations all involved misapplications of stereotyped rules". Later he notes " M.P. has a sophisticated understanding of spelling rules, so

that reading is highly constrained by orthographic context. In this respect M.P. differs from conventional reports of surface dyslexia, where the patients appear to have lost both lexical specification and knowledge of orthographic influences on pronunciation". M.P.'s reading of regular words is almost perfect. In addition she can read a number of irregular words although performance does break down with lower frequency irregular words in a rule-governed fashion. A semantic reading route is not functional in M.P. This is clear as she has severe comprehension difficulties both from oral and written input. The semantic system itself seems to have been destroyed. Examples of errors made by M.P. to irregular words are : character → "/tʃærəktər/", pour → "power", bowl → "bowel". bead → "bed", blood → "/blɑd/"

Although M.P. is the 'purest' surface dyslexic reported in that her incidence of invalid errors is minimal, Shallice and Warrington (1980) have reported on cases who make fewer invalid errors than the originally reported case of J.C., They have called these cases "semantic dyslexias" (Shallice et al 1983).

2. M.S. (Newcombe and Marshall 1984)

M.S. is a twenty-three year old right-handed male. He sustained a severe closed head injury in a road traffic accident at the age of eighteen. On the performance scale of the Wechsler Adult Intelligence Scale I.Q. was within normal limits (PIQ=90). There was a severe impairment of long-term memory. Word reading and spelling were grossly impaired. Newcombe and Marshall (1984) state that "his attempts to read and spell were not haphazard and, accordingly did not suggest lack of cooperation or attention. On the contrary, they were patently rule-bound to the extent that it was possible to predict the errors that he will make. He was able to follow only very simple rules for converting print to sound (reading) or converting sound to print (spelling to dictation). Using this strategy he was able to read and write to dictation some simple, orthographically

regular words (e.g. pig; hat; wed). Irregular words presented an almost insuperable problem (WHOM pronounced as /w/ - /hom/ ; SHOE pronounced as /s/ -/ho/ - /e/ ; FIGHT pronounced as /fig/ - /hat/)."

When reading individual words aloud M.S. would "show a strong tendency to assign a phonetic value to each letter of the stimulus item" Almost all reading errors were valid. Spelling, although producing simplified orthography, was strictly rule-governed. e.g.

	Read	Spelt
whom	"wɔ-hɒm"	HUM
guess	"gɔɛsɔ sɔ"	GES
thumb	"tɔ-hʌm-bɔ"	FUM

M.S. is more successful at reading his own misspellings than at reading conventional spellings. Regularity effects, which were marked reading conventional spellings, disappeared when reading his own misspellings. Reading conventional spellings he read 12/50 regular and 3/50 irregular words on the Stanovich and Bauer list (1978). This difference is significant ($X^2=5.01, p<0.05$). Reading his own representations of the same words 25/50 of the words which had been called regular were read correctly and 22/50 of the words which had been called irregular. M.S.'s own spelling is strictly rule-governed and is regular by his own standards.

3. B.F. (Goldblum 1984) and E.S.T. (Kay and Patterson 1984)

In describing the patient J.C., Marshall and Newcombe (1973) noted that comprehension of the printed word was based on the oral production made. That is, if J.C. read a word in error, his comprehension was based upon the erroneous response rather than the original stimulus Coltheart et al (1983) also note that this characteristic is true of their recently investigated patient, e.g. debt $\longrightarrow$ "to have a long discussion on something....debate". It was considered that this pattern of comprehension was characteristic of all surface dyslexics but recently two

patients have been described who do not conform to this pattern. Both patients, B.F. (Goldblum 1984) and E.S.T. (Kay and Patterson 1984), sometimes give correct definitions for words that they have read aloud in error. In response to the word seige E.S.T. said " a /si:g/... a /si:g/ .....a /si:g/...everybody.../si:g/...you're all there... a /si:g/ and you don't wany anybody to come in." To the word gauge E.S.T. said "something about the railway.../gɔ:dz/". In both patients the incidence of these responses was small.

Surface Dysgraphia

It was noted above that to date all patients with surface dyslexia also have surface dysgraphia. Hatfield and Patterson (1983) have compared the extent to which the two disorders are similar. They refer to surface dysgraphia as phonological spelling, since this is a more neutral term. They point out initially that there are four crucial differences between reading and spelling.

1. The type and quality of information needed to recognise a printed word differs from that needed to produce its written spelling. Reading may take place,correctly, using only partial cues (Frith 1978, 1980).

2. The role of comprehension is different in the two tasks. In reading the aim of pronouncing will interact with the aim of producing a meaningful response. In spelling, comprehension will generally have taken place prior to coding so that the goal of comprehension is less likely to influence outcome in a spelling response than in a reading response.

3. Regularity for reading differs from regularity for spelling (in English). Although there are many irregular words in a reading task, the phoneme - grapheme correspondences for spelling are even more numerous and inconsistent. "There are fewer phonological segments with predictable orthography than there are orthographic segments with consistent pronunciation."

4. Written spelling can have a discrete, sequential character which is less compatible with oral reading.

The spelling errors of phonological spellers tend, as the name suggests, to be phonologically accurate. Thus the patient T.P. described by Hatfield and Patterson maked the errors :"gauge" ⟶ gage, "laugh" ⟶ laf , "answer" ⟶ anser . T.P.'s spelling of words with regular spelling-to-sound correspondences was superior to her spelling of exception words. This superiority on regular words and tendency to phonologically plausible errors suggests a strong reliance on a phonological routine rather than the use of word-specific knowledge. Some spelling errors of T.P. and of most surface dysgraphics are not phonologically accurate. Hatfield and Patterson suggest that partial preservation of word-specific spelling may account for some of these errors. The use of rules based upon segments of a phonological string being assigned to orthographic segments rather than phonemes assigned to graphemes explains even more spelling errors.

Hatfield and Patterson observe that acquired surface dyslexics tend to produce more paralexic responses than phonological spellers produce paragraphic responses, although this is also more generally true for other reading disorders. They suggest that it is only when the reader can match the visual input with a known word that he can make sense of what he is reading. "The experimenter may be content with the response shove ⟶ "/ʃoʊv/", because it is revealing about mechanism but the patient will not be, because it is unrevealing about meaning." Paralexic responses might therefore be interpreted as "manipulations upon the output of a phonological routine....to create a phonological code that will match a known word". If auditory comprehension is impaired this mechanism will be likewise impaired and the incidence of neologiams should then be higher and the incidence of "peculiar" reading responses should be lower. Thus the differential role of comprehension in reading

and spelling may account for the imprecise parallels in the errors in the two disorders.

DEVELOPMENTAL SURFACE DYSLEXIA

In 1973 the same year as the original published description of surface dyslexia by Marshall and Newcombe, Holmes pointed out that the pattern of reading performance of some children with specific developmental disorders of reading were markedly similar to the cases of acquired surface dyslexia. Like J.C., the four developmental dyslexics described by Holmes had difficulty with the rule of 'e', e.g. code ⟶ "cod", stage ⟶ "stag". Ambiguous 'g' and 'c' were problematic,e.g., certain ⟶ "carton", gorge ⟶ "George". Silent letters were frequently given a phonetic realisation that resulted in neologistic responses,e.g. yacht ⟶ /jætʃt/. There was particular difficulty with vowel digraphs. The developmental dyslexics appeared to have no regular guide to stress placements,and consonant clusters were problematic.

The dyslexic children thus exhibited a pattern of reading virtually indistinguishable from the adults with acquired surface dyslexia. This similarity was so great that if one were to compare the data of the child cases of Holmes with the data of the acquired surface dyslexics whom she also studied and one was not told which data were which, it would be impossible to differentiate between them.

Until comparatively recently Holmes suggestion was largely ignored, but Coltheart and Masterson have recently confirmed that her notion of developmental surface dyslexia is valid (Coltheart 1982; Coltheart et al 1983; Masterson 1983). Coltheart et al (1983) compare a case of acquired dyslexia and a case of developmental dyslexia. The cases have very similar characteristics;

1. Irregular words were less likely to be read correctly than regularly spelled words. In a homophone matching task, performance was significantly poorer if the homophones were regularly spelt.

2. Misreadings of irregular words were often regularisations.

3. There was confusion in the comprehension of homophones.

4. There was a spelling impairment : the majority of spelling errors were phonologically correct.

However there is a difference : the developmental surface dyslexic, C.D., was extremely poor at reading non-words. Of 120 non-words,of 4-6 letters in length,only 28 were read correctly. This contrasts with acquired surface dyslexics who tend to read non-words well.

The first references to the cases of developmental surface dyslexia, in the literature, are given in Table 3.

In order to elucidate the syndrome further, some new cases of developmental surface dyslexia will now be described and analysed.

1.	1973	Holmes	J.B.
2.	1973	Holmes	M.C.
3.	1973	Holmes	T.C.
4.	1973	Holmes	R.E.
5.	1982	Coltheart	M.J.
6.	1982	Coltheart	C.D.
7.	1983	Masterson	F.E.
8.	1983	Masterson	K.W.

TABLE 3

The first references to cases of developmental surface dyslexia

CASE STUDIES
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Case 1

Case History

R.B. is an eleven year old girl. There were no features of concern during pregnancy or the early months of life. Early motor milestones were satisfactory. Subsequent motor developmant was unremarkable. There was no clumsiness. Language development was equally satisfactory with plentiful,clear speech well before the third year. There were no early illnesses nor injury of any significance. General health remains excellent. There were occasional upper respiratory tract infections in the past but no ear infections nor any suspicion of hearing disorder. Concern at slowness in learning to read started around age seven. Thereafter there was considerable tension because of school difficulty. Sleep pattern and behaviour ,in general, remain satisfactory.

Prior to the investigations to be reported R.B. was given a neurological examination by Dr Judith Hockaday, consultant in paediatric neurology, at the John Radcliffe Hospital, Oxford. Her conclusions were as follows :

" On examination R.B. presents as an alert, cooperative, attentive child, of good intelligence and peaceful in examination. There is no blemish. Skull and spine are normal. Full tests of stance and gait are all normal. Visual acuity and hearing are all within normal limits. There is no neurological abnormality. There is minor dyspraxia apparent on ocular motor movements and on sequential finger movements. There is impairment of imitative movement, and very poor right-left discrimination. Tests of dominance show mixed handedness, (although writing occurs with the left hand), right foot, left ear, left eye.

R.B. thus presents as a healthy and intelligent child whose

development appears normal. There are minor abnormalities on examination but no evidence of neurological defect."

There is a family history of sinistrality. R.B.'s mother is left-handed. There is also a family history of learning difficulties. R.B.'s father had persistent problems with spelling, which were greater in his youth, R.B.'s aunt, her mother's twin, also has some difficulties. R.B. has one older brother. He has no reading difficulties.

Psychological Background

In February 1982, when R.B. was 10.1 years old, the Wecheler Intelligence Scale for Children was given to R.B., by Melody Appleton, Educational Psychologist. A full scale IQ of 115 was obtained :

Verbal Tests	Age Scaled Score	Performance Tests	Age Scaled Score
Information		Picture Completion	10
Similarities	12	Picture Arrangement	12
Digit Span	14	Block Design	12
Vocabulary	17	Coding	8
VERBAL IQ	122	PERFORMANCE IQ	104

(Mean = 10, Standard Deviation = 3, Range = 1-19)

On the Peabody Picture Vocabulary Test, R.B. attained a raw score at the 99th centile for age. On the English Picture Vocabulary Test a similarly high score of 138 (mean of 100) was obtained. Teachers reports also note that R.B. has a wide vocabulary.

Tested on Ravens Coloured Progressive Matrices R.B. attained a raw score of 32, equivalent to an IQ of 115.

These tests indicate that R.B. is of above average intelligence with an extensive vocabulary. In an attempt to ameliorate R.B.'s severe reading and spelling difficulties she was selected to attend a remedial

DATE	July 1982	Dec 1982	April 1983	July 1983	Progress
Chronological age	10.6	10.11	11.3	11.6	1 year
Neale Reading Age(Accuracy)	7.8	8.7	8.11	9.11	2 years 3 months
Neale Reading Age (Comprehension)	-	10.11	11.1	11.10	11 months in 7 months
Salford Reading Age	7.6	8.3	8.6	9.4	1 year 10 months
Schonell Spelling Age	7.3	7.6	8.4	8.2	11 months

Table 4

Progressive reading and spelling ages for R.B. during her remedial year

year of intensive tuition outside mainstream schooling, at the New Oxfordshire Reading Centre. Her progress while involved in this program is reflected in the scores in Table 4. The first assessment in July 1982, at the age of 10 years 6 months, was prior to the special remediation. The year began in early September and ended in July 1983, when R.B. returned to mainstream education.

The data which will be presented was collected in November and December 1982, two to three months after the remediation began. The remediation did not follow any pre-set or published plan but was varied in its approach. One component in the remediation did involve tuition in phonics. A sample of preremedial writing, given below in the section on spelling, indicates that the qualitative nature of R.B.'s dysgraphia did not alter between entry into the remedial program and the reported testing.

R.B. had no speech impairment. She is described by her teacher as being 'extremely articulate'. She is fluent and readily comprehensible. During the many hours of testing no abnormality of speech was ever observed.

Non-word Reading

The three balanced lists of words and non-words were presented to R.B. for reading aloud. R.B.'s performance was as follows :

List	Words	Non-words
Three letter list	13/14	12/14
Five/Six letter list	12/15	11/15
Coltheart list	23/25	20/25

There is no significant difference in R.B.'s ability to read non-words in comparison to her ability to read matched words. Of the eleven

errors to non-words, five were lexicalisations (that is, the errors were words):

mab ⟶ "mad	lorse ⟶ "lost"
plass ⟶ "place"	cag ⟶ "cage"
noor ⟶ "nor"	

The other errors to non-words were:

ked ⟶ "kep" /kɛp/	chait ⟶ "charit" /tʃɑrɪt/
sutter ⟶ "sunter" /sʌntɚ/	foop ⟶ "floop" /flʊp/
poad ⟶ "pollard" /pɒlɑd/	cimy ⟶ "chimy" /tʃɪmeɪ/

Of the six errors to words, three were neologistic responses , and three were paralexias :

insect ⟶ "insent" /ɪnsɛnt/	head ⟶ "heed"
pencil ⟶ "penchil" /pɛntʃəl/	man ⟶ "men"
fire ⟶ "fime" /fɑɪm/	fence ⟶ "french"

R.B. was also presented with the two other non-word lists to read individually aloud. : the Coltheart-Patterson homophonic list and the Temple homophonic list.On the Coltheart- Patterson list R.B. read 24 of the 40 stimuli correctly. Six of the errors were to stimuli homophonic with words and ten of the errors were to stimuli not homophonic with words. This difference is not statistically significant ($X^2 = 0.81$). On the second list, R.B. read 27/48 stimuli correctly.Eleven of the errors were to stimuli homophonic with real words and ten of the errors were to stimuli non-homophonic with real words. Of the errors to stimuli homophonic with real words, four were to stimuli which also have visual similarity and seven were to those that did not have visual similarity. Thus for R.B. homophonicity with a real word is not a determinant of whether a non-word will be read more easily.

Single Word Reading : Error Analysis

The four word lists used in the error analysis were the Coltheart et al (1979) list, the Stanovich and Bauer (1978) list, the Marshall list and the Temple list.In combination the four lists totalled 434 words.

R.B. read correctly 181 of the 434 words. Thus, there were 253 errors, the majority of which were neologistic responses. Sixty-four per cent of the errors were neologisms (162), and thirty-six per cent of the errors were paralexias. This difference is significant ($X^2=38.7$, $p<0.01$). Of the neologistic error responses, 36% (58) were valid. These are listed in Table 5. It can readily be seen that some of the valid neologistic responses are classical regularisations, e.g. anchor →"/æntʃɔ/", dumb → "/dʌmb/", while others are not, e.g. break → "/brɛk/", host → "/hɒst/", and teach → "/tiːætʃ/".

Although there were fewer paralexic responses than neologistic responses, a number of the paralexic errors were also valid : 19% (17). The valid paralexias were :

angel → "angle"	mope → "mop"
weak → "wake"	fir → "fire"
hid → "hide"	bake → "back
baker → "backer"	aide → "eyed"
couch → "coach"	heir → "her"
lose → "loss"	sour → "sore"
sweat → "sweet"	hope → "hop"
kite → "kit"	win → "wine"
slate → "slat"	

The vast majority of the paralexic responses (75%) were visual paralexias, where the response shared at least fifty per cent of its letters in common with the stimulus, or vice versa. The visual paralexias are listed in Table 6.

There were three paralexias which might be classified as derivational: sing → "singing", removal → "remove", refusal → "refuse". In view of the large number of visual paralexias, a small incidence of errors which could be classified as derivational is not surprising. Since derivational errors have stimuli and responses which share many

engine → /ɛngaɪn/ "engine"	anchor → /æntʃɔ/ "antchor"
alike → /əlɪk/ "alik"	aisle → /æsəl/ "assil"
shady → /ʃædeɪ/ "shaddy"	chorus → /tʃɔərəs/ "tchowrus"
worth → /wɔθ/ "worth"	ashamed → /əshæmɘd/ "as.hammed"
stress → /striz/ "strees"	dumb → /dʌmb/ "dumb"
image → /ɪmɪg/ "imag"	report → /rɛpɔət/ "rèport"
teach → /tiətʃ/ "tea.atch"	breadth → /briɖθ/ "breedth"
political → /pɔlətɪkɔl/ "poliyticall"	govern → /gɔəvɘn/ "go.vern"
beg → /big/ "beeg"	calm → /kælɘm/ "calim"
break → /brɛk/ "breck"	debt → /dibt/ "deebt"
sword → /swɔd/ "sword"	shove → /ʃɔəv/ "showv"
chasm → /tʃæsm/ "tchassm"	blast → /blest/ "blaste"
float → /floəət/ "flow.at"	host → /hɒst/ "host"
banishment → /bænɪʃmɘnt/ "bani.shiment"	busy → /bʌsɪ/ "bussy"
cafe → /cef/ "céf"	cliche → /clɪtʃ/ "clitch"
elite → /elət/ "aylight"	honour → /hɒnɘ / "honour"
liquor → /lɪkwɒ / "liqu.or"	tone → /tɒn/ "ton"
pint → /pɪnt/ "pint"	suit → /sut/ "soo.it"
sword → /swɔd/ "sword"	take → /tək/ "tak"
move → /moəv/ "mowv"	bowl → /bəol/ "boul"
broad → /brəd/ "brad"	castle → /cæstɘl/ "castil"
pint → /pɪnt/ "pint"	report → /rɪpɔət/ "rèport"
revision → /rivɘʒɘn/ "reevishon"	amuse → /əmʌs/ "amus"
persuade → /pɘswəd/ "persued"	truth → /trʌθ/ "truth"
belief → /bilaɪf/ "belife"	nation → /nətɒn/ "natton"
examination → /exæmɪnəʃɘn/ "examination"	naughty → /nəgɘtɪ/ "nagetty"
cheat → /tʃiət/ "chee.at"	whistle → /hwɪstɘl/ "whistel"
press → /prɪz/ "prees"	purchase → /pɘtʃəs/ "purchas"
information → /ɪnfɔməʃɘn/ "information"	invitation → /ɪnvaɪtɘʃɘn/ "inviteishon"

TABLE 5

The Valid Neologistic Responses of R.B.

build → "bundle"	calm → "came"
scorn → "score"	chassis → "chances"
weigh → "wing"	flood → "flew"
orchestra → "orchard"	broad → "bored"
moth → "mouth"	sew → "swear"
mattress → "matters"	banish → "vanish"
record → "recall"	metal → "mental"
compete → "complete"	summit → "submit"
chapter → "chap"	pour → "pure"
digest → "disgrace"	whom → "warm"
competition → "completion"	betray → "beetroot"
cautious → "cotton"	steak → "shark"
revise → "rivers"	complaint → "complete"
broad → "board"	duel → "deal"
fresh → "french"	grill → "girl"
barge → "beg"	politics → "police"
build → "bundle"	cult → "celt"
prove → "poor"	distress → "destroy"
spear → "spanner"	barge → "drag"
save → "shave"	shown → "shone"
patient → "pattern"	secretary → "scratchy"
ripe → "ripple"	war → "wire"
management → "maggot"	cheery → "cherry"
foul → "fellow"	sign → "sing"
fuse → "firs"	pine → "pain"
suck → "stuck"	chaos → "choose"
dew → "drew"	fight → "figit
toll → "told"	want → "went"
clue → "coal"	mimic → "miss"
thin → "tin"	thorough → "forget"
sherry → "shore"	borough → "bothered"
child → "chide"	instance → "instruction"
adjective → "adjust"	design → "decision"
ought → "though"	choir → "chores"

TABLE 6 VISUAL PARALEXIAS OF R.B.

letters in common, it is probable that the three above errors are not truly derivational but are visual errors which happen to look like derivational errors.

One paralexic error was visuo-semantic : county ⟶ "country". This error was made by every child tested in the work for this thesis and is therefore of doubtful significance.

There was only one paralexic stress error : recent ⟶ "resent". More might have been expected.

One remaining paralexic error was unclassifiable : circuit ⟶ "chill".

It has been stated that neologistic errors predominate. Examples of valid neologistic responses have been given, but the majority of the neologistic responses are invalid (64%). Invalid neologistic errors are the largest error category, accounting for 104 of the 253 errors. Within this group the invalidity of ten of the errors appears to result predominantly from sequencing difficulties, that is, either all the individual letters or all the individual graphemes in the stimulus are given phonetic realisation but the order of the phonemic sequence is in incorrect :

refresh	⟶ "refersh"/rəfəʃ/	sort	⟶ "stort"/stɔt/
solemn	⟶ "somelen/sɒmɛlɛn/	aunt	⟶ "anut"/ænʌt/
health	⟶ "he.anthil"/hiænθəl/	north	⟶ "nothir"/nɒθə/
align	⟶ "aling"/əlɪŋ/	sew	⟶ "swee"/swi/
marine	⟶ "armin"/ɑmɪn/	fresh	⟶ "fersh"/fəʃ/

There is also some evidence of a specific difficulty with u-n con confusion, e.g. gauge ⟶ "gung/gʌŋ/, soul ⟶ "sunl"/sʌnl/, doubt ⟶ "dunt" /dʌnt/. The error referred to as a sequencing error above: aunt ⟶ "anut" might also result from u-n confusion rather than

sequencing problems. Responses to another word list, not included in the current analysis, indicated that words with initial au often produce u-n confusion for R.B. Examples of errors from this list are :

authority ⟶ "unthority" /ʌnθɒrɪtɛɪ/
autograph ⟶ "untref" /ʌntrɛf/
autumn ⟶ "antonym"
auction ⟶ "unkont" /ʌnkɒnt/

To return to the current analysis there are many other neologistic errors which do not predominantly reflect sequencing errors or u-n confusion. These are listed in Table 7. Some of these errors will be discussed later. The error analysis for R.B. is summarised in Figure 3.

Regularity Effects

R.B. was asked to read three different lists aloud in order to investigate the effects of spelling-to-sound regularity : the Coltheart et al (1979) list, the Stanovich and Bauer (1978) list, and the regularity portion of Core 80. The results are given below.

Word list	Regular	Irregular	X^2
Coltheart et al list (first responses) (n=78)	18	8	4.67*
Coltheart et al list (icluding corrected responses) (n=78)	24	10	8.81*
Stanovich and Bauer (n=100)	30	14	9.13*
Temple list (n=50)	9	5	.89 n.s.
Total	81	37	32.5*

(* = statistically significant, $p < 0.05$)

government → /gʌvɚɹənt/"goverent"
argument → /ɑgəlmənt/"aregilment"
furnish → /fʌɹɪnɪʃ/ "furinish"
amusement → /ɑɹəsimt/ "araseemt"
complain → /cɒmplænɪn/ "complanin"
gentleness → /gimt/ "geemt"
arrange → /ævredz/ "avrage"
examine → /ɛxæməl/ "examal"
entertainment → /ɛntəteləntˈ/"entertalent"
wise → /wɪvz/ "wivs"
strange → /stræg/ "strag"
arrive → /rɪv/ "riv"
betrayal → /bitæraʊ/ "beetarow"
caution → /kɔræʃən/ "corashon"
destruction → /dəstreɪʃən/"destreshon"
height → /haɪl/ "hile"
calmness → /kɑlɑmɛs/ "calamess"
argue → /ɑrgəl/ "aregill"
certainty → /kəɹɛntɛɪ/ "kerenty"
arrangement → /əmɑrɛnt/ "amarent"
certain → /tʃətən/ "chertan"
furniture → /frɒntɪr/ "frontir"
chemist → /tʃɛzmɪs/"chesmiss"
peach → /pitʃtʃ/ "peachch"
corner → /kɒlə/ "coler"
audience → /ælʌmbaɪ/ "allumbie"
shiny → /ʃɪleɪ/ "shilly"
variation → /væræɪtɒn/ "varaton"
injure → /ɪnjɔɪ/ "injoy"
essay → /ɛsæleɪ/ "essaly"
source → /skʊtʃ/ "scooch"
relation → /rəlæɪtɪnʃɪn/"relatinshin"
stomach → /stɒmtʃ/ "stomtch"
debt → /dɛpt/ "dept"
join → /dzɪn/ "jin"
ration → /ræsɒn/ "rason"
fight → /fɪgʌθ/ "figuth"
deceit → /dɪskɪt/ "diskit"
honesty → /hɔsleɪ/ "horsely"
either → /ɛtɪθə/ "etither"
strict → /strɪtʃ/ "strich"
influence → /ɪnfɪlənsˈ/ "inflence"
capsule → /cəʊsjuəleɪ/"cowsually"
mortgage → /mɔθɪgʊ/ "morthigu"
yacht → /jæts/ "yats"
shrug → /θɒg/ "shog"

throat → /θræt/ "thrat"
average → /ævək/ "averke"
mechanic → /mɛtʃ/ "metch"
ambition → /æmboʊtɒn/ "ambowton"
daughter → /dægəθ/ "daggeth"
since → /snɪtʃ/ "snitch"
neighbour → /nebrɒθ/ "nebroth"
chlorine → /tʃlɔ/ "tchlor"
sight → /sɪŋɛθ/ "singeth"
portion → /pɒrɪnʃən/ "porinshon"
passport → /pəsɒnprɒt/"personprot"
menace → /mɛntʃ/ "mench"
possible → /poʊsəɪd/ "powside"
energy → /ɛnədzleɪ/ "energly"
harsh → /hɑʃi/ "harshee"
shone → /ʃɒnwʌn/ "shone.one"
motion → /mɒtʃɒn/ "motshon"
dress → /prɛz/ "prez"
scarce → /skɑʃ/ "skarsh"
stupid → /stʌmpəd/ "stumpid"
subtle → /stʊpɛl/ "stuepell"
protein → proʊtɛn/ "proten"
bury → /bʌbreɪ/ "bubry"
biscuit → /dɪsɪtʃɪn/ "disitchin"
throng → /θroʊg/"throwg"
trout → /trəʊθ/ "trouth"
trough → /trɔʊθ/ "trouth"
cough → /cɒθə/ "cother"
strewn → /swin/ "sween"
splendid → /slɛndəd/ "slendid"
snob → /shoʊb/ "shobe"
plague → /plɛdzə/ "pleger"
touch → /fætʃ/ "fach"
laugh → /lʌdz/ "luge"
advice → /ædvɪkt/ "advict"
alarm → /ælæm/ "alam"
boost → /blʊst/ "bloost"
divine → /dɪvɛnt/ "divent"
gnaw → /gænəweɪ/ "ganaway"
guess → /gʌsəs/ "gusses"
heir → /hə/ "ha"
hour → /hɒlə/ "holler"
praise → /pɑz/"paze"
phrase → /fəz/ "firz"
thumb → /θʌmp/ "thump"
tour → /θɔ/ "tho"

TABLE 7

NEOLOGISTIC READING ERRORS MADE BY R.B.

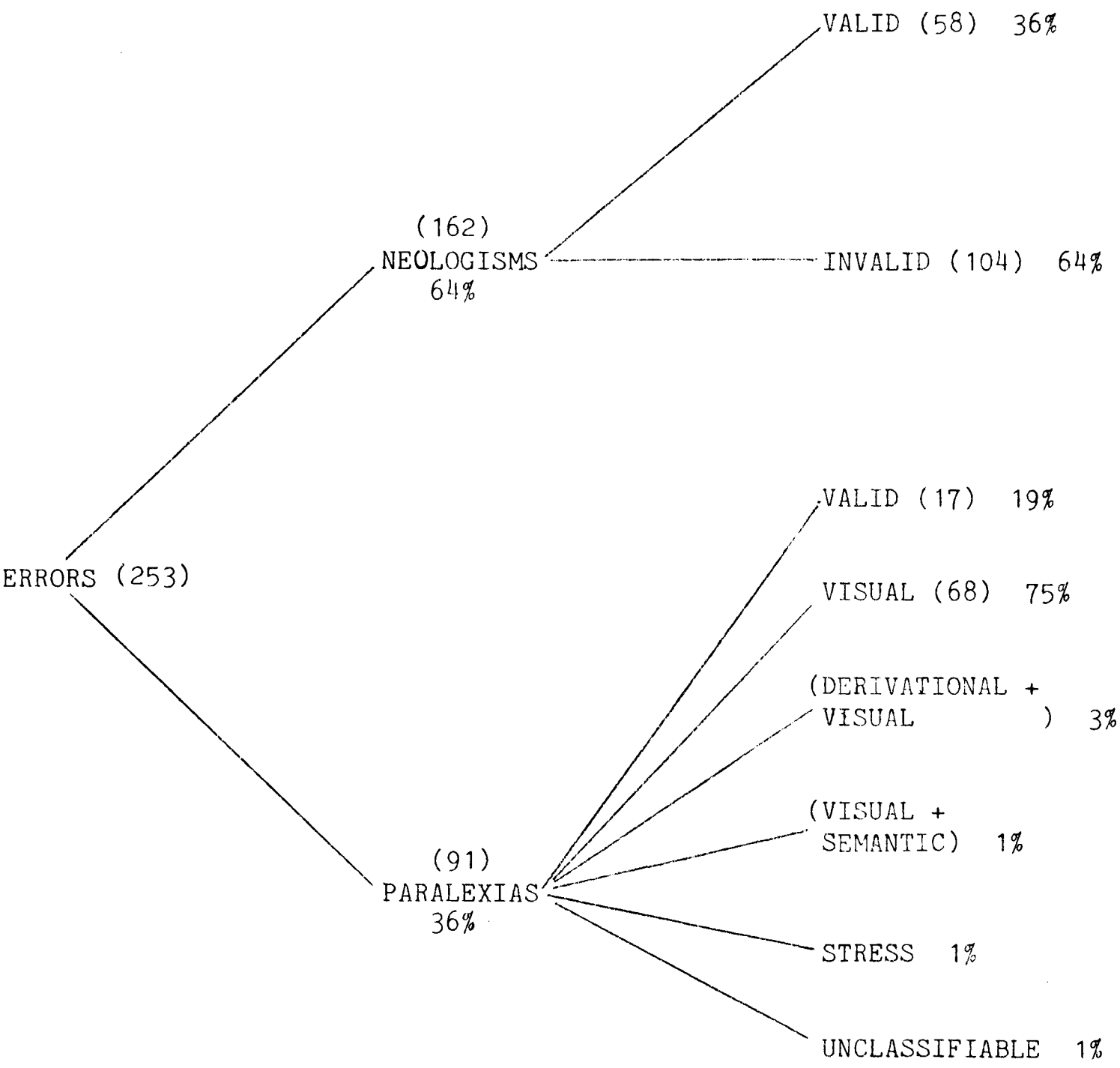


Figure 3

Analysis of R.B.'s reading errors when reading aloud individual words

On both the Coltheart list and the Stanovich and Bauer list regularity effects are marked and significant. Although there is a trend in favour of regularity on the Temple list, the difference fails to reach significance due to the very low level of performance on this test. The presence of regularity effects is consistent with the occurrence of regularisation errors described in the previous section.

Frequency, Imageability, Length and Word Class Effects

R.B. was asked to read aloud Core 80. Fifteen of the forty words of high frequency were read correctly and twelve of the forty words of low frequency were read correctly. Thus, for R.B. frequency does not seem to be a salient determinant of reading performance.

Eighteen of the forty words of high imageabilty were read correctly and nine of the forty words of low imageability were read correctly. This difference just falls short of significance ($X^2 = 3.57$, $0.1 > p > 0.05$). The trend is consistent with the finding of Baddeley, Ellis, Miles and Lewis (1982) that,for both dyslexic and normal children,imageability affects reading performance.

Thirteen of the thirty short stimuli (3-5 letters in length) and ten of the thirty long stimuli (6-9 letters in length) were read correctly. Thus, no significant length effect occurred. It is possible that the previously reported length effects in acquired surface dyslexia are artefacts of imageability and frequency effects, since these factors are seldom controlled for. R.B. herself, might show a more dramatic length effect is tested on a list where performance level was higher.

The effect of word class was not investigated directly, partly because word class effects are not a prevalent characteristic of acquired surface dyslexia and partly because doubt has recently been cast on the validity of noun / verb / adjective effects in any group of aquired dyslexics

(Rickard 1982, Allport and Funnell (1982), Nolan and Caramazza 1982). The part-of-speech effect is contaminated on most lists with imageability ratings. When the latter are controlled, the part-of-speech effect may disappear. The function word list was presented for reading aloud. All were read correctly.

To summarise : the only linguistic dimension which clearly affects reading performance is spelling-to-sound regularity, with irregular words being read more poorly.

Homophone Reading

The forty words on the homophonic words list were presented in random order for reading aloud. After reading each word R.B. was requested to define it. R.B. read 21 words correctly. Ten appropriate definitions were given. In the other eleven cases the target word was defined as one of its homophones. Nine of the definitions were of the homophonic word it had been paired with in the test.

male : "chain mail or mail in the mornings"
dye : "kill yourself"
heel : "cut my knee and it heals"
steal :"a kind of metal"
peace : "a piece of paper"
die : "you dye your clothes"
cheep : "not expensive"
flu : "flew across the sky"
allowed : "shout aloud"

The other two definitions were also to homophones.

bye : "I went by a person"

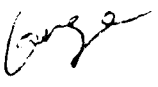
hare : "I'm over here" (hare and here are homophonic in R.B.'s accent)

Thus although R.B. reads each of the twenty-one words correctly, her

ability to comprehend the words and assign a definition to each is random with respect to the words and their homophones. Meaning seems to be derived, not directly from the appearance of the word but, indirectly from its phonological recoding.

Reversed and Handwritten Typescript

In four different test sessions R.B. was presented with the first 25 words in Core 80, in one of four ways : normal typescript, handwriting, reversed lower case type and reversed upper case type. She performed as follows:

Normal Typescript	e.g. large	10/25
Handwritten Typescript	e.g. 	6/25
Reversed Lower Case	e.g. egral	12/25
Reversed Upper Case	e.g. EGRAL	13/25

There is a suggestion that the handwriting is the hardest to read. Reversing of the order of the letters in the words does not impair performance. It will be seen later that R.B.'s performance with reversed typesript is not characteristic of some other dyslexic children.

Spelling

In order to show that the qualitative nature of R.B.'s spelling disorder is not a consequence of the remedial programme which she had recently begun, when tested, the following passage is included. It was written prior to R.B.'s special remedial year, but indicated a spelling disorder of the same type as will be described:

one apon a time there was a littl girl How had a pupy. Everyday as soon as she got home she wood take her pupy ot side. One day she found her dog very ill in is baskit so here and here muthre went to the vets and the vat took a diyecnosis and the pupy had to have a very speshl oprashon wicht cost a lot of muny and so it had the oprashon and it cost a lot of muny and the pupy grow up to de a very dig dog and diy of old age.

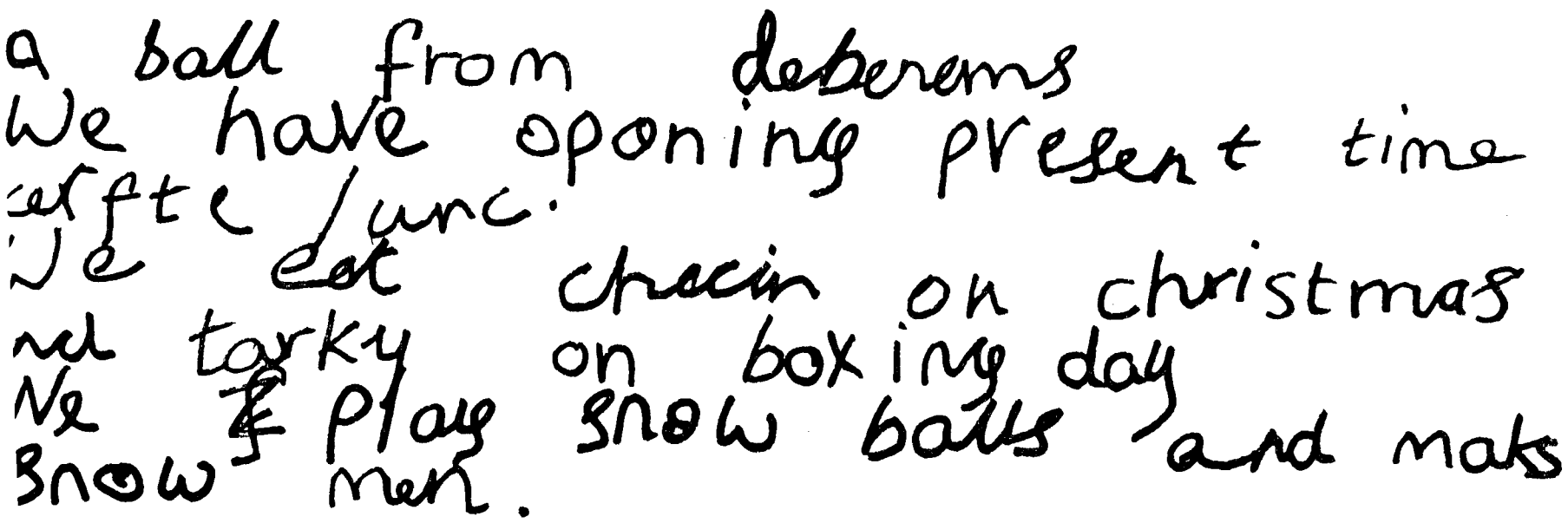
Presumptive intended version

Once upon a time there was a little girl who had a puppy. Everyday as soon as she got home she would take her puppy outside. One day she found her dog very ill in his basket, so she and her mother went to the vets and the vet took a diagnosis and the puppy had to have a very special operation, which cost a lot of money. And so it had the operation and it cost a lot of money and the puppy grew up to be a very big dog and died of old age.

Figure 4 presents a photocopy of R.B.'s spontaneous writing , of a second passage about Christmas day,which was written at the time of the reported assessment, that is, in November and December 1982, two-three months after remediation had begun.

Spelling errors in both texts are predominantly phonologically valid , e.g.

diagnosis → diyecnosis	mother → muthre
operation → oprashon	puppy → pupy
little → littl	chicken → checin
turkey → tarky	



a doll from Debenhams
We have opening present time after lunch
We eat chicken on Christmas and turkey on Boxing day.
We play snow balls and make snow men.

FIGURE 4

Spontaneous writing of R.B.

The writing indicates what R.B. wished to receive for Christmas, followed by a description of her usual Christmas day. Her spelling is transcribed and corrected underneath

Both texts also have instances of b-d confusions:

big ⟶ dig be ⟶ de doll ⟶ ball

There is a sequencing error in text 2 : after ⟶ arfte

There is homophone confusion in Text 1 : would ⟶ wood

It will be seen that these instances of spontaneous writing accurately reflect the disorder observed in spelling to dictation.

Non-word Spelling

Two of the balanced word and non-word lists which had been presented for reading aloud, were in a later test session orally dictated for spelling: the Temple 3-letter list and the Temple 5/6-letter list. On the three letter list , R.B. spelt thirteen of the fourteen words correctly and twelve of the fourteen balanced non-words correctly. On the 5/6-letter list she spelt five of the words correctly and eleven of the non-words. Thus , if anything, R.B.'s ability to spell non-words is better than her ability to spell words. On the three letter list the word error and one of the non-word errors resulted from b-d confusions :

"dig" ⟶ big "dop" /dɒp/ ⟶ bop

The other non-word error was : "tup" /tʌp/ ⟶ pup

On the 5/6- letter list the word errors were :

"lemon" ⟶ lemen	"glass" ⟶ glarss
"apple" ⟶ apell	"chair" ⟶ cher
"insect" ⟶ insekt	"horse" ⟶ hors
"pencil" ⟶ pensel	"truck" ⟶ truk
"fence" ⟶ fens	

All of these errors are phonologically valid. The non-word errors were :

"doptor"/dɒpt /	⟶ bopeer	"chait"/tʃeɪt/	⟶ cate
"upple" /ʌpɔl/	⟶ opul	"plass"/plɑs/	⟶ plos

Word spelling

The Temple word list, which had already been read aloud, was orally presented for spelling to dictation. R.B.'s spelling was written clearly and unambiguously. Transcription for analysis was performed by the author. The independent judges required by some of the children's data (to be presented later) were not used.

R.B. spelt 62 of the 160 words correctly and made 97 errors. Of the errors 67 (69%) were phonologically valid. That is, they are either phonologically accurate in a traditional sense,or they are valid, in the sense that the letters chosen to represent a particular phoneme,or phoneme cluster, would have been correct in in more than one other English word. These errors are listed in Table 8.

Eleven errors would have been phonologically valid, if there had not been b-d confusion : (11%).

"design"	⟶ bizine	"doubt"	⟶ bowt
"debt"	⟶ bet	"deceit"	⟶ becet
"dumb"	⟶ bum	"possible"	⟶ posadill
"dog"	⟶ bog	"ambition"	⟶ amdision
"dim"	⟶ bime	"daughter"	⟶ borter
"dress"	⟶ bres		

There remained nineteen errors (20%) which were phonologically invalid :

"solemn"	⟶ slolom	"audience"	⟶ orduns
"child"	⟶ ciled	"corner"	⟶ carer
"mass"	⟶ maths	"fancy"	⟶ fantasey
"nothing"	⟶ nuting	"stomach"	⟶ sumok

"large" → larg	"relation" → rulashion
"weigh" → way	"cheat" → chet
"instance" → instans	"ration" → rashon
"fire" → fier	"whistle" → wisle
"chemist" → cemist	"fight" → fite
"jelly" → jely	"honesty" → onisty
"invitation" → invitasion	"station" → stasion
"knob" → nob	"stress" → stres
"recent" → resent	"these" → thes
"peach" → pech	"either" → Ithere
"engine" → engen	"strict" → strikt
"jewel" → jule	"influence" → inflowans
"gentle" → jentul	"average" → avrig
"chorus" → coras	"joyful" → joyfell
"confess" → confes	"bright" → brite
"adjective" → agektif	"echo" → ecow
"variation" → veryashon	"neighbour" → naber
"mattress" → matres	"clue" → cloo
"injure" → inger	"digest" → dygest
"essay" → Sey	"chlorine" → cloren
"strange" → strang	"cheery" → chery
"ought" → orte	"kite" → kitte
"source" → strang	"press" → pres
"brother" → bruther	"sight" → site
"orchestra" → orkestrer	"choir" → Quier
"patient" → pashent	"portion" → porshon
"health" → helth	"passport" → pasport
"secretary" → secetre	"menace" → menis
"north" → noth	"win" → wine
"energy" → energey	"mimic" → mimick
"sunshine" → sunshin	"purchase" → purches
"shone" → shon	"they" → thy
"motion" → moshon	"nip" → nipe
"anchor" → anker	

TABLE 8

PHONOLOGICALLY VALID SPELLING ERRORS MADE BY R.B.

"join" → jone	"chapter" → capet
"throat" → trote	"fir" → fare
"disgrace" → discrace	"mechanic" → makik
"since" → sens	"champion" → chapan
"fresh" → fres	"image" → emig
"thin" → fine	

If b-d confusion is overlooked, 4/5 (80%) of the spelling errors are phonologically valid. This proportion is much higher than the proportion of reading errors which were phonologically valid. For the reading errors, 36% of the neologistic responses were phonologically valid, and 19% of the paralexic responses were phonologically valid. In total, 30% of all errors were phonologically valid. Among the words that were used in the reading analysis were the same 160 words that were presented for spelling to dictation. Thus a direct comparison can be made between reading and spelling of the same stimuli.

On the 160 word list R.B. read correctly 69/160 stimuli and spelt correctly 63/160 stimuli. Thus performance is at approximately the same level for both tasks. However, whereas on the spelling task 80% of errors were phonologically valid (ignoring b-d confusions), for the same list, only 27% of reading errors were phonologically valid. The difference is statistically significant ($X^2=48, p<0.001$). There was also a significant difference between the number of paralexic responses and the number of paragraphic responses. Thirty-two of the reading errors (35%) were paralexias. Only 11 of the 97 spelling errors (11%) were paragraphias ($X=14, p<.001$). The greater tendency to produce words when reading might have accounted for the smaller number of phonologically accurate errors on this task. This would be consistent with the suggestions of Hatfield and Patterson (1983). However even if neologistic reading responses alone are examined only 16/59 (28%)

are phonologically valid. The figure indicates that the lower incidence of phonologically accurate reading errors does not result merely from a pay-off in producing word responses. The difference between the incidence of phonologically valid reading and spelling errors provides support for the notion of seperate input and output phonology.

One difficulty in making comparisons of reading and spelling data is that there are often more phonologically valid misspellings of a word than phonologically valid misreadings. This is largely due to the varied ways in which vowels may be represented in English. For example, "meat" may be misspelt phonologically validly in the following ways : meet, mete, meit, met, meete, meite, miete, meate. Whereas meat may be validly misread as "met","mate", or "/mit/". Examination of R.B.'s responses suggests that this arguement is not sufficient to account for the larger number of phonologically valid misspellings, since R.B.'s spelling is not only phonologically accurate, but the rules used are restricted in number. Thus although "meat" may be validly misspelt in a number of ways, if R.B. misspelt it she would do so as met, since e is the preferred spelling for /i/, e.g. "peach" ⟶ pech ,"these" ⟶ thes . "cheery" ⟶ chery , "cheat" ⟶ chet, "deceit" ⟶ becet. Indeed for all the words which are phonologically validly misspelt those that contain the vowel /i/ are always transcribed with the grapheme e.

One may examine the vowels of English and the written representations which R.B. selects for them, when she makes phonologically valid misspellings. This analysis is post hoc and so there are unequal numbers of responses (see Table 9). It is clear from Table 9 that the range of R.B.'s representations for vowels is narrow. Thus,for R.B., the number of potential phonologically accurate misspellings is not necessarily larger than the number of phonologically accurate misreadings.

Although the overall level of performance is similar, the stimuli

VOWEL	EXAMPLE	REPRESENTATIONS USED BY R.B.
/i/	peach	e
/ɪ/	hid	i, i-e
/eɪ/	weigh	a, terminal ay/ey
/ɛ/	chemist	e
/æ/	adjective	a
/ɑ/	large	a
/ɒ/	knob	o
/ɔ/	north	o
/ɷ/	chorus	o, terminal ow
/u/	clue	oo
/ə/	anchor	e, a, u
/ʌ/	brother	u
/ju/	jewel	u-e
/əɪ/	kite	y, itte, i
/əɷ/	doubt	ow
/əə/	fire	ie

/ɔɪ/, /ɪə/, /ɛə/ : no misspelling examples

TABLE 9

THE LETTERS USED IN THE REPRESENTATIONS OF VOWELS IN THE SPELLING ERRORS OF R.B.

that produce errors on the reading and spelling tasks differ. That is, some words are read correctly but not spelt correctly and vice versa.

Words which are read but not spelt correctly are : large, fire, jelly, knob, jewel, mass, gentle, fancy, confess, nothing, they, strange, brother, nip, station, these, disgrace, joyful, bright, echo, champion, dim, dog, sunshine. Words which are spelt but not read correctly are : nation, scorn, shady, naughty, ashamed, worth, shiny, moth, record, angel, hid, hope, mope, war, barge, ripe, shown, and harsh. Since the stimuli were only presented once for each task one cannot be sure of the consistency of these effects.

Reading of Misspellings

The spelling data discussed above was presented to R.B. She had already read aloud the 160 stimuli when they has been presented correctly spelt and typed. On this occasion she was required to read aloud her own misspellings. She read 75/160 correctly. That is, she read a few more of her own spellings correctly than she had read of the typed stimuli, of which she had read 69/160 correctly. A number of individual stimuli were read incorrectly in the typewritten presentation and correctly when handwritten, even when incorrectly spelt (see table 10).

In a number of these instances the original typed stimulus was orthographically complex. The misspelling represents a simplification of the stimulus, that preserves its phonological attributes. The misspelling may then be decoded in the same way as a non-word, by the application of a formal system

Of the 67 phonologically accurate misspellings R.B. read 30 correctly (45%). When the same thirty stimuli were correctly spelt, only ten were read correctly. Thus for a number of words R.B. finds her own representations easier to decode than the correct representations.

Target word	Read	Spelt	Misspelling Reread
anchor	/æntʃɔ/	anker (p)	✓
weigh	"wing"	way (p)	✓
chemist	/tʃɛzmɪs/	cemist (p)	✓
invitation	/ɪnvaɪtəʃən/	invitasion (p)	✓
orchestra	"orchard"	orkestrer (p)	✓
stomach	/stɒmtʃ/	sumok	✓
debt	/dɛpt/	bet	✓
whistle	/hwɪstəl/	wisle (p)	✓
stress	/strɪz/	stres (p)	✓
neighbour	/nebrɒə/	naber (p)	✓
clue	"coal"	cloo (p)	✓
digest	"disgrace"	dygest (p)	✓
press	/prɪz/	pres (p)	✓
sight	/sɪŋɛθ/	site (p)	✓
image	/ɪmæg/	emig	✓
mimic	"miss"	mimick (p)	✓
purchase	/pəʃəɐs/	parches	✓
cheery	"chair"	chery (p)	✓
patient	"pattern"	pashent (p)	✓
health	/hiæɐnθəl/	helth (p)	✓
energy	/ɛnəʤleʊ/	energey (p)	✓
shone	/ʃɒnwʌn/	shon (p)	✓

(p): phonologically valid

TABLE 10

STIMULI WHICH WERE READ AND SPELT INCORRECTLY, BUT WHOSE MISSPELLINGS WERE CORRECTLY REREAD

Spelling of Homophones

In the spelling data that has already been discussed there are a small number of instances of homophone confusion. In the spelling of the 160 stimuli the errors, "weigh" ⟶ way and "sight" ⟶ site, were observed. Both of these responses were later reread correctly.

R.B. was presented with the forty stimuli on the Temple homophonic word list, which had been used to investigate reading aloud and the comprehension of homophones. In this case they were presented orally for spelling to dictation. After each word a sentence containing the word was given , in order to differentiate it from its homophone. R.B. was requested not to start writing until the full sentence had been heard, e.g. "sail....we went to sail the boat up the river,....sail". Of the forty stimuli only four were spelt correctly : "rose", "stare", "male" and "thrown". There were five homophonic spellings :

"deer" ⟶ dear	"rowed" ⟶ rode
"rows" ⟶ rose	"bye" ⟶ by
"groan" ⟶ grown	

Thus the incidence of correct spelling is no higher than the incidence of homophonic spelling. Many of the spelling errors confirmed the preferred spelling of the vowel /i/ as e, which was noted earlier :

"steel" ⟶ stell	"steal" ⟶ stel
"piece" ⟶ peec	"peace" ⟶ pec
"cheep" ⟶ chep	"cheap" ⟶ chepp
"heel" ⟶ hell	"heal" ⟶ hel

The above errors also suggest a tendency to double the terminal letter in the presence of a long vowel. This is also evident for the vowel /e/ :

"sale" ⟶ sall	"sail" ⟶ sall
"mail" ⟶ mall	

but not in all cases : "stair" ⟶ star

The confusion between "hair"/"hare" and "here"/"hear" which was apparent for reading (these stimuli are homophonic in R.B.'s accent), was also apparent for spelling :

"hare" ⟶ here "hair" ⟶ here

There is b-d confusion :

"die" ⟶ bie, although....."dye" ⟶ diy

"dear" ⟶ bear, although....."deer" ⟶ dear

There is blending of spelling :

"aloud" ⟶ alowd "allowed" ⟶ alowd

The remaining errors are :

"tyre" ⟶ ter	"tire" ⟶ tier
"current" ⟶ curent	"currant" ⟶ corent
"bored" ⟶ bard	"board" ⟶ bard
"flew" ⟶ flow	"flu" ⟶ flow
"grown" ⟶ gron	"buy" ⟶ biy
"throne" ⟶ trown	"stair" ⟶ star

Oral Spelling

R.B. was asked to spell aloud the Schonell graded word spelling test A. Her age scaled score was 7.8. The test was administered in February 1983. The score corresponds to the written spelling age which was intermediate between 7.6 (in December 1983) and 8.4 (in April 1983). There was a suggestion that fewer errors were phonologically valid than would be expected from the pattern of written spelling. It has been noted that 80% of written spellings are phonologically valid (ignoring b-d confusions). Of the twelve oral spelling errors on the Schonell

only four are valid :

"lowest"	⟶ "L-O-E-S-T-"	"brain"	⟶ "B-R-A-N-E"
"write"	⟶ "R-I-G-H-T"	"worry"	⟶ "W-O-R-Y"

The remaining eight are :

"four"	⟶ "F-O-N-R"	"loud"	⟶ "L-O-D-E"
"ground"	⟶ "G-R-O-D-E"	"noise"	⟶ "N-O-S-E"
"dancing"	⟶ "D-E-N-C-E"	"hoped"	⟶ "H-O-P-E"
"remain"	⟶ "R-E-A-M-N"	"amount"	⟶ "A-M-T-E"

Rhyme Fluency

As a preliminary, a straightforward fluency task was given. R.B. had to name as many animals and as many things as she could , given one minute for each category. The results were : animals 15, things 11.

The rhyme fluency task was given to investigate R.B.'s skills in the explicit segmentation and synthesis of phonological sequences. The target word was spoken aloud and R.B. had one minute to produce as many words as possible which rhymed with it. Common names were permitted. R.B. was able to produce a rhyme to each word and in each case the first response was rapid occurring within the first three seconds. On no occasion, was a word produced that did not rhyme with the target item, that is, there were no errors or corrected errors. In total , forty correct responses were produced. Some words were easier than others and elicited more rhyming responses. R.B.'s mean level of performance is high and will be compared later to that of another group of dyslexic children .

fear	-	tear, rear, leer, peer, dear	5
ring	-	sing, ping, king, ting, fling	5
shop	-	hop, top, flop, chop, pop	5
nine	-	pine, Rhine, line, sign, fine	5
hate	-	mate, bait, late, Kate	4
wool	-	pull, rule, cool, tool	4
duck	-	buck, luck, suck	3
hen	-	pen, ten	2
cold	-	old, gold	2
bone	-	own, loan	2
crab	-	dab, fab	2
stitch-		Mitch	1
		Mean per word 3.3	40

Auditory Rhyme Pairs

As described in the method section, for each target word in the fluency task, four paired stimuli were produced : P23 rhymed , e.g. duck-stuck; P13 shared initial and terminal sounds, e.g. duck-deck; P12 shared initial and middle sounds, e.g. duck-dull; the final pair included another of the target words that was phonologically unrelated, e.g duck-wine. The pairs were spoken aloud to R.B., in random order. She was required to say whether or not the two stimuli in each pair rhymed.

R.B.'s discrimination was good. She made only two errors. Both were false positives from the P13 group : stitch-starch, crab-crib.

Individual letter tasks

R.B. was requested to both name and sound the sets of upper and lower case letters . She was also asked to match them. All of the lower case letters were named correctly. There was one error in naming the upper case letters and one corrected error : G $\longrightarrow$ "J", Y $\longrightarrow$ "V....Y". When required to sound lower case letters greater difficulty was encountered.

For four letters a sound could not be produced, their names ould only be repeated : f ⟶ "F", e ⟶ "E", v ⟶ "V", x ⟶ "X". The letter g was sounded in softened form as /dzə/ rather than in hardened form as /gə/, The letter w was sounded as /dwə/ instead of /wə/. When sounding upper case letters, some were also failed and could only be named: X ⟶ "X", R ⟶ "R", I ⟶ "I". As for lower case W was sounded as /dwə/ and G as /dzə/.

Thus total scores are :

Name lower case	25/26
Name upper case	25/26 (+ 1 corrected)
Sound lower case	20/26
Sound upper case	20/26

These results indicate that despite her reliance on phonics in reading R.B.'s mastery of the sounds of even individual letters is not complete.

The letter matching task was performed perfectly.

The subset of letters was also presented for judgement of tail direction, right/left orientation and rhyme with 'C'. On these three tasks there was only one error. On one of its two occurrences in the final task, the letter q was considered to rhyme with "C".

The perfect performance on the tail direction and orientation tasks indicates that the b-d confusions displayed by R.B. in the earlier reading and spelling tests do not result from peripheral perceptual confusions. R.B. herself considers that her difficulty in determining whether the stimulus she is looking at is b or d is a difficulty deciding whether the one that faces the right is a b or the one that faces the left, that is, the letter is perceived correctly but there is difficulty in making the association between the percept and verbal label.

The letters of the alphabet were dictated, in random order, first as letter names and then as letter sounds. With one exception, R.B. wrote all the letters correctly. She wrote /zə/ as s.

Lexical Decision

The three balanced lists of words and non-words, which had been given for both reading aloud and spelling to dictation , were presented once more, in written form,for lexical decision. On the 3-letter list there was only one error, a false positive : het was considered a word. On the Coltheart list there was also only one error, a false negative : fire was considered not a word. On the 5/6-letter list there were errors on nine of the thirty stimuli. There were six false positives : to chait, upple, trock, inlect, plass, gemon. There were three false negatives : to chair, carrot, and insect.

SUMMARY

Background

R.B. is an eleven year-old girl with no known neurological abnormality. She is of above average intelligence with an above average vocabulary. Speech is normal.

Non-word Reading

1. There is no significant difference in her ability to read words in comparison to her ability to read matched non-words.

2. Non-words homophonic with real words are read no more easily than non-words which are not homophonic with real words.

Word Reading

1. Error data is summarised in Figure 3 (p56). Errors are predominantly neologistic. A substantial number of both neologistic responses and paralexias are valid (30%). There is no significant incidence of semantic, derivational, visuo-semantic, or visual + semantic errors.

2. Spelling-to-sound regularity is a significant factor influencing her ability to read words. No other linguistic dimension significantly influences performance.

3. There is substantial homophone confusion.

4. Reading performance does not decline when stimuli are presented with the letters typed in the reverse order, thus prohibiting global strategies.

5. Reading comprehension is better than accuracy at reading aloud.

Spelling

1. R.B.'s ability to spell non-words is no worse than her ability to spell matched words.

2. The majority of her spelling errors are phonologically valid.

3. b-d confusion is apparent, which is not attributable to peripheral perceptual difficulties.

4. There is a higher incidence of phonologically correct spelling errors than phonologically correct reading errors. Misspellings seem to be narrowly rule-governed ; the difference is therefore not attributable to the larger number of potential phonologically accurate misspellings that the language allows. A number of words are read but not spelt correctly and vice versa.

5. When reading her own misspellings, R.B. was able to read correctly a number of stimuli which she had read incorrectly when they were presented in correctly spelt typescript.

6. R.B. can read as many of her own spellings as she can of the correctly typed stimuli.

7. Fewer orally spelt stimuli are phonologically valid.

Performance on rhyme fluency and rhyme recognition tasks was high. Individual letter analysis is mildly impaired, as is lexical decision.

Case 2

Case History

N.G. is a thirteen year-old boy from a Hindu family in Tanzania. The family came to England when N.G. was three. All education has been given in English although N.G.'s first language was Giyurati. He is the youngest of six children. He has three sisters. The eldest, aged 21, has a history of temporal lobe epilepsy. There is no other serious family illness. Birth and early development were normal. Birth weight was $7\frac{1}{2}$ lbs. When 18 months of age, N.G. had his first generalised tonic-clonic seizure without any focal features. Seizures of this type continued to occur until age 5, each lasting up to five minutes. At age 9, he developed complex partial seizures with confusion and automatisms followed by sleepiness. By age 11, his seizures had become longer in duration. More recently they have developed further, consisting of partial onset with secondary generalisation into a convulsion followed by prolonged post-ictal confusion. At the time of referral to the Park Hospital for Children, in Ferbuary 1982, these episodes were occurring about once a week, although occasionally in clusters of two or three within a few days. Earlier treatment with phenytoin has had limited effect and more recently carbamazepine has been introduced.

Within the last two years N.G. has become agressive and otherwise difficult at home. His school reports had been poor. Reports from teachers and medical staff involved with him state :
"He is not making progress at school at present and has not done so for several years." "When given verbal instructions for practical work he is unable to remember more than one or two things and will immediately seek assistance when an assignment begins. " "N... is a friendly outgoing boy, who speaks clearly. Although his vocabulary is limited he copes well in superficial social interaction. On longer acquaintance his problems become more apparent. He is seldom able to

answer questions in class. Any guesses he makes show no apparent link with the actual answer. His free speech is often inappropriate. Some of his favourite phrases are "Yes, Mr Men" and "Are you happy? Where's your nappy?".He is anxious and apologises excessively."

Other siblings have experienced no school difficulty. The eldest brother, aged 22, is studying architecture at a polytechnic in London.

Treatment on admission consisted of phenytoin, 100mg twice a day, with carbamazepine, 400mg twice a day. Blood levels of both drugs were within optimal range.

On examination, he was left-handed. He showed moderate gum hypertrophy he was myopic and had a mild degree of sustained, horizontal nystagmus to the left. Skull X-ray and computerised tomography were normal. EEG investigation (which included standard recording, sleep and sleep deprived recordings) showed diffuse slowing of basic rhythms and independent spike discharge in the right anterior to mid-temporal areas, that on the left tending to be more active. Further investigations failed to reveal the cause of the seizure disorder.

During admission carbamazepine was increased and phenytoin gradually discontinued with some improvement in seizure frequency. His behaviour also improved to some extent, but arrangements were made for him to attend a residential school for children with epilepsy following his discharge in November 1982.

Psychological Background

There is a large discrepancy between the I.Q. which N.G. attains on verbal and performance tests. In January 1981, the Wechsler Intelligence Scale for Children (Revised Version) was administered by Mrs B. Brighton, Educational Psychologist. The following results were obtained :

Verbal Tests	Age Scaled Score	Performance Tests	Age Scaled Score
Information	5	Picture Completion	10
Similarities	6	Block Design	15
Arithmetic	9	Coding	9
Comprehension	4	Mazes	10
(10 is an average subtest score, S.D. = 3, Range 1-19)			
Verbal IQ = 75		Performance IQ = 106	

N.G. was retested in September 1982, by Mr Ralph Burland, Chief Clinical Psychologist of the Park Hospital for Children, Oxford :

Verbal Tests	Age Scaled Score	Performance Tests	Age Scaled Score
Information	2	Picture Completion	10
Similarities	5	Picture Arrangement	8
Arithmetic	8	Block Design	16
Vocabulary	1	Object Assembly	14
Digit Span	9	Coding	7
Verbal IQ = 69		Performance IQ = 106	

A short WISC taken from the above,to give a more pure verbal-performance picture (Maxwell 1956) yields :

Similarities	5	Block Design	16
Vocabulary	1	Object Assembly	14
Verbal IQ = 59		Performance IQ = 135	

The poorest score on the WISC is for vocabulary. This deficit was confirmed by an age-scaled score of 6 years 10 months on the Peabody Picture Vocabulary Test.

A number of memory tests were also carried out by Mr Burland. The tests were part of the Baxter-Burland battery (unpublished) for which only norms for 8 year olds are available. The scores obtained are given in Table 11. The results indicate that the verbal/ non-verbal discrepancy apparent on the WISC scores is also present on memory tests. All of the verbal tests except digit span are performed at a level below that of an eight year old, a marked impairment for a thirteen year old boy. Digit span is consistently good. With the exception of recall of the Rey, performance on non-verbal tests is much better than on verbal tests.

Reading and spelling are also impaired, though in view of the verbal IQ scores, are not as poor as might have been anticipated :

Schonell Single Word Reading Age	11 years 6 months
Schonell Single Word Spelling Age	11 years 1 month
Neale Reading Age (Accuracy)	10 years 6 months
(Comprehension)	6 years 11 months

Reading and spelling are all at least a year and a half below age level. Reading comprehension is even more severely impaired.

Reading Words Aloud

1. Regularity Effects and Regularisation Errors

N.G. was presented with a list of 78 words constructed by Coltheart et al (1979). The words were presented individually for reading aloud. All 39 regular words were read correctly. Only 20 of the 39 irregular words were read correctly. This indicates a highly significant regularity effect, ($X^2 = 22$, $p < 0.001$), The errors were :

gauge	→ "gouge"	aunt	→ "ownt"/ɑɷnt/
steak	→ "steek"/stik/	debt	→ "debt"/dɛbt/
mortgage	→ "mortgage"/mɔtgeɪdz/	pint	→ "pint"/pɪnt/
move	→ "mowve"/moɷv/	lose	→ "lows"/loɷz/

	Mean for 8 year olds	N.G.'s score	Scaled score for 8 year olds (x=10,SD=3)	Interpretation in relation to 8 year level
VERBAL TASKS				
Recall of stories (immediate)	7	6	9	below
Recall of stories (delayed)	6	1	3	well below
Digit Span	5	8	13	above
Sentence Repetition	18	15	7	below
Paired Associate Learning	3	5 correct after 5 trials	-	well below
PERFORMANCE TASKS				
Rey figure (copy)	26-27	34	15	well above (at 70% ile for own age)
Rey figure (recall)	12-13	10	9	below (below 10%ile for own age)
Paired Faces Learning	3	2 trials	12	above
Faces Delayed Recognition	37	37	10	at 8 year level
Corsi Span	$4\frac{1}{2}$	8	16	well above
Benton Recognition	$6\frac{1}{2}$	10	16	well above

TABLE 11 N.G.'s memory scores and standard scores on the Baxter-Burland Battery (unpublished), in comparison to eight year old norms. (N.G. is thirteen)

prove → "prowv"/proʊv/	gross → "gross"/grɒs/
borough → "borrow"	thorough → "thorrow"/θɔroʊw/
sword → "sword"/swɔd/	bowl → "bowel"
trough → "trowf"/trɒʊf/	soul → "sowl"/sɒʊl/
subtle → "sub'tl"/sʌbtl/	sew → "sue"
circuit → "kircute"/kɔkjut/	

The errors to circuit, pint and aunt were self-corrected.

All of the errors, including the self-corrected errors, reflect valid grapheme-phoneme translations. That is, the translation would in some circumstances have been correct but, in the context of the particular words in question, were not appropriate. Most of these errors are errors of regularisation. Some regularisation involve the pronunciation of a silent letter : mortgage → /mɔtgedz/, subtle → /sʌbtl/, and debt → /dɛbt/. Some involve translation of the vowel in a more usual way : sew → "sue". lose → /loʊz/, move → /moʊv/, prove → /proʊv/, gross → /grɒs/, bowl → "bowel", soul → /sɒʊl/, steak → /stɪk/, pint → /pɪnt/. There are six errors which fall into neither of these categories. These six errors are valid but are not strictly regularisations. The error circuit → /kɔkjut/ is valid in that the grapheme c often takes the translation /k/. However, it is not a regularisation since when c is followed by i it is pronounced in softened form, /s/, as in city, cinema. Errors involving the cluster ough are not regularisations since there is no regular phonetic translation for this letter group. It may take one of many translations, e.g. rough, cough, thorough, through, bough, dough. The errors to words involving the cluster ough are valid since the translation chosen does occur in some words. Thus, with borough → "borrow" and thorough → /θɔroʊw/, the translation chosen is the

one which would have been correct if the stimulus had been dough. The error trough ⟶ /trɑʊf/"trowf" is an error in the translation of the vowel ou rather than the letter group ough. In other contexts N.G. always pronounces the vowel ou as /ɑʊ/. This error is valid given, for example,the word sour. Two further valid errors occur as the result of a vowel being pronounced as /ɑʊ/. In the errors gauge ⟶ "gouge" and aunt ⟶ /ɑʊnt/"ownt" the digraph au is pronounced /ɔʊ/. These are not regularisations as au is regularly pronounced /ɔ/. The usual effect of regularisation is to produce a neologism. Three of the errors which N.G. made to this list were words, but these paralexias seem merely a fortuitous result of the grapheme-phoneme rules employed.

The word list of Stanovich and Bauer (1978) was also presented to N.G. for reading aloud. Forty-eight of the fifty regular words were read correctly and twenty-eight of the irregular words were read correctly ($X^2 = 19.79$, $p<0.001$). The two errors on regular words were summit ⟶ "summit", a stress error and toll ⟶ /tɔl/. This second error is certainly valid, considering, for example, doll. Indeed,the classification of toll as a regular word may be open to question given the ambiguity of the cluster oll. Errors to irregular words were of a similar form to those made to irregular words on the Coltheart list ; that is, they were all valid:

aisle ⟶ "ais'le"/eɪzlə/	broad ⟶ "browed"/brɑʊd/
cafe ⟶ "cafe"/kɑf/	chaos ⟶ "chose"
chasm ⟶ "chasm"/tʃæsm/	cliche ⟶ "clitch"/clɪtʃ/
elite ⟶ "A.light"/eɪlaɪt/	gnaw ⟶ "ginaw"/gɔnɔ/
gone ⟶ "goan"/gɑʊn/	heir ⟶ "hair"
honour ⟶ "honor"/hɔnɒ/	iron ⟶ "i.ron"/ɪrɔn/
liquor ⟶ "liquor"/lɪkwɔ/	lose ⟶ "lows"
marine ⟶ "marign"/mɑræɪn/	ninth ⟶ "ninth"/nɪnθ/
plague ⟶ "plagyou"/pleɪgju/	sew ⟶ "sue"
sweat ⟶ "sweet"	sword ⟶ "sword"/swɔd/
tour ⟶ "tower	

Finally the regularity portion of Core 80 was presented. Eighteen of the twenty-six irregular words were read correctly and twenty-five of the twenty-six regular words. This difference is also statistically significant ($X^2 = 4.83$, $p<0.05$). The regularity effect is smaller here due to a ceiling effect. The regular word error was a stress error menace ---"menāce". The irregular word errors were :

shone → "shown"	image → image (stress error)
dumb → "dumb"/dʌmb/	deceit → "desite"/dəsaɪt/
mechanic → "mēchanic"(stress er.)	ration → "rayshon"/reɪʃən/
ambition → "ambItion"/æmbəʃn/	anchor → "ankor"/æŋkɔ/
influence → "influengk"/ɪnfluɛŋk/	

Once again all the errors are valid.

Five control children with both chronological and reading ages in the range 10.6-11.6 were also tested on the first two lists. Although all the children showed small trends in favour of regularity effects on both lists, none showed significant regularity effects on both lists. One child showed a significant regularity effect on the Coltheart list (38/39 regular, 29/39 irregular, $X^2=6.75$, $p<0.01$), but did not show a significant regularity effect on the Stanovich and Bauer list (43/50 regular, 41/50 irregular). Another child showed a significant regularity effect on Stanovich and Bauer (49/50 regular, 39/50 irregular, $X^2 = 7.67$, $p<0.01$) but did not show a regularity effect on the Coltheart list (36/39 regular, 34/39 irregular). The remaining children showed no significant effects. N.G. was significantly poorer than the control children at reading irregular words on both the Coltheart list ($X^2=8.48$, $p<0.01$) and the Stanovich and Bauer list ($X^2=9.52$, $p<0.01$).

Reading aloud : other aspects

It has been seen that N.G. reads regular words with good accuracy.

Are there limitations to this skill ? Can he, for example, read very long regular words ? With a reasonable degree of accuracy he seems to be able to do this. Thus at the fourteen and fifteen year old level on the Schonell test (the hardest words on this list) he can read correctly preferential, belligerent, procrastinate, adamant, statistics. Given the low vocabulary skills, one may assume that these words are meaningless to him. N.G. was also asked to read aloud the 20 words on Nelson's Regular word list (Nelson and O'Connel 1978). These words are all 9-14 letters in length. They are of declining frequency. N.G.'s performance was very good:

adventurously → ✓
individual → "invidual"/ɪnvɪdjuəl/
uninterested → ✓
experimenter → ✓
apprehensive → ✓
indiscoverable → ✓
manufactured → ✓
organisation → "organis...ations...arganations" /ɔgənɛɪʃənz/
masterpiece → ✓
chitterling → ✓
herpetology → "herpetrology"/həpɛtrɒlɔdzɛɪ/
fleeringly → ✓
huckaback → ✓
intertergal → ✓
tipularian → "tipulian"/tɪpɷləæn/
gressorial → "gressorian"/grɛsoɷrəæn/
pegmatic → ✓
hectographic → ✓
shibboleth → ✓

Three errors, those to tipularian, organisations and individual, involve the omission of a syllable. In reading organisations the syllable appears to have dropped out near the end of the reading

process as it was heard, by the examiner, before the segments were blended together. The only other uncorrected error, that to gressorial, involves the mistranslation of one letter, the terminal letter. This error may have had a perseverative aspect as the previous word tipularian ended in ian. The errors on this word list are the first invalid errors that N.G. was observed to make. They may well have arisen as a result of the length of the stimuli involved.

Given the good performance reading words, one would predict that N.G. would perform well reading non-words. He was asked to read aloud the balanced words and non-words on the Coltheart list. These stimuli were listed earlier. All of the twenty-five words were read correctly and all of the non-words were also read correctly, except for doy which was read as "boy". Thus N.G.'s performance reading non-words is extremely good, and is no worse than his ability to read matched words.

Spelling

On the Schonell graded word spelling test N.G. attained an age scaled score of 11 years 1 month, which is two years below his chronological age level. His spelling errors indicate an excellent mastery of phonics, for nearly all are phonologically valid. N.G. was presented with 78 of the words on the Temple list for spelling to dictation. He was also presented with fifty of the words on the Schonell test for spelling to dictation. Of the 128 words, 88 were spelt correctly and there were 40 errors. The words spelt correctly were : time, call, help, week, pie, sight, mouth, large, might, brought, yoke, island, join, fare, iron, health, direct, headache, final, circus, increase, slippery, lodge, copies, guest, library, safely, patient, account, earliest, orchestra, bat, large, kiss, nation, shiver, anchor, at, scorn, talk, child, came, fire, mug,

chemist, jelly, shady, invitation, knob, naughty, peach, gentle, night, corner, mop, both, enjoy, that, school, engine, jewel, audience, worth, then, shiny, rip, orchestra, adjective, record, short, moth, fancy, thunder, nothing, they, strange, wine, design, ought, mate, cheat, join, fight, chapter, nip, hide, station, and clear. Thirty-four of the errors were phonologically valid (85%):

"solemn" → solumn	"weigh" → we
"instance" → instunce	"chorus" → courus
"variation" → viriation	"confess" → conffess
"mattress" → matress	"injure" → injur
"essay" → essey	"source" → saurce
"relation" → rilation	"doubt" → doute
"stomach" → stomache	"debt" → dett
"ration" → rashon	"whistle" → wistle
"deceit" → deceat	"honesty" → onestie
"nerve" → nurve	"calm" → carm
"style" → stile	"bargain" → bargin
"cushion" → cusion	"view" → vue
"similar" → simmelar	"generous" → generos
"equally" → equaly	"individual" → indivigiol
"merely" → mirrly	"appreciate" → aprisiate
"source" → saurce	"immediate" → imediate
"breathe" → breath	"recent" → riscent

The remaining six errors were not phonologically valid :

"policy" → polyusy	"institution" → instision
"familiar" → forimiar	"enthusiastic" → imfusiastic
"mass" → mask	"brother" → rather

The latter two errors are paragraphias.

Since so few spelling errors were phonologically invalid it was anticipated that spelling of non-words would be very good. This was

found to be true. Spelling of four-, five-, and six-letter nonsense words was perfect. Since no error was found at all on this task, the word spelling data was re-examined to observe whether the 6 spelling errors that were not phonological had been made to long words. The trend seemed in favour of this hypothesis. As a fraction of the number of words of each length presented the six errors were distributed as follows : two-letter 0/1, three-letter 0/6, four-letter 1/26, five-letter 0/29, six-letter 1/24, seven-letter 1/23, eight-letter 1/10, nine-letter 0/5, ten-letter 0/3, eleven-letter 1/1, twelve-letter 1/1.

Regularity and length thus appear to affect spelling ability.

Homophone Confusion

Twenty homophonic word pairs, described earlier, were randomly ordered and individually presented for reading aloud. All forty words were read correctly. After reading aloud each word, N.G. was asked what it meant. Twenty-two of the words were defined correctly. Eleven of the words were defined as their respective homophones :

steal → "something metal"
stair → "keep on looking at someone"
steel → "nick something"
current → "a fruit"
dye → "you're dead"
flew → "you sneeze"
bye → "you're sitting by something"
aloud → "you can do it, you are allowed to do it"
dear → "animal"
throne → "you threw something"
board → "not pleased or happy"

Two of these eleven errors were self-corrected : dear → "an animal ....no..... it means dear Fred, how are you and all that" ; flew → "you sneeze.....no.....you're flying". This performance indicates

significant homophone confusion ($X^2 = 10.91$, $p < 0.01$). Five words produced the response "don't know", when a meaning was requested : groan, rowed, tire, hare, and cheep. The final two errors were to the words heal and heel. Although both were read correctly, they were both glossed as "standing on your knees". Presumably there was confusion for N.G., between heel and kneel.

The same forty words were presented in random order for written spelling. They were spoken aloud, by the examiner. After each word , a definition was given so that the meaning was clear. There were eleven errors. Ten of these errors resulted from spelling a homophonic word.

"heal, the doctor helps to heal the sick" → heel
"rows, all the rows were full of people" → rose
"aloud, the old man spoke his thoughts aloud" → allowed
"rowed, John rowed the boat along the river " → rode
"dye, Martha used to dye her hair red" → die
"heel, I got a blister on my heel" → heal
"currant, I love black currant jelly" → current
"peace, at the end of the war there was peace" → piece
"mail, she sent the letter by air mail" → male
"heal, the doctor's job is to heal the sick" → heel
"groan, his sore head made him groan" → grown

The final error was "flu, I stayed in bed because I had flu" → flue.

Since there were eleven homophonic errors in the reading definitions and ten homophonic errors in the spelling task , the error data were examined to see whether the same words had been affected. However, for only one word, dye, was a homophonic error made on both tasks, and for one homophonic pair an error was made to one of the pair on each task : current (reading) and "currant" (spelling).

Comprehension

N.G.'s ability to read aloud is superior to his ability to comprehend written material. In this, he resembles the children with hyperlexia, first described by Silverberg and Silverberg (1967). It has been shown that N.G. confuses homophones but this does not account for the comprehension deficit. Although for accuracy, he attains a reading age of 10 years 6 months on the Neale Analysis of reading ability, his comprehension score is only 6 years 11 months. For some children, the ability to use context to aid their reading means that they attain accuracy reading ages on the Neale which are a few months higher than those obtained on the Schonell. This is because the Neale is a test of text reading, whereas the Schonell is a single word reading task. In N.G.'s case, his Neale reading score is seven months below his Schonell score. On these tests context does not appear to aid him. Although there was little comprehension of the material read in the Neale intelligent guesses were sometimes made.

The first story on the Neale is about a little boy and a Robin. When asked with respect to the first story, "What did the little boy give the robin ?", N.G. who should have replied "some bread", instead replied "some weeds". In the second story, two children are sent some presents. The final question about this passage is "Why were the children so pleased to receive these presents?" The correct answer is "they were what the children had wanted for a long time." N.G. replied "because it was his birthday". The guess also reflects an auditory comprehension problem, since the questions were addressed in the plural and answered in the singular. Deficits in auditory comprehension became more apparent as the stories progressed. Thus, for example, in a later story about a school sports' day, the question "Why was her team so keen to win ?", was answered as "they were lazy".

It was decided to investigate further the deficit in auditory

comprehension. N.G. was given Dr Dorothy Bishop's TROG (Test of the Reception of Grammar) test. In this test the child is required to listen to a phrase or sentence. The child must then point , in a choice of four pictures, to the picture which is considered to represent the sentence just heard. The test assesses the child's ability to comprehend for example, singular and plural nouns and pronouns, active and passive verbs, and prepositions. In the section assessing the comprehension of the prepositions in and on, one of the test sentences is "The pencil is on the box". The four-choice pictures show a picture of a pencil on a box, a pencil in a box, a pencil beside a box, and a box on a pencil. On TROG, N.G. performed at the level of an eight-year old. There was difficulty with the construction "not only.....but also". For example, for the sentence "the box is not only big but also blue", N.G. picked a small blue box. A similar difficult was found in " "neither.....nor" constructions. Four test sentences are of the form "the pencil is on the book that is yellow". In each case N.G. assigned the final adjective to the first noun instead of to the second. This would have been correct with the same words in a slightly different order : " the pencil that is on the book is yellow". The consistency of N.G.'s performance on these four items shows that his performance is not random but rule-governed, although the wrong rule has been applied.

Performance on the Neale has shown a deficit in reading comprehension and indicated an auditory comprehension deficit on questions. The TROG results indicate a further deficit in grammatical comprehension. How does the level of comprehension of written material compare with the level of comprehension of spoken material ? In order to answer this question, performance on the Peabody Picture Vocabulary Test , given in spoken form, was compared with the performance when the stimulus items were presented individually, typed on cards, to be read silently by

N.G. When presented in spoken form, an age scaled score of 6 years 10 months was attained. When presented on typed cards an age score of 7 years 6 months was attained. Thus, although N.G. has impaired reading comprehension, his reading comprehension is at least as good as his auditory comprehension.

Summary

Background

N.G. is a thirteen year old boy who suffers from epilepsy. He is left handed. There is a marked discrepancy between his verbal and performance I.Q. In addition to a poor verbal I.Q., verbal memory is severely impaired.

Reading

1. Spelling-to-sound regularity is a significant factor affecting his ability to read aloud.
2. Almost all errors are valid.
3. Visual paralexias are absent, as are semantic, visuo-semantic and derivational paralexias.
4. Even long unfamiliar regular words are read with good accuracy.
5. Non-word reading is excellent.

Spelling

1. The majority of spelling errors are phonologically valid.
2. Spelling of non-words is very good.

Homophone Confusion

There is considerable confusion in the comprehension of homophones.

Comprehension

Both aural and reading comprehension are severly impaired.

DISCUSSION
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Developmental Surface Dyslexia ?

Extensive data has been presented on two developmental cases of reading disorder : R.B. and N.G. If one examines the integral characteristics laid out in the introduction it can be seen that both cases display all the features of surface dyslexia. That is, they are more likely to read correctly regular words than irregular words. Incorrect readings of regular words are often regularisations. Many other reading errors are valid. Semantic and derivational errors are effectively absent. Non-word reading is not impaired in relation to word reading. It is also markedly better than in previously reported cases of developmental surface dyslexia. There is homophone confusion. Phonological spelling is exhibited. It is thus justifiable to call both cases developmental surface dyslexia.

One may then examine the explanatory models postulated for acquired surface dyslexia and determine whether any of them can provide adequate explanations of the developmental phonomenom.

In principle, each model could account for developmental surface dyslexia at least as well as it can account for acquired surface dyslexia, if one posits specific failures of development rather than impairments.

Thus, in Marshall and Newcombe's terms the developmental surface dyslexic may have a partial failure to establish " grapheme-phoneme correspondence rules". In addition, there is a failure in the development of visual word representations. In Shallice and Warrington's terms, the developmental surface dyslexic is using small orthographic units as a basis for processing in the phonological route and has failed to develop the ability to process larger segments. In Marcel's terms, orthographic specification of the input logogens for some words have not

been aquired, fewer, that is, than in the case of normal beginning raeders. Additionally, a strategy of word production (rather than neologism) is operant so that the responses is meaningful to the child.

However, it is clear that the reading performance of R.B. is also very different from the reading performance of N.G. Just as there is variability amongst cases of acquired surface dyslexia, so there is similar variability amongst cases of developmental surface dyslexia. The models outlined in the introduction do little to account for this variability. One reason for this is that, in many cases of surface dyslexia, both developmental and acquired, the phonological route is itself functioning in an imperfect way.

Only Shallice and Warrington specify a mechanism, for such impairment, suggesting that the units upon which correspondences are based may be reduced. This does not account for the crucial difference between R.B. and N.G. which lies in the incidence of invalid errors made by the two subjects. Marcel's strategy of word production could account for an increased incidence of invalidity for R.B., if her invalid errors were all the result of an increased amount of paralexic response. But her invalid errors are also marked when neologisms are produced. Both R.B. and N.G. also show sporadic errors where segments appear to drop out of words or are missequenced. None of the models described posit a mechanism for these omission and sequencing errors.

An expanded model of the reading system will therefore be proposed in order to explain some of the variation in the syndrome of surface dyslexia.

An expansion of the representation of the phonological route

A new view of the phonological route is incorporated in the model presented in figure 5 . When a word is read by this phonological route

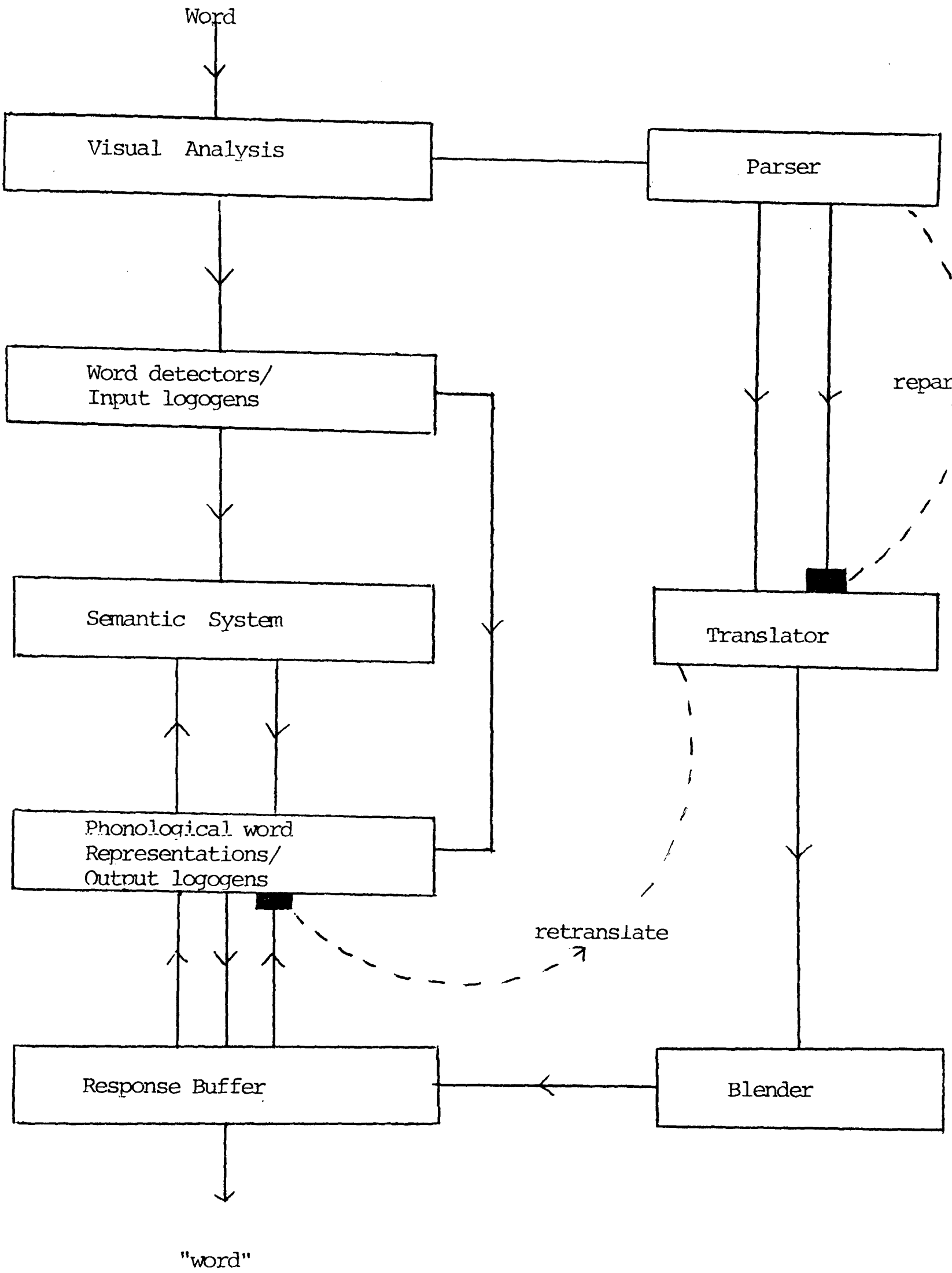

Figure 5

An amended model of reading

the following process is envisaged. After peripheral visual analysis the letter string is input to the parser. The parser is responsible for segmenting the word into orthographic units or chunks. Coltheart(1978) has described a system of graphemic parsing based upon Venezky's analysis of English orthography (Venezky 1970).In this system, a string of letters is converted into a string of graphemes where "grapheme" is defined as the written representation of a single phoneme. This definition of grapheme will also apply here. Thus the correct graphemic parsing of sheep is :

sheep $\longrightarrow$ <sh> + <ee> + <p>

The system of chunking envisaged here differs from graphemic parsing in that chunks may be larger than graphemes. A "chunk" is defined as the written representation of p phonemes where $0 < p \leqslant N$, and N is the number of phonemes in a word.

Thus, for example, :

station $\longrightarrow$ <st> + <a> + <tion>

A word may be parsed in a number of different ways. The preferred parsing will depend upon the experience of the reader. As contact with the printed word increases more extensive parsing rules are internalised. A young beginnning reader will tend to parse into smaller chunks than an experienced adult reader. The smallest chunk size is the single letter. A fluent adult reader may be able to use polygraphemic chunks. The reader will initially parse into the largest chunks that his system can deal with. An extreme version of this hypothesis would be that a fluent adult reader could use morphemic chunks and that, thus, the direct route could be incorporated into the phonological route rather than existing as a distinct entity. Indeed Shallice and Warrington (1980) do abandon the direct route on grounds similar to those here argued for. However, the expansion of the phonological route envisaged here does not necessitate such action and in the

current model the direct route will be left as a separate mechanism. It will be assumed in the discussions that follow that the phonological route cannot process whole words. If it could, the definition of chunk would have to alter, so that $0 < p < N$.

After parsing of the letter string, the chunks are input to the translator. The translator differs from previous representations not only in that it can translate chunks of larger size, but also in that it has multiple potential translations. A number of different phonological forms can be assigned to any one orthographic chunk. Thus, just as the translator of languages may have a variety of different alternatives from which to select his preferred equivalent, so the translator of chunks may have alternatives from which to choose. Once again, experience will affect this system.The fluent reader will have more alternatives to choose from than the beginner. Readers of English will have more alternatives to choose from,than readers of Italian. All the alternatives, from which the selection is to be made, are valid,in the sense that such a translation would be appropriate for some word in the language. The alternatives are graded. That of highest token frequency is most likely to be tried first. If this does not work, the next most frequent may be tried. Thus the translation ch $\longrightarrow$ /tʃ/ is more probable than the translation ch $\longrightarrow$ /k/. When dealing with a chunk like oll both /ɔl/ and /oʊl/ are probable translations. Recent prior activation will increase the probability that a particular translation will be selected. This would account for the findings of Kay and Marcel (1981) who observed that in reading a list of stimuli the pronunciation of a vowel in a non-word was affected by the way that vowel was pronounced in a word, which had been read immediately previously.

The phonological segments that are selected pass to the blender where they are combined and a phonological output emerges.

Two feedback loops act as checks upon the system. Firstly, if the translator has no representation to translate a chunk it had been sent, a feedback demand will be made for reparsing. The word will then be reparsed into smaller chunks. Secondly, if after blending, the output is not a word, a feedback system may again demand retranslation. The blended phonological output is held in the response buffer while a check is made in the phonological word representations to see if there is a matching word. If there is no match, there is a feedback demand to the translator. A properly functioning highly developed system is likely to demand more retranslations then an impaired or poorly developed system. Such a feedback system enables the alternative translations available to the translator to be employed in sequence and enables appropriate output selection. Thus, for example, if

$$\underline{\text{pint}} \xrightarrow[\text{parser}]{} \langle p\rangle + \langle int\rangle \xrightarrow[\text{translator}]{} /p/ + /ɪnt/ \xrightarrow[\text{blender}]{} /pɪnt/$$

then, there will be no match in the phonological word representations for /pɪnt/. A retranslation demand will ensure ; i.e., there is a lexical checking system. Some retranslation demands are clearly under cognitive control. If the stimulus is short and there is confidence in the response, or the subject is told that the stimulus is a non-word, then there may be no retranslation demand and a neologism may be produced.

To illustrate the system and its limitations, the reading of three irregular words : deaf, dread, and bread will be outlined.The system cannot process the word deaf in unity. The first parsing is into the largest (sub-word) chunk possible.

1. $\underline{\text{deaf}} \longrightarrow \langle d\rangle + \langle eaf\rangle \longrightarrow$ "no translation" $\longrightarrow$ REPARSE

2. $\underline{\text{deaf}} \longrightarrow \underset{\text{parser}}{\langle d\rangle + \langle ea\rangle + \langle f\rangle} \longrightarrow \underset{\text{translator}}{/d/ + /i/ + /f/} \longrightarrow \underset{\text{blender}}{/dif/}$

$\longrightarrow$ "no word" $\underset{\text{check}}{\longrightarrow}$ RETRANSLATE

3. deaf → <d> + <ea> + <f> → /d/ + /ɛ/ + /f/ → /dɛf/
parser translator blender

→ "O.K." → "deaf"
lexical check

Deaf is a difficult word for the system to cope with. It will only be read correctly if the system is sufficiently developed that the alternative translation ea → /ɛ/, which occurs in about sixty words, has been internally coded.

1. dread → <dr> + <ead> → ?

bread →
 + <ead> → ?

The translation of the letter combination ead poses a problem for the translator since it may take a translation as in : mead, bead, lead and plead, or as in head, dead, instead, dread, thread. If the translation /ɛd/ is chosen in dread the lexical check system should detect that the output is not a word and demand a correct retranslation. However, if the translation /id/ is chosen in bread the lexical check system will detect no difficulty as "breed" is a word. Bread may then be misread as "breed". If dread is being read in a mixed list of words and non-words, then misreading may occur since the lexical check system will be (strategically) inoperative. Thus the system envisaged can read a number of irregular words that cannot be read by the phonological reading route of Coltheart. However, words like bread will still have a high risk of being read incorrectly by the system and words like yacht will never be read correctly by it.

Different malfunctions in the system will produce different symptoms of disorder. When the parser is not functioning properly but the rest of the system is intact, one may see an error of the sort cheat → /kəhɛɐt/, i.e. cheat → <c> + <h> + <e> + <a> + <t> instead of cheat → <ch> + <ea> + <t> or station → /steɪtəɔn/ (i.e. <st> + <a> + <t> + <i) + <on>), instead of station → <st> + <a> + <tion> These types of errors will be called chunking errors. The first is

also an error of graphemic parsing. The second is a failure to parse into a chunk larger than a grapheme. When the translator is not functioning properly two different types of error may result. If the ability to utilise alternatives or the ability to correctly select between alternatives is lost, one may get an error of the sort low $\longrightarrow$/lɔʊ/. This type of error will be called a valid translation error. Many, but not all, of these errors will be regularisations. If, alternatively, the malfunction of the translator produces mismatches between chunks and phonological segments one may get errors of the sort table $\longrightarrow$ "pable". This error will be called an invalid translation error. These errors will often produce non-words. Other researchers heve interpreted these errors as resulting from an earlier processing stage. It is clear that if a misparsing has occurred and the translator is intact, valid translation errors will nevertheless result. All parsing errors produce mistranslations. But mistranslations may also occur in the absense of a misparsing. Thus, for example, the error cheat $\longrightarrow$ /kəhɛɹt/ is a parsing error which produces a resultant valid mistranslation. In contrast, the error rough $\longrightarrow$ /rʊ/ is a valid translation error which has not resulted from a misparsing : Rough $\longrightarrow$ <r> + <ough> the correct parsing. This is the correct parsing since it contains the largest chunks below the level of the whole word, for which translations are available. However, the selected value of translation for ough is inappropriate, but not invalid (c.f. ough in dough).

The most probable type of error to result from malfunction of the blender is the omission or repetition of one of the phonological segments. The blender is more likely to have difficulty with long series of segments than with short. This is , no doubt, a simplification and a malfunctioning blender is capable of more severe perturbations, but for the moment, these will be ignored. It is a theoretical possibility

that omissions also occur in the parsing process. This is clearly an empirical issue but omission errors are restricted to the blender here because of the observation in both children and adults that surface dyslexics can be heard to systematically sound out detached parts of a word. Yet, when attempting to blend them into a word, chunks seem to disappear from the output. It may be that a poor short term memory reduces the efficiency of the blender.

Surface dyslexics may thus vary on at least four dimensions : in their chunking skills ; in their ability to choose from multiple valid translations ; in their ability to use only valid translations ; and in their ability to blend.

Interpretation of Aquired Surface Dyselxia

Having outlined a modified model of reading, one may now determine the extent to which it can account for the variability in the adult patients.

M.S. (Newcombe and Marshall 1984,thesis p 37) no longer retains even the most fundamental chunking skills. Parsing is at a single letter level. Even the digraphs th and sh have been lost. He never reads th as /θ/ or /ð/ and he never reads sh as /ʃ/ . Thus we find errors:

these → "tihessey"/təhɛseɹ/
them → "tihem"/təhɛm/
either → "e-it-her"/ɛ/-/ɹthə/
shone → "sihonney"/sə/-/hɒneɹ/

Almost invariably, each grapheme in a double consonant is assigned its own phonological translation. Thus we find errors :

press → "piresisi"/pərɛsəsə/
mattress → "mate tir esisi"/meɹt/-/tə/-/ɛsəsə/

There are a few exceptions, e.g. doll ⟶ /dɔl/ and toll ⟶ /tɔl/.

Having parsed at the single letter level, M.S. almost always assigns a valid translation. However, even where the single letter parsing is correct, valid translation errors may be produced when vowels are involved. M.S. has difficulty determining whether the translation of a vowel should be long or short. Thus we find :

hid	⟶	"hid" or "hide"
mop	⟶	"mop" or "mope"
rip	⟶	"ripe" or "rip"

Only one type of invalid translation error now occurs. B-d confusion was present : but a recent mnemonic taught by Dr Freda Newcombe to the patient seems to have been largely effective in eliminating these errors. Previously such responses occurred as :

debt	⟶	"bedit" /bɛdɔt/
	or ⟶	"debit" /dɛbɔt/
knob	⟶	"kinobby"/kɔnɒbeɪ/
	or ⟶	"kinoddy"/kɔnɒdeɪ/

The invalid translations that remain occur as the result of the use of letter names. Thus we find :

cold	⟶	"C....old" /siˑ/-/oʊld/
clue	⟶	"C....louis" /siˑ/-/luiˑ/
mimic	⟶	"mimi....C" /mɪmɪsiˑ/

It is clear from a number of the above examples that M.S. also tends to insert schwas into consonant clusters. Some of these are presumed to be produced as a result of limitations of the vowel tract, which cannot

utter some digraphs without schwas, e.g. bt in debt.

To summarise, M.S. is a surface dyslexic with very extensive impairment in the semantic and direct routes. His primary disorder in the phonological route is an inability to parse into chunks, he can only parse at a single letter level. In addition, he makes invalid translation errors resulting from the use of letter names.

The patient of Bub (1984, see also p36) has a parser which functions at a much higher level than that of M.S. Nearly all the errors made by Bub's patient are valid errors. Bub cites five errors to irregular words , made by M.P. The mechanism by which these could arise in the current model is outlined as follows:

1. character ⟶ "tcharakter"/tʃærəktɔr/

This error results from the selection of the value /tʃ/ for the digraph ch rather than the less frequent /k/. The error is thus a classical regularisation. By definition, it is also valid. In terms of the current model there is a failure in the lexical checking system when a neologistic response is produced.

2. pour ⟶ "power"

pour —parser⟶ <p> + <our>

—translator⟶ /p/ + /ɑʊɔ/

—blender⟶ /pɔʊɔ/

—lexical check⟶ "O.K., a word"

⟶ "power"

A correct parsing for pour has taken place. The most frequent translation for our is selected. In this case the blended output is a word and so the lexical checking system does not detect the error. Thus, this error does not indicate any impairment in the phonological route. A perfectly functioning phonological route could produce this error, which is also a classical regularisation.

3. bowl ⟶ "bowel" This error results, once more, from the selection of a more common translation for part of the word segment. ow is regularly translated /aʊ/, as in cow, how, crowd. The translation may also have been based on the larger orthographic unit owl, since the regular pronunciation of owl is /aʊl/ , as in owl, fowl, growl, cowl, and howl. The lexical check system indicates that this is a word and it is output.

4 bead ⟶ "bed"

This error is not a classical regularisation and it cannot be accounted for in terms of the functioning of the phonological route postulated by Marshall and Newcombe. It is an irregularisation in Masterson's terms (1983) or, in the terms used here, a valid error. bead is parsed into <b> + <ead>. The translation for ead is that which occurs in head, dead, dread, and bread. Of the sixty words in which the translation ea ⟶ /ɛ/ occurs, one third are words ending in ead (Wijk1966), but it is not the most common translation of ead The error therefore reflects an impairment in the selection of the appropriate valid response in the translator.

5. blood ⟶ "blued"/blʊd/ This error is also a classical regularisation and valid, since the most frequent translation of ood is /ʊd/. But once again as there is a neologism produced the lexical check system must have failed.

M.P. is able to read a good number of irregular words correctly. Some of these may be read by the phonological route outlined above but a number must be read by the direct route from visual word representations to oral word representations. Although Shallice and Warrington (1980) abandon this route altogether, it is difficult to see how any phonological route could read a word like one, for example, which is read correctly by M.P. This highly irregular word is extremely unlikely to have a correspondence for itself alone, in the phonological system. Since Bub's patient has a profoundly impaired

semantic route, the direct route must exist in addition to the phonological route.

Thus Bub's patient reads in part by a partially preserved direct route and in part by a well preserved phonological route. There may be some impairment in the lexical checking system and a mild impairment in the process of selection from valid translations, but the phonological system functions with remarkable efficiency.

The more unusual cases of acquired surface dyslexia are thus explicable within the current model. But what of J.C., the first and more usual type of surface dyslexic , who makes many invalid errors ? J.C.'s chunking skills are less well developed than those of M.P. but are the single letter level of M.S. J.C. is able to process the digraphs th, ch, and sh. The letter g tends not to be parsed with the following vowel and is translated in hardened form, e.g. image → /ɪmæg/, digest → /dɪgɛst/. The letter combination tion is rarely parsed as one chunk and translated /ʃən/. The translation /tɒn/ is frequent, e.g. nation → "naton" /neɪtɒn/, portion → "porton" /poəʃtɒn/, motion → "moton"/mɒtɒn/. Both valid and invalid errors are plentiful, e.g.

shiny → /ʃɪneɪ/		purchase → /pɔsdz/	
shady → /ʃædeɪ/		strange → /stɛrɪdz/	
choir → /tʃoəʃ/			

Marcel (1980) pointed out that, for J.C., the phonetic values given to graphemes are often inconsistent from one word to the next. The current model can account for this by proposing that the mechanism in the translator which enables the correct selection between valid alternatives has been lost. Selection becomes, to an extent, random and inconsistencies result. Marcel also noted that omissions of

syllables (e.g. banishment ⟶ "banment"/bænmɔnt/), and of single letter realisations (e.g. guest ⟶ "just") may occur. These may be accounted for in the current model by positing a blender impairment that produces loss of phonological segments during blending.

A number of more severe perturbations are found in paralexic responses. There are two possible explanations within the current model. Many paralexic responses may not result from processing within the phonological route at all ; rather they may result from imperfect analysis in the partially preserved direct and semantic routes. Even in the severe case of M.S. some sight vocabulary remains and thus there is partially preserved processing capacity in these routes. Alternatively, the stimulus may be processed via the phonological route and a neologistic output obtained. If the system of feedback for retranslation is impaired and yet J.C. knows that he is seeking a word not a neologism, he may use the neologistic phonological information to access an entry with some similarity to phonological word representations. Since most paralexic responses are more similar to the original stimulus in the first few letters than in the last, it may be that selection is based on the initial rather than the terminal sounds. The system is in some ways similar to Marcel's "strategy".

Even when responses are neologistic there are occasions when phonemes or phoneme clusters appear to be added to the stimulus. To account for these errors one must clarify the range of invalid errors that are possible. That is, invalid errors may produce a phonological output inappropriate to the chunk size of the input, e.g.

strange	⟶ ⟨st⟩ + ⟨r⟩ + ⟨ange⟩	parser
	⟶ /ste/ + /r/ + /ɹdz/	translator
	⟶ /sterɹdz/	blender

Alternatively , or additionally one might wish to posit a further way in which the translator may malfunction. Specifically, it may

occasionally output a phoneme or phoneme cluster which should not be activated, e.g. :

<u>strange</u> ⟶ ⟨sr⟩ + ⟨r⟩ + ⟨ange⟩ parser
⟶ /st/ + /e/ + /r/ + /ɪdz/
⟶ /sterɪdz/

Certain circumstances might make these interjections more probable. Thus, the occurrence of a consonant cluster might increase the possibility of an interjected vowel.

J.C., then, has fairly widespread impairment of the phonological route that affects parser, translator, blender and lexical checker.

The other variation in acquired surface dyslexia is in the type of comprehension which occurs when errors are made. This variation is accounted for,not by any difference in the phonological route, but by the site of functional impairment in the semantic route. A "lesion" that was pre-semantics would account for the comprehension of patients , like J.C., who base comprehension of the written word on their spoken output. A "lesion" post semantics would account for patients in whom comprehension is always based on the written input regardless of their responses. (Such 'pure' patients have not yet been observed). For the patients B.F. and E.S.T. (see p 38), whose comprehension is sporadically based on the written word despite erroneous responses, one must posit two impairments in the semantic route : one pre-semantic and one post-semantic. It would be necessary to collect more comprehension data on these patients to determine whether these impairments are word specific of simply perturb the system independent of specific stimuli.

Interpretation of Developmental Surface Dyslexia

The cases of developmental surface dyslexia may also be explained in terms of the expanded model.

R.B. shows fairly widespread impairment, similar in some ways to J.C. If one examines her neologistic responses (listed on p51 and 55), which, one assumes, result from the phonological route, one sees instances of parsing errors. For example :

1. engine ⟶ "engine"/ɛngaɪn/ may be interpreted as a parsing error. In order for g to be pronounced in softened form as /dz/ rather than as/g/ it should have been parsed with the i that follows it. Parsing at too small a unit level could produce the above response.

2. ashamed ⟶ "as.hammed"/æshæmɔd/

The letters s and h should have been parsed together as one unit sh. Separate parsing produces the two sounds /s/ and /h/ rather than the combined /ʃ/. The pronunciation of the a in shortened form as /æ/ (rather than as /e/) also results from a misparsing. The a should have been parsed with the unit that contains the following e, so that a lengthened translation would occur. Since the e is parsed separately it receives its own phonetic translation /ə/.

3. teach ⟶ "tee.atch"/tiætʃ/

A misparsing produces separate sounds for the e and the a. teach should have been parsed as<t> + <ea> + <ch ◇but was in fact parsed as <t> + <e> + <a> + <ch>

4. A similar misparsing of the vowel occurs in the error float ⟶ "flow.at"/floæt/, where the o and a have failed to be parsed together.

5. A misparsing at a level above the grapheme is exemplifies in the error nation ⟶ /nætɒn/ "natton". The grapheme segment tion should have been parsed as one chunk. Parsing at a lower level means that, instead of the translation /ʃən/, there is a translation /tɒn/. This response also contains a valid translation error, where the a is translated as /æ/ instead of /e/.

6. Another example of failure to parse into chunks above the grapheme is seen in the error belief ⟶ "belife"/bɛlaɪf/. The most common

pronunciation of ief is /if/, as in brief, chief, relief, grief, and thief. This translation of ie is also common when the f is not present, e.g. field, priest, piece, shield. However, equally common when the f is absent is the pronunciation /aɪ/, as in die, lied, pie, skies, tie. If belief had been parsed <be> + <l> + <ief> then the only pronunciation which could have been selected for ief would have been /if/. But , if parsing has taken place at a lower level, so that belief ⟶ <be> + <l> + <ie> + <f>, then the translation of ie as /aɪ/ is highly probable and the resultant error can occur.

It is clear that, in terms of the model, R.B. has a poorly developed parser. It is however, functioning at a level above the single letter, since sh, ch, th etc. can usually be read correctly, it is also capable of functioning at a level above the grapheme since, for example, the letter string tion is often read correctly.

In addition to an incompletely developed parser R.B. has an incompletely developed translator. The number of invalid errors indicates that there are often mismatches between orthographic chunks and phonological segments. There are also a substantial number of valid errors, indicating that a system of potential translation from orthographic chunk to phonological segment has developed. In many cases the most frequent and regular pronunciation of an orthographic chunk is the one which is selected so that classical regularisations occur :

liquor ⟶ "liquor" /lɪkwɒr/
sword ⟶ "sword" /swɔd/
shove ⟶ "showv" /ʃoɷv/

Many of the other valid errors are not classical regularisations but, in terms of the model, they utilise correspondences which may

appear in the phonological route. There is simply an impairment in the ability to select the appropriate target translation, e.g. :

blast ⟶ "blaste" /blest/, with a translated as in cake, station, chamber, danger, haste, bass, Cambridge.

break ⟶ "brek" /brɛk/ , with ea as in dread, dead, bread, health, pleasant, sweat, breath, feather, heaven, meant, weapon.

Blender errors were defined in the model as those in which a segment had disappeared or has been missequenced. It was noted in the translation of R.B.'s errors that a number of them result from missequencing (see p 53), e.g.

refresh ⟶	"refersh"/rəfəʃ/	aunt ⟶	"anut"/ænʌt/
marine ⟶	"armin"/ɑmɪn/	north ⟶	"nothir"/nɒθɚ/

It would appear, though, that for R.B. some missequencing errors occur at a processing stage prior to blending. In the error :

align ⟶ "aling" /əlɪŋ/

the assignment of the corresponding phonological segment has occurred after the missequencing, not before. One may conclude that missequencing may occur at an early stage, although the model provides another explanation. A parsing of align ⟶ ⟨al⟩ + ⟨ign⟩ might produce a segment ign which is sufficiently similar to ing to activate its translation if the translator is not perfectly developed. That is, the imperfectly developed translator may accept minor deviations in some of its stimuli and still activate entries.

R.B. makes very few errors where orthographic or phonological segments appear to have been deleted.

Thus, R.B. exhibits developmental failure in the parser, where unit size of analysis is often too small; in the translator where

where mismatches may produce invalid errors ; in the translator where inappropriate selection from valid alternatives results in valid errors; and in the blender where sequencing errors occur. In addition, the large number of neologistic responses suggests an impoverished lexical check system.

The case of N.G.

The case of N.G. is much simpler to explain in terms of the model. Looking at the different component stages, it is clear that his impairment is much less widespread than R.B.'s. Parsing errors are rare, although they do occur occasionally. In the error circuit → "kir.cute", the c should have been parsed with the following i so as not to be translated in hardened form. In the error trough → /trɑʊf/, the ough should have been parsed as one chunk, whereas the vowel was parsed as a chunk ou and processed seperately as /ɑʊ/. These parsing errors result in valid translation errors but most of the valid translation errors are not attributable to an earlier parsing defect. The almost total absense of invalid translation errors indicates that N.G.'s translator has developed to a much higher degree of competence than R.B.'s, the association between orthographic chunks and phonological segments has been well encoded.

Given that N.G.'s errors are comparatively rare, occurring only to irregular words of low frequency, one must decide whether or not the valid translation errors reflect a developmental failure in the phonological route. The upper limit of the functioning of the phonological route in normal readers has not been specified. Are the valid translation errors exhibited by N.G. to be considered indicative of a defect or has the normal capacity of the translator been stretched to its limits? Is it already performing as well as possible and only failing with particular irregular words ? This question may also be addressed to the

acquired dyslexic patient of Bub, whose performance clearly resembles that of N.G. very closely. Has Bub's patient really suffered an impaired translator or are we observing in this patient the uppermost limit of the translator's normal abilities? In Bub's case it would seem that there is probably a mild impairment in the selection of valid responses, since the response bead ⟶ "bed" suggests the selection of an equivalence which is not the most likely realization for ead, although, as has already been pointed out, a large number of words ending ead do take this translation.

With respect to the developmental case it is even harder to speculate upon an impairment of development of the translator since, for example, the noted valid errors often occur to words ending in ough, for which it would be hard to produce an efficent algorithm for the translator. Even if one decides that there is no impairment of the translator for N.G., there does appear to be a mild impairment of development of the blender since, for very long stimuli, segments may drop out, e.g. tipularian ⟶ "tipulian"/tɪpəlɪən/, individual ⟶ "invidual"/ɪnvɪdjʊəl/

Thus for N.G. there may be a very mild impairment in the parser and the blender; any impairment of the translator is debatable. The extremely good performance of N.G.'s phonological route is all the more remarkable given how impoverished the development of his semantic route is in comparison. Semantic impairment is seen in all verbal tasks and vocabulary is pitifully small, yet this highly efficient and complex system for translating English orthography has developed.

Despite these indications of an extremely competent phonological route, one could not claim that N.G. reads all irregular words by this route. Some of the more predictable may be so mastered, but since N.G. is able to read the highly irregular word yacht one must assume that the direct route has also developed to a degree. The interpretation of N.G.'s case is thus very similar to Bub's patient's ; an almost

completely impaired / undeveloped semantic route; a partially preserved developed direct route ; a very well preserved / developed phonological route.

Short-term Memory?

Many developmental dyslexics have been noted to have very low digit spans. This is also true of many adults with acquired dyslexia. Baddeley (e.g. 1981) has introduced the concept of working memory and suggested that this mechanism may be crucially involved in reading (Baddeley 1979). If one thinks of the different stages of the reading model one might consider that working memory could be crucially involved in the functioning of the phonological route. The system must segment its visual input, select translations for the segments and then retain these segments while blending takes place. The developmental cases have been interpreted in a way that suggests that N.G. has a highly competent phonological route while R.B.'s is relatively less developed and efficient. Might N.G. have a better working memory than R.B.? The only indicator there is of N.G.'s working memory is his score on digit span and, non-verbally on Corsi blocks.Both of these are high for a thirteen year old. Digit span and Corsi block scores are both eight, a good score for an adult. But contrary to expectation, R.B.'s digit span is also extremely high. Her scaled score on the WISC digit span subtest is fourteen (mean = 10, S.D. = 3). This score is determined from digit span, both forward and backward. The score of fourteen is at the 91%ile for age. Thus there is not even a mild suggestion of an impairment. On the contrary, R.B.'s digit span is well above normal expectation for age. And, indeed, given that N.G. N,G,'s scaled score on WISC for digit span is 9, it would seem that R.B. has a relatively more efficient working memory than N.G. It must be concluded that, at least from the evidence of span tests, an

impoverishment of working memory cannot account for any impairmant exhibited by R.B. or N.G., nor can it account for any of the differences between the two children. However, it does remain possible that the short term memory requirements for the two tasks, reading and digit span, are not the same.

Visual Paralexias

There has been much speculation among researchers over the site of the deficit that produces visual paralexias. Most of these arguments have centred around localisation in some stage of the semantic route or logogen system. Contrary to this view, many of the errors interpreted by others as visual paralexias have been called here valid paralexias, since the application of a rule system of graphemes to phonemes and graphemic chunks to phonological segments can account for them. It will be seen later that substantial numbers of valid paralexias are not found in the data of other dyslexic children even when the incidence of paralexic responses is much higher. This reinforces the claim that in surface dyslexia these errors emanate from phonological processes. But what of the other paralexias : the invalid visual paralexias. Might not some or all of these like the invalid neologistic responses result from processing of an imperfect phonological route. This is particularly so since a lexical checking system is believed to be operating, which in surface dyslexia may accept mismatches. If, in surface dyslexia many so-called visual paralexias do result from an impaired phonological route (in which case phonological or invalid paralexias might be a better term), then in cases where the phonological route was functioning with greater efficency one would expect to see a much reduced incidence of visual paralexias. Thus is , of course, what has been observed. Both the acquired patient of Bub and the developmental case,

N.G., have efficient phonological routes and neither makes visual paralexias. That is, where there are no invalid neologistic responses there are no invalid paralexic responses. The claim then, is not that all visual paralexias in surface dyslexia emanate from the phonological route, but rather, that for surface dyslexia, there is no justifiable reason to assume that visual errors are usually the result of impairment in the logogen system (semantic route) rather than the phonological system. It also remains for those who support the notion that visual paralexic errors always emanate from the semantic route, to explain why the association between an efficient phonological route and an absense of visual paralexias is found for N.G. and Bub's case.

Developmental Phonological Spelling

Both N.G. and R.B. make spelling errors which are predominantly valid. In R.B.'s case 80% of spelling errors are phonologically valid if b-d confusions are overlooked. In N.G.'s case 85% of spelling errors are phonologiaally valid. Hatfield and Patterson (1983) noted that for their acquired phonological speller more spelling errors were phonologically accurate than reading errors and there were more paralexias in reading than paragraphias in spelling. They suggested that the two phenomena might be connected, since a quest for comprehension in reading might produce an increased tendency to produce word responses; this could mean that invalid word responses are produced in preference to valid neologistic responses. R.B. displays a similar discrepancy in that she makes more valid spelling errors than reading errors, and produces more paralexias when reading than paragraphias when spelling; but for her this account alone will not provide sufficient explanation For even if the neologistic spelling errors of R.B. are compared with the neologistic reading errors, a discrepancy in the degree of validity

is still apparent. In addition, R.B.'s spelling rules seem to be quite narrowly defined and fairly consistently used. An examination of the representations used for different words in her spelling errors showed that the range of representations used were far fewer than the potential number of spelling variants. For example, for the sound /e/ only the representation e was ever used. In reverse, the rule does not apply so that when reading a word in error but validly, or when reading a non-word, the grapheme e is seldom read as /e/. It is therefore suggested that the discrepancy observed between reading and spelling results from differences in the phonological systems for reading and spelling. In comprehending and processing oral input R.B. is not required to cope with the irregularities of English orthography. That is, from the point of view of the listener asked to interpret sounds, English is as simple and regular as Italian. R.B. may then develop a logical system to represent these sounds on paper. The system may be quite narrow witn one sound corresponding to one letter or letter pattern and she will still be able to write down phonologically valid representations of spoken words. Thus if she treats English as a regular language, she will make many spelling errors, but those errors will be predominantly phonologically valid. The errors will also be largely neologistic. When the system breaks down it may be, as Hatfield and Patterson (1983) suggest, that word specific knowledge interferes with some responses. Thus for R.B specific instruction in the irregularities of the written representation of English may reduce the number of phonologically valid errors that she makes, rather than increase it.

In reading, R.B. is faced with a much more complex task. Unless she analyses words at a single letter level she is faced with a very large number of letter combinations and patterns. If she tries to develop a simple rule system (comparable to her spelling rules) in order to translate these patterns, the response will frequently be meaningless

to her. As Patterson and Hatfield suggest, the quest for comprehension influences production and it may additionally reduce the liklihood that a fixed rule system is established, since whenever a rule system is used, a neologism is produced. R.B. then knows that the rule system is wrong and alters it. She may therefore develop a much wider number of potential translations in her rule system and they may be more poorly fixed.

This suggests that output phonology has developed in a limited but consistent fashion to produce a phonologically valid (but often incorrect) rule system. Input phonology develops as a less consistent, more variable systen consequenct upon the complexities of the input and awareness of error when processing does not produce a word.

PHONOLOGICAL DYSLEXIA

INTRODUCTION
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The first description

The term 'phonological alexia' was first used by Beauvois and Dérouesné (1979), to describe a French patient with an acquired reading disorder. The patient, R.G. was a right-handed, 64 year old man. Two years prior to the reported assessment he had been operated upon for a left parieto-occipital angioma.Computerised tomography scans showed a lesion involving the left angular gyrus, the posterior part of the second temporal convolution, the inferior longitudinal fasciculus, the geniculostriate fibres and some fibres of the tapetum. At the time of the assessment, in addition to dyslexia he had a right inferior quadrantanopia, mild memory deficit, mild calculation impairment, minimal constructional apraxia and astereognosia. He had no motor or sensory defect. His oral expression and comprehension were good, except for bilateral tactile aphasia.

The Alouette test of text reading (Lefavrais 1963) indicated that R.G. was reading at the level of a six year old child. This was due to excessively slow reading (62 stimuli in 3 minutes), and to errors that particularly involved articles, possessive adjectives, conjunctions and some verbs.

Most of the individual words presented for reading aloud were high frequency, concrete nouns. Of these, 80% were read correctly. The misreadings consisted of derivational errors, visual errors and omissions. There were no semantic errors. Function word substitutions also occurred.

R.G. was requested to read aloud 40 nouns of 4-5 letters in length and 40 non-words also of 4-5 letters in length (e.g. PCIVO,DIRMA). All nouns, but only 10% of non-words were read correctly. The non-words were read slowly. Misreadings of non-words resulted from failed attempts to decode analytically or attempts to produce words from a non-word which resembled it, e.g. VINA : "C'est presque vinaigre". (This dissociation between the ability to read words and non-words was also found between the ability to read meaningful and meaningless four digit numbers, e.g. 1984 versus 3729). Although on all tests R.G. found non-word reading difficult he found it easier to read non-words which were homophonic with real words (78% correct) than those that were not (36% correct). Misreadings of homophonic non-words were more frequently words than misreadings of non-homophonic non-words.

The effects of stimulus length and syllabic composition were investigated for both words and non-words. Non-word reading was affected by the length of the stimuli employed : longer words being read more poorly. Length did not affect the reading of nouns. Non-words with complex syllabic composition (e.g. CCVC STOK) were read more poorly than those of simple composition (e.g. CVCV VORA). This difference was not found in the reading of words.

Two identical lists of 20 words were presented to R.G. for reading aloud. On one list, global perception was prohibited by typing the words in upper case with the letters in reverse order. In the other, the intention was to prohibit analytical perception by writing the words in poor handwriting. Nineteen of the twenty handwritten stimuli were read correctly but none of the reverse order stimuli.

There was some impairment of letter reading (87% accuracy) and of pointing out a spoken letter on request (80% accuracy). Both letter matching and letter repetition were perfect.

R.G.'s writing was also impaired. He displayed what Beauvois and

Derouesne have called lexical or orthographic agraphia, and has been described elsewhere as surface dysgraphia or phonological spelling. He wrote non-words very well and made many phonologically correct spelling errors, e.g. "eglise" → aiglise,"enfant" → enfans

Since the description of R.G.,a small number of phonological dyslexics have been described in published papers. (Others have been described at conferences). In total, sixteen more cases have been reported. The first references to these cases are given in Table 12.

Integral Features

There is much variation in the characteristics of the recently reported cases of acquired phonological dyslexia. The variation has been reviewed by Sartori, Barry and Job (1984) and this sub-section draws much material from their chapter. One table of their chapter is reproduced in its entirity as table 13 here. The table gives data for 16 of the 17 reported cases of phonological dyslexia. The recent Kremin case is not included as full details are not yet published. Of the sixteen patients, 7 are female and 9 are male. At least three patients have dyslexia consequent upon a right hemisphere lesion ; one of these cases (Leonardo) is right handed with no familial history of left-handedness. The incidence and type of aphasia vary: five patients are non-fluent aphasics, five are fluent, two have aphasia that was not specified in the reports and two (R.G. and P.H.) have no aphasia.

Non-word reading

The salient feature of phonological dyslexia is that non-word reading is impaired in relation to word reading. As Sartori et al's table (table 13) indicates there is variation in the extent of this discrepancy. Most phonological dyslexics can read some non-words. Errors to non-words include both visually similar words (lexicalisations) and incorrect non-words. Some (but not all) phonological dyslexics

1. Beauvois and Dérouesné (1979)	R.G.
2. Dérouené and Beauvois (1979)	J.A.
3. "	P.H.
4. "	M.F.
5. Shallice and Warrington (1980)	B.T.T.
6. "	G.R.N.
7. Allport and Funnell (198	A.L.
8. Patterson (1982)	A.M.
9. Martin (1982)	J.S.
10. De Bastiani, Barry and Carreras (1982)	A.M.M.
11. Job and Sartori (1982)	Leonardo
12. Funnell (1983)	W.B.
13. Dérouesné and Beauvois (1984)	L.B.
14. Kremin (1984)	R.I.C.
15. Sartori, Barry, and Job (1984)	Raffaella
16. "	Beatrice
17. "	Lucrezia

TABLE 12

The first references to cases to acquired phonological dyslexia

Patient	Sex	Hem.	Hand	Aphasia	Dysgraphia	Reading (%correct)			
						Nonword	Word	a	b
French									
R.G.	M	L	r	-	+	10-25	80	-	+
L.B.	M	R	l	F	+	48	95	-	+
J.A.	M	L	r	+	+	55	100	-	+*
P.H.	M	?	r	-	+	80	100	-	+*
M.F.	F	L?	r	+	+	42	100	-	+*
English									
B.T.T.	F	L	r	?	+	50	90	-	+
G.R.N.	F	L	r	?	+	5-8	95	+	+
A.M.	M	R	l	F	+	0-26	86	+	+
A.L.	M	?	-	F	?	can't	12-65	+	-
W.B.	M	L	r	NF	+	0	87-93	+	+
J.S.	M	L	r	F	+?	15-20	38	-	-
Italian									
Raffaella	F	L	r	F	+	15-30	83	-	-
Beatrice	F	L	r	NF	+	0	62	-	-
Leonardo	M	R	r	NF	+	0-10	50	+	+
Lucrezia	F	L	r	NF	+	0-6	55	+	+
A.M.M.	F	L	r	NF	+	2-6	88	+	+

Hem. : hemisphere damaged

Hand : handedness of patient

Aphasia - F : fluent, NF : non-fluent, + : present, but not specified

Dysgraphia - + : present, ? : not reported

a : + : non-word reading is less than ten per cent correct

b: + : of which word reading is above 75% correct

* : these patients appeared to be tested only on their reading of forty items

TABLE 13 (taken from Sartori et al 1984)

PHONOLOGICAL DYSLEXIC PATIENTS

have been reported to be more successful at reading non-words that are homophonic with real words than pronouncable but non-homphonic non-words. Thus, floo is easier than ploo (Beauvois and Dérouesné 1979, Patterson 1982). The validity of this claim has been questioned : in reported cases, visual similarity to real words has been a confounding factor (Martin 1982, Patterson 1982).

Patterson (1982) has suggested that the effect results from the strategy that is used. The patient may locate in his lexical system the word that is most visually similar to the non-word he is trying to read, and then retrieve the pronunciation of this visually similar word. 'Inadvertently' this may result in a correct reading of the non-word. In a post hoc analysis of 37 homophonic words, Patterson (1982) found that 0.58 of high visual similarity were read correctly while 0.32 of low visual similarity were read correctly. Contrariwise, Beauvois and Dérouesné (1979) did not find that the visual similarity of homophonic non-words to their respective words affected the ability of their patients to read homophonic non-words, although they did nevertheless find the homophonic superiority effect. However the patient R.G., of Beauvois and Dérouesné, was given explicit instruction and was told when the stimulus was homophonic with a real word. Patterson's patient (A.M.) was not given this information. More recently, Dérouesné and Beauvois (1982) have shown with the patient L.B. that, although homophonic non-words are read better than non-homophonic non-words,the effect is significant only when the use of the homophonic strategy has been suggested to the patient. Visual similarity did not affect the patient's performance when the non-words were graphemically simple; if the words were graphemically complex and homophonic to a word, then visual similarity did significantly affect performance.

Word Reading Levels

Just as non-word reading levels vary in phonological dyslexia,

so word reading levels also vary. In the main, the level varies from an ability to read from 50% to 100% of test material. These comparisons have limitations since different stimuli for both word and non-words were employed for different patients, even within the same language.

Some researchers do give standardised test scores based on adult and child reading tests. The patient reported by Patterson (1982), A.M., appears to be one of the least impaired. A.M. reads 83/100 words on the Schonell test - a reading age of 13 years 4 months.(this scale ends at15 years). On the Nelson Adult Reading Test (Nelson and O'Connell 1978) he reads 31/50 words giving a verbal IQ of 112. G.R.N. reported by Shallice and Warrington(1980) is poorer at reading. She reads 73/100 words on the Schonell list, giving a reading age of 12 years 4 months. On the Nelson adult test she reads 18/50 (Verbal IQ 102). W.B., described by Funnell (1983) read 60/100 words correctly on the Schonell, giving a reading age of 11 years. However, the French patient, R.G. reported by Beauvois and Dérouesné (1979) read text at the level of a six year old child. He has an "alexia serious enough to prevent return to work". "While he had been a passionate reader, R.G. could no longer read a paper". It is difficult to compare reading levels directly though, as this French test is a timed test of text reading, in contrast to an untimed single word reading test, like the Schonell or the Nelson.

Reading errors

When phonological dyslexics make reading errors they are generally one of two types : derivational (e.g. weigh $\longrightarrow$ "weight", child $\longrightarrow$ "children") or visual (e.g. camp $\longrightarrow$ "cape", picture $\longrightarrow$ "patter"). The incidence of visual and derivational errors in phonological dyslexia varies from case to case. Clearly , in a patient with over 90% accuracy the incidence of either error type must be small. It has been argued that one or other of the error types (derivational or visual) may not

be a crucial characteristic of phonological dyslexia (Patterson 1982, Funnell 1983) and that one type (derivational or visual) may be assimilated to the other. Phonic regularistaion errors (broad → "brode"/brɔ͡ɔd/) of the type characteristic of surface dyslexia (Marshall and Newcombe 1973) are not found in these patients. In only one case of phonological dyslexia have semantic errors been reported (Funnell 1983), and here the incidence was extremely small. An occasional error in phonological dyselxia may be classified as visuo-semantic, e.g. satirical → sarcastic (Patterson 1982). The incidence of these errors is also small; and they have not been reported for every patient.

Function Word Reading

Of the eleven phonological dyslexics reviewed by Sartori et al (1984), four have difficulty reading function words in isolation (Funnell 1983, Beauvois and Dérouesné 1979, Patterson 1982, Sartori et al 1984). For some patients, these function word substitutions have a visual component, e.g. W.B. : an → "and", any → "many" (Funnell 1983); A.M. : neither → "either", is → "his" (Patterson 1982). Beatrice (Sartori et al 1984) made substitutions which did not have a visual component. Other phonological dyslexics have been reported to have no such difficulty (Shallice and Warrington 1980; Dérouesné and Beauvois 1982). Since this feature is variable, it cannot be considered a defining characteristic of phonological dyslexia. However, it is beginning to emerge that even those phonological dyslexics who do not have difficulty reading function words in isolation have extreme difficulty reading function words within text (Kremin 1984; Shallice, personal communication). Normal adult readers make some errors reading function words in text but the difficulties observed in cases of phobological dyslexia are much more severe. It remains to be established whether the function word

difficulty in text will prove to be true for all phonological dyslexics.

To summarise : phonological dyslexics are much poorer at reading non-words than at reading words. They make visual and derivational errors but no (or very few) semantic errors or phonic regularisations. Many have function word difficulties.

Imageability, Frequency , Length and Regularity.

The effects of imageability, frequency, length and regularity have not been thoroughly investigated in most cases of phonological dyslexia. The available data are contradictory. In Sartori et al's review (1984) it is noted that, of nine patients for whom data are available, only one shows a frequency effect. For the same nine patients three show some effect of length. For ten patients data is available on the effect of concreteness. In only one case has a clear effect been shown. There is meagre evidence of a second case.Sartori et al (1984) conclude that "no variables have a consistent or general effect". It is possible that for some patients, where effects of linguistic dimensions were not significant, a ceiling effect was operative.

Reversed Typescript and Handwriting

As noted earlier, Beauvois and Dérouesné (1979) found that their phonological dyslexia patient R.G. was impaired at word reading when stimuli were presented with their letters typed in the reverse order thus prohibiting global perception but was not impaired in reading handwritten stimuli.

Spelling

The qualitative nature of the spelling disorder that accompanies acquired phonological dyslexia varies from patient to patient. R.G., the phonological dyslexic patient, examined by Beauvois and Dérouesné (1979) is surface dysgraphic. That is, he is a phonological speller of the type discussed in the section on surface dyslexia. Thus when

R.G. makes spelling errors they are frequently phonologically valid and often result in regularisation of irregular spelling. He is also proficient at spelling non-words.

Although R.G. is a surface dysgraphic, not all phonological dyslexics are surface dysgraphic. A.M. (Patterson 1982) does not produce phonologically correct spelling errors and he cannot spell non-words. Both input and output phonology are impaired. His spelling errors were of four types : omissions, derivational errors (e.g. 'hoped'⟶ hopes), paragraphias or word substitutions (e.g. "doll" ⟶ dog,'amount' ⟶ among) and errors which resemble the stimulus word both visually and phonologically (e.g.'daughter' ⟶ dorgher). Ellis (1982) calls this final category, errors of partial lexical knowledge.

These spelling patterns indicate that when an acquired phonological dyslexic patient is dysgraphic the qualitative nature of the dysgraphia cannot be predicted.

Lexical Decision

Some phonological dyslexics have been reported to have preserved lexical decision abilities (Patterson 1982; Martin 1982), although some of the Italian patients do show impairment (Sartori et al 1984) At least one patient has been reported as being able to classify correctly in the lexical decision task the very non-words that produced a visually similar word on oral reading (De Bastiani et al 1982).

Theoretical Explanations

Beauvois and Dérouesné (1979)

R.G. has already been described in some detail. Dérouesné and Beauvois considered that the pattern of performance of this patient could be summarised in three essential dissociations :

1. A disturbance of the phonological reading process without disturbance of the lexical reading process.
2. A disturbance at the level after the phonological stage that permits grapheme-phoneme correspondence, without disturbance at the perceptual and expressive stages.
3. A disturbance of reading without comparable disturbance of oral expression, oral comprehension, oral spelling and writing.

They considered that R.G.'s performance provided support for the existence of the postulated non-phonological reading route. This semantic route, they conjectured, could function independently of phonological processes and the independent functioning involved intermediate linguistic stages and not only visual or expressive stages.

Since the patient's speech was normal the phonological processes necessary for speech had to be seperate from the phonemic representations used in reading. As loss of grapheme-phoneme correspondence rules was found in reading without being found in writing, reading and writing were concluded not to be symmetrical activities.

Shallice and Warrington (1980)

Shallice and Warrington consider that whereas surface dyslexia is a multiple component dyslexic syndrome, requiring more than one functional lesion for explanation, phonological dyslexia is a single component syndrome. They argue that phonological dyslexics have a highly selective deficit involving grapheme-phoneme translations.

Shallice and Warrington, and Beauvois and Dérouesné explain phonological dyslexia in terms of one functional impairment. But they do not address the issue of why phonological dyslexics not only have difficulty reading non-words but also make derivational errors and often have difficulty reading function words, even if only in text. Patterson (1982) has attempted to address the issue via the

model of reading proposed by Shallice and Warrington (1980)

Patterson (1982)

Patterson points out that in Shallice and Warrington's (1980) model (outlined in the section on surface dyslexia), short frequent words and frequently occurring sub-word segments are represented as whole units in the phonological route. She suggests that the most likely candidates for the two classes are function words and affixes. In Shallice and Warrington's model there is only one route in addition to the phonological route. This route involves orthographically based identification of the word, which provides access to the word's semantic representation, which in turn, addresses phonology in an output lexicon of known words. If this route is not suited to reading function words and bound morphemes (which have a largely syntactic role) then the only alternative for dealing with these segments will be the phonological system. Patterson suggests that the phonological system is particularly well equipped to provide a code for those segments, a code that would support oral reading and could assist comprehension. It would be expected that any patient with a defective phonological assembly system would also have impaired function word reading (particularly for purely syntactic function words) and should make derivational errors in reading. The increased incidence of function word errors in text is noted even for normal readers, though not to the same degree. Kolers (1966) has indicated that the reading of text, even aloud, appears to be guided by the semantic system. Patterson suggests that the variability between patients in the degree of function word difficulty (in contrast to their consistent difficulty with derivational endings) may result from the fact that minimal graphemic segmentation is required for reading function words whereas some segmentation is required for reading affixes and non-words.

Patterson makes two predictions :

1. That patients with a deficit in assembling phonology from print (deep and phonological dyslexics) will invariably have difficulty in reading grammatical morphemes.
2. That patients with an impairment of reading via the semantic system, who therefore rely on the phonological system for reading (surface dyslexics) should never show a selective on grammatical morphemes.

Patterson thus considers that since phonological dyslexics read fairly well this adds further support to the view that the system for phonological recoding is used very little by normal adult readers. It may be used for items which are deficient in semantic information - function words, non-words, unfamiliar words and names.

Newcombe and Marshall (1980)

Newcombe and Marshall do not consider that the performance exhibited by phonological dyslexics results from the functioning of the semantic route alone. They believe that the semantic route is intrinsically unstable and that the semantic errors observed in deep dyslexia (see next section) are an exaggerated manifestation of this phenomenon. Very minimal phonological reading can block the overt expression of semantic errors. Phonological dyslexics do retain some minimal phonological reading skills. Newcombe and Marshall (1980) therefore argue that these residual skills are crucial in eliminating the possibility of semantic errors. Some support for this hypothesis is provided by the patient W.B. (Funnell 1983). W.B. is the only phonological dyslexic reported who is unable to read any non-words. He is also the only phonological dyslexic who has been observed to make a small number of semantic errors which do not have a visual component.

De Bastaini, Barry and Carreras (1982)

De Bastiani et al (1982) have tried to explain phonological dyslexia within the theory of lexical analogy (Marcel 1980;Henderson 1982;

Glushko 1981). The impairment is seen in terms of damage to the systems of orthographic segmentation and phonological assembly. De Bastiani et al described an Italian patient A.M.M. They argue that A.M.M.'s performance reflected damage to the assembly of lexically activated phonology. This would explain her visual errors to non-words : e.g. funvo ⟶ "fungo" (mushroom), and the production of strings of such responses,e.g. ralgo ⟶ "salgo, salvo". They speculate that such strings may include hesitatingly produced, incorrect non-words made of syllables, that are derived/assembled from lexically activated phonology (e.g. tampo ⟶ "tango, tanpo"). If impairment is also assumed in the process of orthographic segmentation, then the account may extend to the visual and derivational errors made in reading words.

One criticism of lexical analogy theories, as explanations of phonological dyslexia, has been raised by Funnell (1983). She claimed that orthographic segmentation is intact in her phonological dyslexic patient, W.B., since he was able to find and pronounce words embedded in non-words (e.g. alforsut). Funnell also argued that phonological assembly was intact since W.B. could repeat separately two syllables of an auditorally presented word, e.g. forget ⟶ "for" + "get".

Sartori et al (1984) also note that W.B. could orally repeat letter strings that he could not read. They therefore suggest that Funnell's phonological assembly tasks could be performed by an auditory "arm" of a model of phonological recoding and not a component that is necessarily involved in the assembly of phonology from print.

Some cases of developmental dyslexia will now be presented, and the extent to which their pattern of performance resembles acquired phonological dyslexia will be investigated. The first two cases are both seventeen year old girls and their data will be presented together.

CASE STUDIES
****

Cases 3 and 4 : H.M. and J.E.

Case Histories and Psychological Background

H.M. is a seventeen year old girl. Labour was long and birth was delayed. Speech appeared early with no apparent abnormalities. Milestones are reported to be normal. There is no clearcut family history of specific reading disorders, although there is comment that the mother's brother did not learn to read well. There is no history of serious family illness and H.M. has no known neurological abnormality.

H.M. came to the attention of the educational authorities prior to her O'level examinations when attempts were being made to obtain extended time limits for her. She had previously gained several C.S.E.s and a 'D' grade for Biology at O'level.

H.M. is of good average intelligence. When tested on the W.I.S.C., at the private school she was attending in 1976, she was found to have a Verbal IQ of 114 and a Performance IQ of 115. Retested in August 1982, her Verbal IQ was 105 and Performance IQ 86. The decline of score with age seems to be characteristic of the dyslexic child on the WISC. Absolute scores may not drop over time but they do not increase to the same extent as those of the average child. Thus, when the scores are scaled with age norms, the 'intelligence' of the dyslexic child appears to fall. With increasing age the child is penalised more and more by the dyslexic handicap. The breakdown of H.M.'s 1981 scores is :

Verbal Tests		Performance Tests	
Information	10	Picture Completion	9
Similarities	8	Block Design	10
Arithmetic	8	Object Assembly	9
Vocabulary	13	Coding	4
Comprehension	15		
(Digit Span	7)		

(Mean = 10, S.D. = 3, Range = 1-19)

The slightly below average performance score clearly results from the extremely low coding score. The Coding subtest is almost always found to be problematic for the poor reader. The task involves the serial identification of symbols, the association of each pattern with its respective 'code' symbol and a transcription of these code symbols. This chain of events (visual analysis $\longrightarrow$ cognitive association $\longrightarrow$ motor transcription) conducted in a sequential fashion, mimics the skills needed for reading more closely than any other subtest. It is also a timed subtest, so the processing must be both efficient and quick. The dyslexic child who is a poor reader, bad speller, and slow writer loses out at every stage.

More extensive testing was carried out with H.M. between April 1982 and March 1983. Over this period (when the current data were collected) the pattern of her performance changed very little either quantitatively or qualitatively. Her scores were in the average range for a number of cognitive tasks. By contrast reading and spelling were impaired (see table 14).

H.M. has now obtained B grade O'levels in Biology and History. She also has an A grade A/O'level in Community studies.

Cognitive Tasks

Ravens Progressive Matrices: Raw Score 47, IQ 107-111

P.P.V.T. : IQ 113 81%ile for age

Token Test (De Renzi and Vignolo 1962) : one error

Oldfield Object Naming (Oldfield and Wingfield 1965) : 31/36

Digit Span : 6 forward 4 backward

Reading and Spelling

April 1982

Schonell single word reading age		10.11 (max. 15 years)
Neale text reading age :	accuracy	9.7 (max. 13 years)
	comprehension	12.2 "
Schonell spelling age		10.7

March 1983

Schonell single word reading age	11.0 *
Schonell spelling age	10.10 **

* : This increase of one month on the previous score is achieved if one more word on the test is read correctly.

** : This increase of three months on the previous score is achieved if three more word on the test are spelt correctly

TABLE 14

STANDARDISED TEST SCORES FOR H.M.

J.E. is a seventeen year old right handed girl, with no known neurological abnormality. There is a family history of reading and spelling difficulties. The father was affected and still has residual difficulties. J.E.'s elder sister, although possessing a University degree, is an extremely poor speller and mild reading difficulties were displayed on detailed examination. J.E. was first seen and assessed at the age of $16\frac{1}{2}$. She was tested, at the request of her sister,who was concerned about J.E.'s prospects in impending examinations.

The Weschler Intelligence Scale for Children (Revised Version) was administered :

Verbal Tests		Performance Tests	
Information	9	Picture Completion	15
Similarities	16	Picture Arrangement	9
Vocabulary	10	Block Design	10
Comprehension	15	Object Assembly	13
Verbal IQ	115	Performance IQ	112
Full Scale IQ	116		

Digit span was 4 forward and 3 backward. Although of high average intelligence, reading and spelling were below expectation:

Schonell single word reading age	12 years 4 months
Schonell single word spelling age	10 years 7 months
Neale text reading age (accuracy)	9 years 2 months

J.E. subsequently obtained the following O'levels : Biology C grade; English Literature C grade; History B grade; Art C grade; and English Language C grade. The last result is somewhat surprising in view of the performance that will be reported.

The tests and data to be reported were collected when J.E. participated in a detailed study of her abilities at the age of 17 years 7 months. At this time she was attending Chelsea Art College's pre-degree course. Reading, no longer being so extensively practised, had declined slightly, although spelling had mildly improved :

Schonell single word reading age	11 years 8 months
Schonell single word spelling sge	10 years 10 months

The Peabody Picture Vocabulary Test was also administered at this time. A raw score of 107 was obtained, equivalent to a score at the 44th percentile for age. This is consistent with the earlier found vocabulary subtest score of 10 on the WISC.

J.E.'s speech is fluent and well articulated. Two samples of her spontaneous speech follow. The first is a description of "Marilyn" a transvestite pop star of current "fame". It contains a number of unfamiliar names which refer to pop groups. The second passage describes J.E.'s work at Art College.

1. " The Marilyn clone, yes, he hit the West End about two years ago with his image of 'I'm Marilyn Monroe'.But, he's all male. Boy George's ex-boyfriend, now hated by Boy George also, and hitting the big time.... on Top of the Pops last week, and Sixty Minutes just before Top of the Pops.....and I believe Riverside a couple of weeks ago. This male from the clubbing scene has long blonde dreadlocks. He used to dress up as Monroe but got bored with that idea.....em.....lived in America for two years while his hair grew back 'cos nobody would take him seriously with short hair apparently.....em. His new single is "I'm calling your name" which proves that the same people producing his records produce Culture Club's and Hazy Fantazy's. He sounds like Boy George on it. Boy George won't speak to him at the moment.....

and he's a real "wilf" but he's beautiful."

2. "Friday mornings are spent, for an hour, discussing History of Art. At the moment we are doing Cubism.Picasso was the main Cubist, Matisse, no Braque as well, influenced by Matisse. Picasso went through various stages. His art was not liked by the French,the em normal French artists...um... but he enjoyed it. He kept to it and Braque followed along very much the same lines. They became very friendly and some of their early work you can't tell the difference between. It's very difficult. Cubist painting tends to have much more life and much more feel about it. It can express anger with much more power than a conventional painting can...Cubism is...was criticised by the Futurists in Italy and they said it wasn't art. But the Cubists said that Futurism wasn't art, while the constructivists said it all wasn't art."

Non-word Reading

Both girls were presented with the three balanced word/non-word lists used with R.B., for reading aloud. The following results were obtained :

	H.M.		J.E.	
	Words	Non-words	Words	Non-words
3 letter list	14/14	11/14	13/14	10/14
5/6 letter list	15/15	9/15	15/15	9/15
Coltheart list	25/25	9/25	25/25	11/25
Totals	51/54	29/54	53/54	30/54
	$X^2=23.34, p<0.001$		$X^2=27.53, p<0.001$	

Both girls, although able to read some non-words, are significantly impaired on reading non-words in comparison to word reading. To

illustrate the discrepancy and to compare the two girls, the responses to the stimuli on the Coltheart list are given in Table 15.

On the three-letter and five- and six- letter lists a number of the errors to non-word were lexicalisations :

H.M. :	J.E. :
chait ⟶ "chit"	chait ⟶ "chart"..."trait"
inlect ⟶ "inlet"	inlect ⟶ "inlet"
fince ⟶ "finish"	mab ⟶ "mad"
zan ⟶ "van"	zan ⟶ "tan"
fip ⟶ "flip"	fip ⟶ "flip"
	tup ⟶ "tub"

The remaining errors on these two lists were :

H.M. :	J.E. :
doptor ⟶ "dopper"/dɒpə/	doptor ⟶ "dobtor"/dɒbtɔ/
gemon ⟶ "jemon"/dzɛmən/	fince ⟶ "fiyence"/fɪjɛns/
fex ⟶ "feg"/fɛg/	faper ⟶ "fader"/fæda/
klower ⟶ "kanowla"/kænəʊlɑ/	trock ⟶ "trog"/trɒg/

The Coltheart non-word list (unpublished) also contains long stimuli. These were also given for reading aloud. There are 20 word and 20 non-words. J.E. read two non-words correctly : forgivunable and habitination. She also read three words correctly : categorically, disproportionately and overconfident.Three further words would have been correct had it not been for slight derivational errors : confederations ⟶ "confederation", dissatisfactions ⟶ "dissatisfaction" municipality ⟶ "municipal". H.M. read only one non-word correctly : forgivunable. She also read three words correctly: dissatisfactions, inappropriateness, and categorically.

Errors to both words and non-words on this list were very similar. They were predominantly neologistic, otherwise they were derivational (see tables 16 and 17).

NON-WORD	H.M.		J.E.		WORD	H.M.	J.E.
gouse	"goose"	l	"grouse"	l	goose	✓	✓
noor	"nor"	l	"nor"	l	door	✓	✓
doney	"donkey"	l	"donkey"	l	money	✓	✓
foom	"foam"	l	"flown"	l	room	✓	✓
chold	"cold"	l	"called"	l	child	✓	✓
foop	"flop"	l	"fop"	l	food	✓	✓
ede	"Ed"	l	"Ed"	l	eye	✓	✓
floon	"flown"	l	"flon"/flon/	n	floor	✓	✓
fime	"firm"	l	"flime"/flaɪm/	n	fine	✓	✓
streed	"stress"	l	"stred"/stred/	n	street	✓	✓
cimy	"clammy"	l	"crimy"/crimɛ/	n	city	✓	✓
garl	"gall"	l	✓		girl	✓	✓
moman	"mormon"	l	✓		woman	✓	✓
boak	"book"	l	✓		book	✓	✓
fape	"fap"/fæp/	n	"flape"/flecp/	n	face	✓	✓
charch	"chark"/tʃak/	n	✓		church	✓	✓
cag	✓		"Craig"	l	car	✓	✓
schoom	✓		"scorn"	l	school	✓	✓
pand	✓		✓		hand	✓	✓
doy	✓		✓		boy	✓	✓
mun	✓		✓		man	✓	✓
heam	✓		✓		head	✓	✓
poad	✓		✓		road	✓	✓
nater	✓		✓		water	✓	✓
toble	✓		✓		table	✓	✓

reading responses of H.M. and J.E, to the short stimuli on the cheart balanced word and non-word list

LE 15

Stimulus	H.M.	J.E.
repudiating	reportating /rəpoʊteɪtɪŋ/	reputant /rəpjutənt/
linguistically	injustical /ɪndzʌstɪkəl/	illiguistical /ɪlɪgwɪstɪkəl/
belligerently	belligerentical /bəlɪdzərɛntɪkəl/	bellygravely /bɛleɪgreɪvleɪ/
existentialism	existemistic /ɛksɪstɛmɪstɪk/	extental /ɛkstɛntəl/
miscalculations	miscalculation	miscalaneoustion /mɪskəleniəsʃən/
imperceptible	impercemtiable /ɪmpəsɛmtiəbəl/	impercepible /ɪmpəsɛpɪbəl/
recapitulate	recaptulate /rikæptʃuleɪt/	recampult /rikæmpjult/
procrastination	procrastation /proʊkræsteʃən/	procrayshinyshone /proʊkreɪʃaɪn/
confederations	confedrelation /kənfɛdrɪleʃən/	confederation
dissatisfactions	✓	dissatisfaction
prototypical	protomical /proʊtɒmɪkəl/	protopical /proʊtɒpɪkəl/
municipality	munikapalatey /mjunɪkæpælətɛɪ/	municipal
humiliatingly	humanicatingly /hjumənɪkeɪtɪŋleɪ/	humililitaytionly /hjumɪlɪlɪteɪʃənleɪ/
overconfident	overconfidence	✓
inappropriateness	✓	inpropriateness /ɪnproʊpriɛtnəs/
disorderliness	disorderness /dɪsɔdʌnəs/	disorderelly /dɪsɔdʌrəleɪ/
categorically	✓	✓
presupposition	presupportation /prisʌpoʊteʃən/	presupposetion /prisʌpoʊsʃən/
undemocratic	underbromatic /ʌndəbroʊmætɪk/	undermocratic /ʌndəmoʊkrætɪk/
disproportionately	disproportionly /dɪsprəpoʊʃənleɪ/	✓

Responses to the long words on the Coltheart list

TABLE 16

STIMULUS	H.M.	J.E.	
exaggationers	exaygrattionos /ɛgseɪgrætʃənəs/	exgarrytion /ɛksgærɛɪʃən	
cannistilalic	cannistibalic /kɑnɪstɪbælɪk/	canibistal /cænɪbɪstəl/	
forgivunable	forgiveunable (✓)	forgiveunab	)
logibiocally	log.I.buy.ocal /lɒg.aɪ.baɪ.oʊkəl/	logibic..al /lɔdzɪbɪk..ə	ibicolybol ›dzɪbɪkplɛɪ bɒlɛɪ/
laborcolator	labicolation /læbɪkoʊleɪʃən/	laborcurato /læbɔkjureɪt	
lumilinations	limitinations..limitations /lɪmɪtɪneʃənz/	lumination /lumɪneɪʃən/	
incocidental	incoridental /ɪnkɔrɪdɛntəl/	incoidental /ɪnkɔɪdɛntəl	
gracontulation	gratcontulation /grætkɔntjuleɪʃən/	gra.con.you /grə.kɒn.ju.	
comormemating	comormetating /cɔmɔmɛteɪtɪŋ/	comeration /cɒmərefən/	
cenectricities	cenelectricals /sɛnɛlɛktrɪkəlz/	centricalit /sɛntrɪkəlɪt	
ramifationic	ramifactionic /ræmɪfækʃənɪk/	ramificatio /ræmɪfɪkeɪʃə	
cirsemicular	crisemicircular /krisɛmeɪsɪrkjulɑ/	circomicula /sɪrkɒmɪkjul	
reostephonic	reostomionic /rɪɒstɔmɪɒnɪk/	reeostempho /rɪɒstɛmfɒnɪ	
algenerities	algentieraesi /ɑldzɛnt r s /	ageln..itic /ædgɛln..ɪtɪk	
electrifationic	ɮetrofactionic /lɛtroʊfækʃənɪk/	electrifica /əlɛktrɪfɪke	ɪic .k/
lucinhallations	looshinhalation /luʃənhɑleɪʃən/	lucidhallti /ləɔɪdhɔlʃən/	
dimeocrities	democritis /dɛmoʊkrɪtɪs/	dimocritic /dɪmoʊkrɪtɪk	
habinitation	habitation	✓	
compatibinility	capatability /kæpætəbɪlɪteɪ/	combatelati /cɒmbætəleʃə	
imparsonious	imparsontion /ɪmpɑsənʃən/	imparsonish /ɪmpɑsənɪʃʌs/	

TABLE 17

Responses to the long non-words on the Coltheart list

In the attempts to read the long words and non-words there are many word subcomponents produced in the response. These are underlined in Tables 16 and 17.

H.M. and J.E. were also asked to read the two non-word lists containing non-words homophonic with real words. The Patterson/ Coltheart list had been used with Patterson's (1982) acquired dyslexic patient and so a direct comparison could be made. The responses of the two girls on the Patterson/Coltheart list are given in Table 18. The performance of H.M. matches the performance of the acquired case, A.M., more closely than does that of J.E. Indeed as table 19 indicates, A.M. and H.M. have extremely comparable performances. The overall performance levels of the two are similar, with H.M. marginally superior; approximately a third of the errors of both are incorrect word responses ; more non-words homophonic with real words are read correctly than non-words not homophonic with real words. A.M. reads seven homophonic and two non-homophonic stimuli; H.M. reads ten homophonic and four non-homophonic.

J.E.'s pattern of performance differs. She reads more stimuli correctly than either A.M. or H.M. She also shows no difference in the ability to read homophonic non-words in relation to non-homophonic non-words. She reads ten that are homophonic and eight that are non-homophonic. The error responses are split fifty-fifty between incorrect word and non-word responses.

The Temple homophonic list was also given to J.E. and H.M. The responses read correctly are given in Figure 6. The figures involved are small but there is a suggestion that for H.M. the homophonic superiority is not merely a result of visual similarity. For J.E. the data are even less clear. Full responses to this list are given in Table 20.

Reading of the Coltheart/Patterson homophonic list — TABLE 18

Homophonic Non-words

Correct responses

H.M.	J.E.
wun	wun
hoal	hoal
ahms	braik
woar	woar
floo	peese
soal	soal
throan	throan
ile	waid
brooze	fraze
	horl

Incorrect word responses

H.M.	J.E.
stawk → squawk	ahms → aims
horl → hall	boaled → boiled
waid → wide	taks → talk
peese → peace	brooze → bronze
fraze → freeze	
taks → talk	
bair → blare	
lele → lake	
kie → kit	

Incorrect non-word responses

H.M.	J.E.
braik → brack/bræk/	floo → fleur/flɔ:/
boaled → bollid/bɔlɪd/	stawk → strot/strɒt/
chuze → chersey/tʃɜ:zɪ/	bair → brair/brɛə/
J.E.	leke → lek/lɛk/
ile → illed/ɪld/	chuze → chuz/tʃuz/

Non-homophonic Non-words

Correct responses

H.M.	J.E.
brone	kie
gaks	dode
dort	brait
ploo	dort
hefe	rild
	porce
	mobe
	korp

Incorrect word responses

H.M.	J.E.
flure → flew	ploo → blue
murld → muddle	murld → milled
porce → porch	dake → date
mobe → mop	phroo → Prue
korp → crop	wute → what
trude → true	bol → boil
wute → rut	barl → brawl
bol → bowl	
barl → barrel	
rild → rile	

Incorrect non-word responses

H.M.	J.E.
brait → brath/brɑ:θ/	hefe → heff/hɛf/
dake → drak/drak/	flure → fleur/flɜ:/
phroo → phrone/frəʊn/	gaks → gok/gɒk/
dode → dod/dɒd/	brone → bron/brɒn/

Comparison of H.M.'s performance on the Coltheart/Patterson list with that A.M.(Patterson 1980)

	A.M.	H.M.
No of stimuli correct	9/40	14/40
Ratio of H:N correct	3.5:1	2.5:1
% of errors that are incorrect non-words	26%	27%
% of errors that are omissions	2%	0%
% of errors that are incorrect words	68%	73%

H: homophonic non-words

N: non-homophonic non-words

TABLE 19

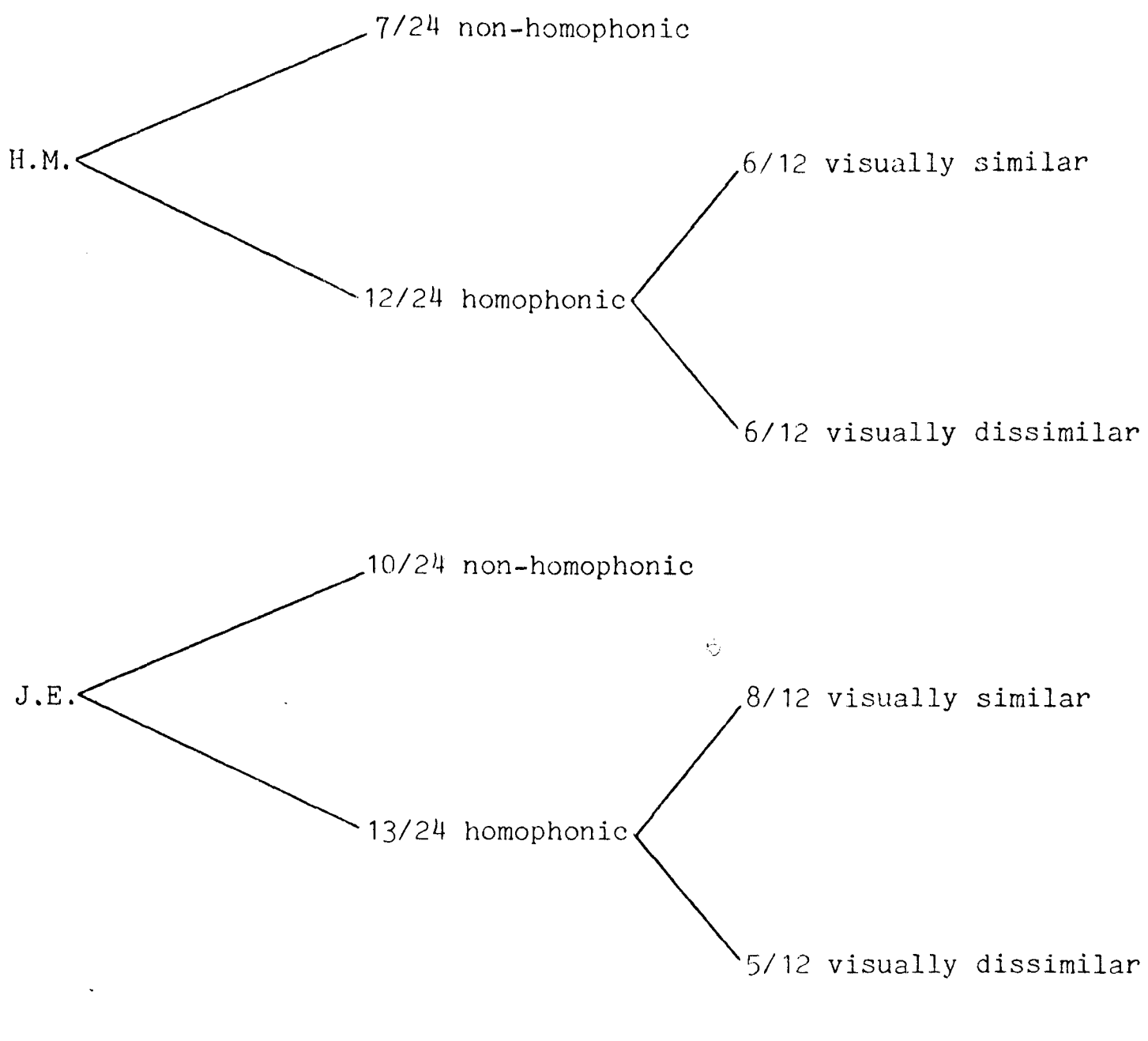


FIGURE 6

Stimuli read correctly on the Temple homophonic list

Homophonic non-words

Non-homophonic non-words

Correct responses

H.M.		J.E.		H.M.		J.E.	
flore (v)	✓	shoo (v)	✓	antor	✓	fide	✓
heer (v)	✓	flore (v)	✓	phogo	✓	scort	✓
solemm (v)	✓	heer (v)	✓	spoo	✓	fich	✓
ankor (v)	✓	solemm (v)	✓	goom	✓	flere	✓
wond (v)	✓	ankor (v)	✓	fich	✓	sheb	✓
roze (v)	✓	roze (v)	✓	flere	✓	pume	✓
korde	✓	scowt (v)	✓	sheb	✓	etum	✓
fite	✓	moov (v)	✓			opil	✓
riste	✓	otum	✓			phogo	✓
wissil	✓	fite	✓			antor	✓
wich	✓	riste	✓				
scule	✓	pholo	✓				
antor	✓	wich	✓				

Incorrect word responses

H.M.	J.E.	H.M.	J.E.
grene (v)→dream	skie (v)→ski	loze→lose	loze→louse
shoo (v)→show	shef (v)→shelf	glud→blood	rond→Ron
scowt (v)→scoot	wond (v)→wound	scuge→scourge	goom→gloom
moov (v)→moo	blud→blub	grele→grill	
shef (v)→sheaf	apil→april	vissil→vessel	
tume (v)→theme	korde→cod	scort→school	
woom (v)→whom	scule→scrawl	rond→rod	
	tume→tum	pume→plume	
		skoe→shoe	
		heeb→heap	

Incorrect non-word responses

H.M.	H.M.
skie (v)——→skay /skeɪ/	niste——→nistey /nɪstɛɪ/
apil——→aprill /æprɪl/	voor——→vor /vɔr/
blud——→blid /blɪd/	polemm——→pole.em /poʊl.ɛm/
otum——→othum /ɔθʌm/	fide——→frid /fraɪd/
J.E.	etum——→etrum /ɛtrʌm/
grene (v)——→gren /grɛn/	dorde——→dorded /dɔdəd/
wissil——→wizil /wɪzəl/	opil——→owpill /aʊpɪl/
woom——→voom /vum/	J.E.
	polemm——→plome /ploʊm/
	scuge——→scrug /skrʌg/
	niste——→nist /nɪst/
	voor——→vore /voʊɪ/
	glud——→grud /grʌd/
	vissil——→vizil /vɪzəl/
	heeb——→heb /hɛb/
	spoo——→spow /spoʊ/
	skoe——→skoo /sku/
	grele——→grel /grɛl/
	dorde——→dor /dɔɪ/

ABLE 20 (v): visually similar to homophonic word

esponses to the Temple homophonic non-word list

Single Word Reading : Error Analysis

J.E.'s single word reading age on the Schonell (12 years 4 months) is higher than that of H.M. (10 years 9 months).Both these scores lie within the range covered by the acquired phonological dyslexics. The words on the Schonell test are graded in order of difficulty. Preliminary observations of the error patterns were made by examining the first ten errors on the Schonell test. For H.M. these were :

1. angel ⟶ "angle"	6. campaign ⟶ "campaigner"
2. appeared ⟶ "appearance"	7. intercede ⟶ "interceded"
3. attractive ⟶ "achieve"	8. fascinate ⟶ "fascinated"
4. imagine ⟶ "image"	9. recent ⟶ "resend"
5. smoulder ⟶ "smouldering"	10. prophecy ⟶ "prophency"/prɒfənsɛɪ/

For J.E. they were :

1. saucer ⟶ "sauce"	6. intercede ⟶ ———
2. applaud ⟶ "applause"	7. colonel ⟶ "clone"
3. imagine ⟶ "image"	8. slovenly ⟶ "solventlу"
4. nourished ⟶ "nourish"	9. pivot ⟶ "prot"/prɒt/
5. diseased ⟶ "disease"	10. pneumonia ⟶ ———

The most striking aspect of these errors is the prevalence of derivational errors. Four of J.E.'s ten errors are derivational and six of H.M.'s. Only one neologistic response appears in each set of ten, and these are made by H.M. to the hardest of the ten and by J.E. to the second hardest. Both H.M. and J.E. did produce more neologistic responses to the harder stimuli on the Schonell. These stimuli bear little resemblance to any real word other than the target. The other paralexic responses recorded above are visual paralexias.

A more detailed error analysis was conducted using the stimuli on the Coltheart et al (1979), the Stanovich and Bauer (1978), the Marshall derivational and the Temple lists. These were the stimuli which had been used for the error analysis with R.B., in the previous section on surface dyslexia. The stimuli totalled 434 in all.

H.M. made 69 errors and read 385 stimuli correctly; J.E. made 49 errors and read 385 stimuli correctly. The majority of the errors were paralexias. Fifty-two of H.M.'s errors (75%) were paralexias and 44 of J.E.'s errors.

Both girls made substantial numbers of derivational errors. For J.E. derivational paralexias were the largest paralexic category accounting for 55% of the paralexias and 49% of all errors. For H.M., 21% of the paralexias were derivational, 16% of all errors. These errors were :

H.M.

weigh → "weight"
instance → "instant"
cautious → "caution"
beautiful → "beauty"
removal → "remove"
high → "height"
belief → "believe"
examination → "exam"
kept → "keep"
spend → "spent"
aunt → "auntie"

J.E.

baker → "bake"
thinness → "thin"..."ness"
certainty → "certain"
manage → "management
examination → "examine"

J.E.

weigh → "weight"
instance → "instant"
shady → "shade"
chorus → "choirs"
honesty → "honest"
image → "imagine"
children → "child"
jumper → "jump"
spend → "spent"
classes → "class"
cautious → "caution"
sickness → "sicken"
sharpness → "sharpen"
reporter → "report"
gentleness → "gentle"
political → "politician"
enetrtainment → "entertain"
banishment → "banished
arrive → "arrival"

H.M.'s predominant paralexic category was visual. These accounted for 69% of her paralexias and 52% of all her errors. J.E. made fewer visual paralexias. They accounted for 41% of her paralexic responses and 37% of all her errors. The visual paralexias are listed in Table 21.

The remaining paralexias are visuo-semantic :

H.M.	J.E.
thiness → "thickness"	county → "country"
arrangement → "agreement"	float → "flood"
politics → "policies"	
click → "clink"	
liquor → "liqueur"	

J.E. made only five neologistic responses :

shove → "showv"/ʃoɷv/	throng → "throg"/θrɒg/
chasm → "chame"/tʃeɪm/	gnaw → "gaw"/gɔ/
aisle → "I.sill"/aɪ.sɪl/	

H.M. made 17 neologistic errors :

barge → "barget"/bɑdzət/	chaos → "chasi"/tʃæseɪ/
unjust → "injust"/ɪndzʌst/	pint → "pint"/pɪnt/
whistle → "whistol"/hwɪstɔl/	adjective → "adjustive"/ædzʌstɪv/
align → "orgine"/ɔgaɪn/	shove → "showv"/ʃoɷv/
gnaw → "grawn"/grɔn/	barge → "barg"/bɑg/
distress → "distree"/dɪstrit/	throng → "trong"/trɒŋ/
spade → "spad"/spæd/	subtle → "subtickle"/sʌbtɪkəl/
scarce → "scarsea"/skɑsi/	borough → "bowroff"/bəɷrɒf/
persasion → "purse.you.A.tion" /pəs.ju.ei.ʃən/	

This error analysis is summarised in Figure 7.

VISUAL PARALEXIAS MADE BY H.M. AND J.E.

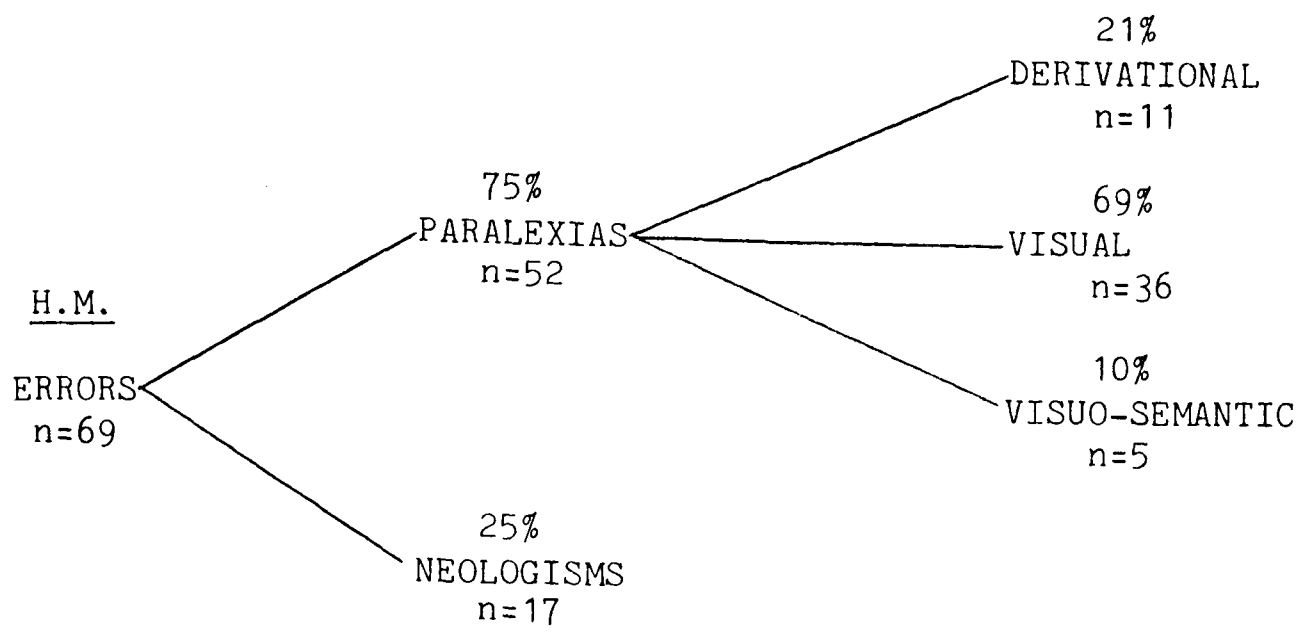
H.M.

fir → "fry"
average → "avenge"
chimp → "crimp"
press → "pass"
mope → "mop"
cheery → "cherry"
ripe → "rip"
harsh → "hushed"
shone → "stone"
solemn → "Solomon"
scorn → "score"
recent → "resent"
mass → "mess"
shady → "shandy"
ashamed → "ascent"
variation → "Venetian"
bake → "break"
persuade → "pursuit"
breadth → "breath"
destruction → "destraction"
approve → "approach"
strength → "strange"
aide → "eyed"
along → "alone"
classes → "classy"
dew → "drew"
aisle → "alas"
heir → "here"
elite → "alight"
cliche → "clinch"
chassis → "classist"
rub → "rib"
sew → "shrew"
trough" → thought
thorough → "through"

J.E.

jewel → "jury"
fir → "fire"
mop → "mope"
cheery → "cherry"
rip → "ripe"
adjective → "abject"
archer → "anchor"
subtle → "stubble"
gauge → "gorge"
boost → "boast"
lose → "loose"
fight → "fright"
cliche → "clique"
couch → "cough"
furnish → "finish"
strength → stretch
chassis → "chase"
thorough → "through"

TABLE 21



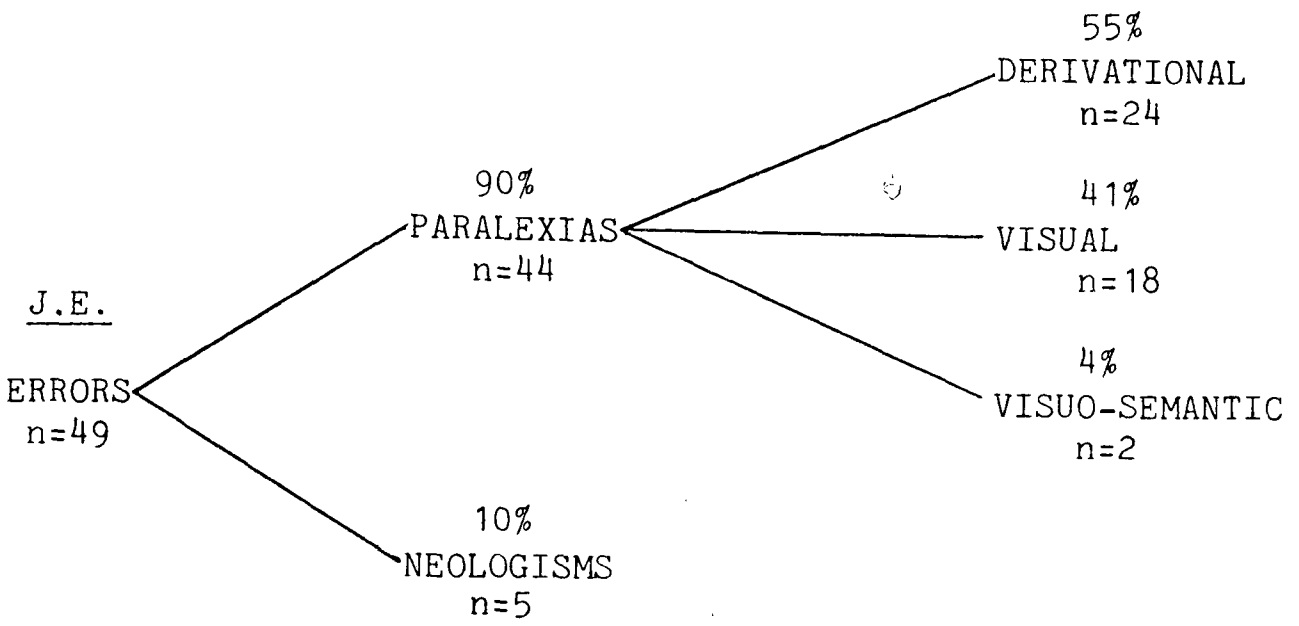


FIGURE 7

SINGLE WORD READING : ERROR ANALYSIS FOR H.M. AND J.E.

Two further lists (which had not been used with R.B.) were given to H.M. and J.E. One was given because of the prevalance of derivational errors. This first list consisted of prefixed and pseudoprefixed words taken from the appedices of Taft (1981) and Rubin, Becker and Freeman (1979). There were 90 stimuli. The responses are listed in Tables 22 and 23.

The final reading list was Nelson's long regular word list (Nelson and O'Connell 1978), which contains 20 words of declining frequency. Proficient readers, even if unfamiliar with these stimuli, should be able to read them aloud correctly. The poor performance of J.E. and H.M. on reading non-words suggested that performance on this list might illustrate reading breakdown when sight vocabulary cannot be employed.

STIMULUS	H.M.	J.E.
adventurously	adventurous	adventurous
individual	✓	✓
uninterested	uneinterested/unɪntrɛstd/	✓
experimenter	✓	experimental
apprehensive	✓	apprecia..ap.pre.sae.hen.siv /æprisiet..æp.pri.set.hen.siv/
indiscoverable	✓	✓
manufactured	✓	✓
organisations	organisitations/ɔgæɪsɪte ʃənz/	organisation
particularly	✓	✓
masterpiece	✓	✓
chitterling	chatetaring/tʃætərɪŋ/	chiltering/tʃɪltərɪŋ/
herpetology	herpetrolog/hɜpɛtrɔlɔg.	hepetology/hɜpɛtɔlɜgeɪ/
fleeringly	fledringly/flɛdrɪŋleɪ/	flurring/flʌrɪŋ/
huckaback	hugaback/hʌgəbæk/	✓
intertergal	intratraegal/ɪntrətregæl/	inter.cr.er.igal/ɪntɜ.kr.ɛr.ɪgɜl/
tipularian	tripulaerian/tripəleriən/	tipularin/tɪpjuleɪrɪn/
gressorial	gassorical/gæsɒrɪkæl/	grezoral/grɜzoərɜl/
pegmatic	paedmatic/pɛdmætɪk/	pegmetitik/pɛgmɜtɪtɪk/
hectographic	hetrographic/hɛtroəgræfɪk/	✓
shibboleth	shabipolethic/ʃæbɪpɔlɛθɪk/	shibbocet.th/ʃɪboəsɛt.θ/

STIMULUS	H.M.	J.E.
absent	✓	✓
assure	✓	✓
contribute	✓	✓
devoid	✓	devowel
define	✓	✓
disappear	✓	dispair
discourage	✓	✓
enact	✓	✓
impress	✓	✓
impulse		✓
indirect	✓	✓
intervene	✓	✓
misplace	✓	✓
mistake		✓
propose	proproše	✓
recover	discover	✓
remark	✓	✓
uniform	✓	✓
unknown	✓	✓
unlike	✓	✓
intrigue	✓	introog
impeccable	✓	✓
rejoice	✓	✓
convince	✓	✓
retard	✓	✓
obscure	✓	✓
engage	✓	✓
recognise	✓	✓
subsidize	subsidee, sibsidezen, subsides	substidise
delete	✓	elite
advance	✓	✓
regard	✓	✓
demolish	✓	✓
deposit	✓	✓
replenish	✓	replenished
deprive	✓	reprive
convex	✓	✓
confide	✓	✓
impudent	impugnant	impotent
constellation	consolidation	consolation
insolent	insolvent	isolated
intrepid	interpede	✓
repugnant	reugnet	✓
prostrate	✓	✓
replica	reeplenee	✓

TABLE 22 RESPONSES TO PREFIXED WORDS

STIMULUS	H.M.	J.E.
abbey	✓	✓
abrupt	✓	✓
asset		✓
avenue	✓	✓
concert	✓	✓
delicate	✓	✓
disaster	✓	✓
dismal	✓	✓
engine	✓	✓
impetus	impetows	impertent
infant	✓	✓
misery	mystery	✓
probable	✓	✓
reckon	✓	✓
unique	✓	✓
uncle	adequate	✓
premium	✓	✓
interim	intermit	✓
remedy	✓	✓
devout	✓	✓
assasin	ascending	✓
enamel	✓	✓
delicious	✓	✓
enigma	✓	✓
regime	redeem	✓
despair	respair	✓
instrument	✓	instructment
deluge	delude	delude
regatta	regretter	regetta
unique	uniquate	✓
religion	✓	✓
delirious	delearious	✓
destination	disination	✓
desciple	discruple	✓
eclipse	✓	✓
indigo	indigno	✓
prosaic	prosatic	prostatic
promenade	promedded	✓
referendum	refemen	refer.endum
embryo	✓	✓
amiable	aimble	amible
precipice	precaptise	preciate
benign	benigine	bend,been,no
predation	predate	predentation
comedy	✓	/

TABLE 23

Responses to pseudoprefixed words

It is clear that the words at the end of the Nelson list are being treated like non-words and the responses resemble those made to the long regular word on the Coltheart list.

Effect of linguistic dimensions

Regularity effects were investigated with the Coltheart et al (1979) list, the Stanovich and Bauer (1978) list and the Temple list. Stimuli on the Temple list were also used to investigate the effects of length, imageability and frequency.

Effect	List	H.M.	J.E.
Regularity	Coltheart	32/39R 29/39I	36/39R 35/39I
"	Stanovich and Bauer	45/50R 41/50I	46/50R 43/50I
"	Temple	18/26R 21/26I	23/ 6R 24/26I
Imageability	Temple	36/40H 23/40L*	35/40H 36/40L
Frequency	Temple	36/40H 23/40L*	37/40H 34/40L
Length	Temple	23/30G 25/30S	25/30G 27/30S

R:Regular, I:Irregular, H:High, L:Low, G:Long, S:Short

(* X= 9.29, $p < 0.01$, statistically significant)

None of the above linguistic dimensions have a significant effect upon the reading of J.E. H.M.'s performance is significantly affected by both imageability and frequency. A breakdown of her scores indicates that she reads 20/20 words of high frequency and imageability; 16/20 words of high frequency and low imageability; 16/20 words of low frequency and high imageability; and 7/10 words of low frequency and low imageability. Thus not only does each dimension have an effect but the effects are cumulative.

Part of speech effects were not investigated directly but the

reading of function words was checked.J.E. and H.M. were both asked to read aloud the stimuli in the function word list. H.M. read all 32 words correctly. J.E. read all but one correctly.

Although the girls are good at reading function words in isolation, problems are created when the function words are presented in text. A substantial proportion of the errors in text reading are on function words and this disability accounts in large part for the score for Text reading on the Neale Analysis of Reading Test, in comparison to the single word reading age on the Schonell test . (J.E. :Schonell reading age 12.4; Neale Reading age 9.2; H.M. :Schonell reading age 10.11; Neale reading age 9.7). Many children and adults make errors on function words when reading aloud, but the severity of the problem for the two children is striking.

For example, in the fifth passage of the Neale (form C),H.M. made 20 errors. Seven of these (35%) were on function words. In the sixth passage of the same text, she made 15 errors. Five (33%) were on function words.

The function word difficulties, combined with the other reading problems, produce severely impaired reading of text. An example for each girl is given below. The sentences are taken from the Neale analysis of reading test. H.M. was presented with the passage. :

> Among animals the fox has no rival for cunning. Suspicious of man,who is its only natural enemy, it will, when pursued, perform extraordinary feats, even alighting on the backs of sheep to divert its scent trail.

She read it as follows :

> Amongst animals the fox has no rivals for cunning.Surprisingly of man, who is its only natural enemy, at will, with pursued performance extraordinary feat_, even alighting on the backs of sheep to divert its scent trial.

J.E. was presented with the following sentence:

> Each April, at the re-appearance of the cuckoo in its familiar haunts, bird-watchers must marvel at the accurate flights with which birds span the distances between their seasonal abodes.

She read it :

> Each April, at the re-appearance of the cuckoo in the familiar haunts, the bird-watchers must marvel at the accent flights,___ which the birds span the distance_ between the seasonal abdoze.

It is apparent that both girls' reading is paragrammatic (Kleist 1934).

Homophone Reading

The 40 word homophone list was presented to J.E. and H.M. for reading aloud. After reading each word they were asked to say what it meant. H.M. made three reading errors. Of the 37 words read correctly only three were defined as their respective homophones. J.E. read and defined all the stimuli correctly. Thus neither girl displays significant homophone confusion. The three stimuli for which H.M. made comprehension errors despite correct reading were : grown, currant, and peace. They were all stimuli which differed from their respective homophones by only one letter : groan,current, and piece. Given H.M.'s incidence of visual paralexias these confusions are not surprising.

Distorted Typescript

H.M. and J.E. were presented with the Core 80 words written in four different ways. They contained the 25 words used with R.B. As with R.B., the first presentation was in normal lower case type, the second in poor handwriting. the third in lower case type with the

letters in the reverse order, and the final presentation with upper case type and the letters in the reverse order.

STIMULI	H.M.	J.E.
Normal Typescript,e.g.large	60/80	71/80
Handwritten e.g. 	66/80	67/80
Reversed lower case, e.g. egral	56/80	49/80
Reversed upper case,e.g. EGRAL	69/80	52/80

The figures above give the number of stimuli read correctly in the different presentations. J.E. is not significantly impaired when handwritten stimuli are presented but is significantly impaired when the stimuli are presented typed in the reverse order (lower case $X^2 = 14.7$, $p<0.001$; upper case $X^2 = 11.38$, $p<0.001$). That is, the distortion that requires analytical perception impairs reading performance.

With H.M. the results are less clear cut. However, the figures as stated above give a somewhat misleading representation of her performance. Firstly, although there is no decrement in overall performance in the reverse type conditions for H.M., there was a dramatic increase in reaction times. Reading the normal typeface always occured in under a second. Reading of the reversed stimuli often took over 20 seconds. No such dramatically lengthened responses had occured when R.B., the surface dyslexic, performed the task (see p 59).

Secondly, H.M. developed the strategy in the latter part of the reversed lower case list, of writing each of the words with her finger on the table. She wrote the words with the letters in the correct order and then seemed to 'read' from the invisible writing on the table. Once this strategy had been developed H.M. made only

one further error; this suggests that self-generated visual and kinesthetic cues facilitated performance. When reading the reverse order capitals she again started to use her hands. She was requested to keep them still but was repeatedly unable to stop. When her fingers were not used, her whole arm would make tiny movements tracing out the word. On those trials for which hand and arm movements were successfully prevented, H.M. would look at the word quickly and then shut her eyes tightly, producing the response some 20 seconds later. She claimed that if she was looking at the stimulus she could not perform the task. It seemed from these unexpected behaviours that this intelligent teenager had developed an elaborate strategy to cope with the task demands, which utilised some mechanism or routine not normally employed during reading. Although asked to introspect about what she was doing, with her eyes shut, she said that she was unable to describe the process.

Spelling

Non-word Spelling

Both H.M. and J.E. were asked to spell to dictation the 3- letter and 5/6-letter lists of balanced words and non-words. H.M. spelt all the three letter stumuli correctly. There were five errors on the 5/6-letter list. All were lexicalisations of non-words.

"doptor" ⟶ doctor	"plass" ⟶ place
"lorse" ⟶ horse	"gemon" ⟶ gammon
"chait" ⟶ cheat	

J.E. made one error with the three-letter stimuli; the non-word "gen" ⟶ gan. There were nine errors on the 5/6-letter list. Two were to words : "horse" ⟶ horce, and "glass" ⟶ class.

The other seven were non-word errors. Five were lexicalisations:

"doptor" → doctor	"inlect" → inlet
"hencil" → pencil	"gemon" → gammon
"chait" → chat	

The two remaining errors were : "fince" → fic, "trown" → tron.

Of the twenty-nine non-word stimuli on these two lists, H.M. had read 20 correctly and, as seen above, spelt 24 correctly. J.E. had read 19 correctly and spelt 21 correctly. Although spelling is slightly better than reading for these stimuli, the effect is not marked. In each case non-words are more problematic than words and are frequently lexicalised.

Single Word Spelling

Both H.M. and J.E. have the same Schonell spelling age of 10 years 7 months. The 160 word list was dictated for spelling and the error types analysed.

Both H.M. and J.E. made 45 errors on this list. For H.M. 19(42%) of these were phonologically accurate. For J.E. 13(29%) were phonologically accurate. A number of these were errors in which spelling was simplified, e.g.

H.M.	J.E.
"solemn" → solom	"chorus" → corus
"mattress" → matress	"mattress" → matras

But some appear to involve more complex correspondences, e.g:

H.M.	J.E.
"throat" → throught	"whistle" → wiscle
"write" → wright	"doubt" → dought

The other phonologically accurate errors were :

H.M.		J.E.	
"dumb"	→ dum	"hop"	→ hopp
"invitation"	→ invatation	"fir"	→ fur
"joyful"	→ joyfull	"anchor"	→ ancher
"portion"	→ pourtion	"recent"	→ resant
"menace"	→ menous	"ought"	→ ort
"purchase"	→ purchess	"source"	→ sorce
"archer"	→ archor	"passport"	→ pasport
"gentle"	→ gental	"purchase"	→ perchase
"doubt"	→ dout	"health"	→ helth
"cheat"	→ cheet		
"debt"	→ det		
"whistle"	→ whisle		
"deceit"	→ desete		
"honesty"	→ onistey		
"stomach"	→ stomac		

A number of spelling errors are phonologically accurate except for the vowel. Some of these are valid in the terms laid out in the section on surface dyslexia, i.e. in the context of some words they would have been appropriate representations for the vowel but they are wrong in the context of the word in question:

H.M.		J.E.	
"fresh"	→ freas	"solemn"	→ solume
"hop"	→ hope	"rip"	→ ripe
"fir"	→ fure	"debt"	→ deat
"mechanic"	→ mechanice	"cheery"	→ chery

Others are phonologically accurate except for the vowel , but the representation of the vowel is invalid:

H.M.	J.E.
"possible" ⟶ possiable	"audience" ⟶ adience
"choir" ⟶ chore	"influence" ⟶ inflince
"variation" ⟶ varation	"ration" ⟶ reation
	"mechanic" ⟶ mechinic
	"champion" ⟶ champon
	"unjust" ⟶ injust

H.M. makes two errors which are phonologically accurate except for a misordering : "influence" ⟶ infulence,"chlorine" ⟶ colrean. J.E. makes two errors which are phonologically accurate but are also misorderings : "gentle" ⟶ gentel, "thunder" ⟶ thundre.

If the above errors are grouped together, then 28(62%) of H.M.'s errors are basically accurate phonologically and 25(56%) of J.E.'s errors are basically accurate phonologically.

H.M. makes two errors that are derivational :"weigh" ⟶ weight, "hid" ⟶ hide ; one that is both derivational and orthographic : "patient" ⟶ patiance ; one that is either derivational or a misordering : "ate" ⟶ eat, and one that is a misordering : "mate" ⟶ meat.

J.E. makes an error that is derivational : "hid" ⟶ hide; one that is derivational or a misordering, "ate" ⟶ eat;and in addition to the two errors listed previously a further three errors that are misorderings alone : "throat" ⟶ thoart, "mate" ⟶ meat, "patient" ⟶ paitent.

H.M. and J.E. made a further three paragraphias :

H.M.	J.E.
"pat" ⟶ pad	"dumb" ⟶ dump
"short" ⟶ shone	"wine" ⟶ whine
"source" ⟶ sour	"angel" ⟶ angle

The ramaining 9(20%) errors of H.M. and 12(27%) errors of J.E. resemble the stimulus both orthographically and phonologically and are errors of partial lexical knowledge (Ellis 1980).

H.M.	J.E.
"audience" → aurdence	"chlorine" → chorine
"chorus" → chorce	"digest" → dyest
"mope" → momb	"disgrace" → descrass
"secretary" → secatary	"strict" → strick
"record" → recond	"choir" → qure
"shiny" → shinny	"archer" → achet
"orchestra" → orchester	"barge" → barage
"ration" → rason	"scorn" → scrorn
"relation" → retation	"instance" → stance
	"nothing" → nothin
	"honesty" → horesty
	"menace" → manache

In conclusion, the pattern of spelling, particularly for H.M., appears to be primarily phonological and indeed on the regularity section of Core 80 , it was found that H.M. spelt correctly more regular than irregular words. The figures were respectively 21/26 and 14/26 (This difference just falls short of significance $\tilde{X}^2=3.42, p<0.06$).

The spelling analysis is summarised in figure 8.

Reading of misspellings

Only J.E. was required to reread her own spellings of the Temple list. She made 27 errors, reading 133 words correctly. On original presentation with all stimuli correctly spelt, she had made only 15 errors. Thus J.E. finds her own representations harder to read than

Spelling Error Analysis (categories not mutually exclusive)

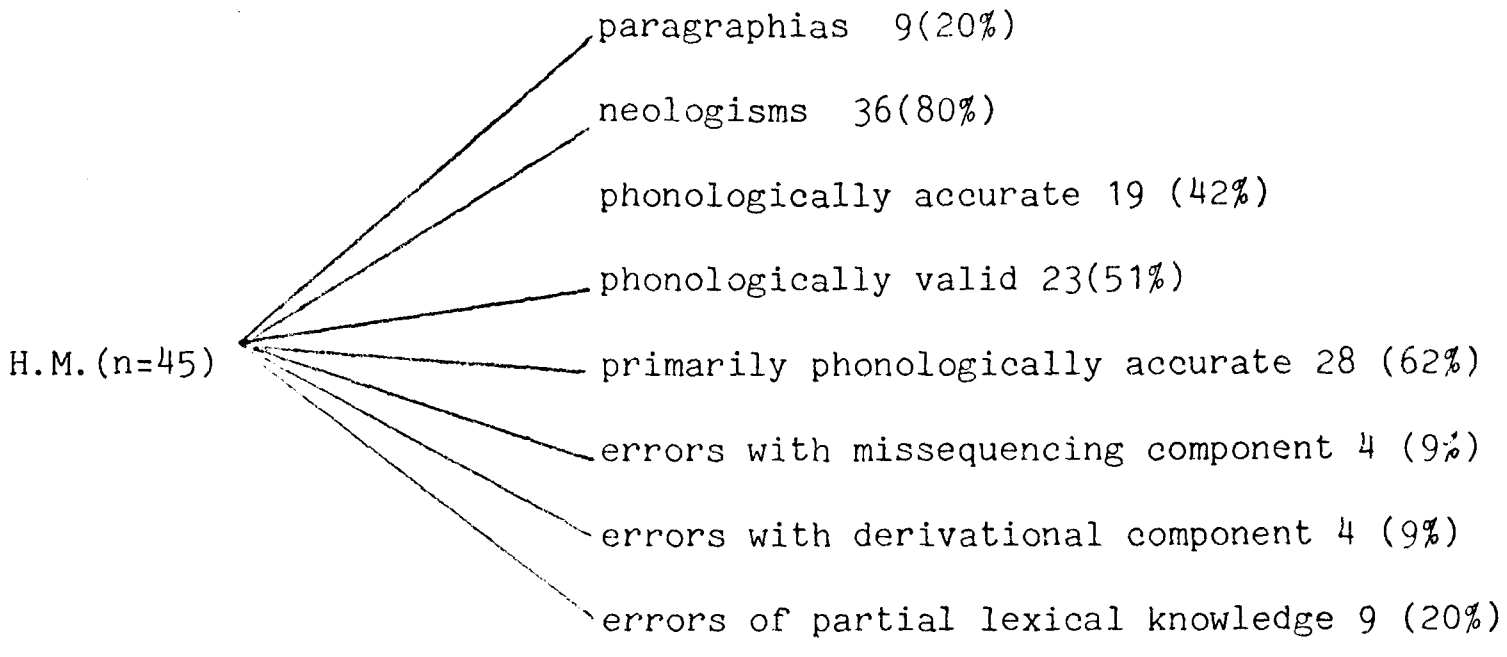


FIGURE 8

the correctly typed spellings.

Unlike the numerous examples listed for R.B., there are only two instances where a correctly spelt word is read wrongly on the original presentation yet is read correctly when spelt wrongly in the later handwritten presentation.

fir ⟶ read as "fire"
⟶ spelt as fur ⟶ reread as "fir"
chorus ⟶ read as "choirs"
⟶ spelt as corus ⟶ reread as "chorus"

A number of J.E.'s other misspellings are read correctly but these responses are all to words which were read correctly when spelt correctly as well. There are 29 examples. The spelling errors which J.E. fails to reread correctly are :

"hid" ⟶ hide reread as "hide"
"chlorine" ⟶ chorine reread as "crown"
"choir" ⟶ qure reread as "queue"
"menace" ⟶ menache reread as "mechanic"
"purchase" ⟶ perchase reread as "purchase" (stress error)
"archer" ⟶ cher reread as "anchor"
"cheery" ⟶ chery reread as "cherry"
"ate" ⟶ eat reread as "eat"
"barge" ⟶ barage reread as "barage"
"unjust" ⟶ injust reread as "injust"
"instance" ⟶ Istance reread as "instant"
"rip" ⟶ ripe reread as "ripe"
"mate" ⟶ meat reread as "meat"
"ration" ⟶ reaction reread as "reaction"
"honesty" ⟶ horesty reread as "horsey"

Spelling of homophones

The homophone word list was dictated (with a gloss for meaning) for written spelling. J.E. made ten errors on the forty word list. On five occasions the homophone not the target was written. The other five errors were :

"tyre" → tye	"tire" → tie
"cheap" → sheep	"flew" → fly
"aloud" → alloud	

The first two errors indicate an awareness of the difference between the homophones. The error to flew is derivational. The final error is a blending of the spelling of the two homophones :aloud and allowed.

H.M. made only four errors; none were homophonic spellings. Two were errors produced by the blending of homophones :

"piece" → pieace "peace" → pieace

One error was derivational, "flew" → fly. In the final error to "heel", the third letter was written so that it was neither an e nor an a but looked like ɑ.

J.E. thus exhibits some homophone confusion where H.M. shows no clear-cut instances.

Oral Spelling

On the Schonell spelling test (Form A), H.M. obtained a written spelling age of 10 years 7 months. When the same test was presented for oral spelling two months later she attained a spelling age of 9 years 11 months.The words on the Schonell are graded for difficulty. In order of increasing difficulty the words that provoked errors are listed in Table 24. There were 34 written errors and 39 spoken errors. Seventeen of the written errors (50%) were phonologically valid. There was one written derivational error and one misordering. 22 (56%)

STIMULUS	WRITTEN RESPONSE		ORAL RESPONSE	
by	✓		BUY	(p)
talk	tock	(p)	TAKL	(o)
noise	noice		✓	
hoped	hope	(d)	HOPE	(d)
worry	worrie	(p)	WORRIE	(p)
dancing	danceing	(p)	✓	
else	eals	(p)	ELES	(o)
entered	entra		ENTAR	
cough	cought		✓	
fitted	✓		FITED	(p)
spare	✓		SPEAR	(o)
edge	eadge	(p)	EAGE	(p)
search	surch	(p)	SURCH	(p)
recent	resent	(p)	RESENT	(p)
instance	✓		INSTANT	(d)
assist	assast		ASISTE	(p)
readily	readly		REALLY	
guess	juss		GESS	
attendence	✓		ATENDANCE	(p)
description	precriperion		DISCRIPTION	(p)
welfare	✓		WELFAR	(p)
genuine	genovin		GENUN	
interfere	interferrer		INTERFER	(p)
accordance	✓		ACORDANCE	(p)
mechanical	macanical	(p)	MECANICAL	(p)
anxious	anshious	(p)	ANSURS	
signature	signitous		SIGNITURE	(p)
allotment	altotment	(p)	ALOTMENT	
approval	aproval	(p)	APROVEL	(p)
accomplished	acomplished	(p)	ACOMPLISHED	(p)
remittance	✓		REMANCE	
financial	financhal	(p)	FINANCHAL	(p)
capacity	capasatly		CAPASTY	
surplus	cerples	(p)	SERPLES	(p)
preliminary	prolimnary		PROLIMNARY	
resource	✓		RESOCE	
prologue	prolog	(p)	PROLOG	(p)
colonel	cornol		CORNOL	
coarse	cource	(p)	COURCE	(p)
referring	✓		✓	
courteous	curtus		CURTUS	
exceptionally	exceptionaly	(p)	EXCEPTIALY	
successful	sucessful	(p)	SUCESSFUL	(p)

(p) : phonologically valid; (d) :derivational; (o) :misordering

TABLE 24

H.M.'s written and oral spelling errors on the Schonell

of the spoken errors were phonologically valid. Two were misorderings and two were derivational. If written and spoken errors to the same stimuli are compared there are 30 relevant stimuli. 16 of these are spelt correctly in written form (53%) and 17 are spelt correctly in oral form (56%). Thus the same proportion of written and spoken errors are phonologically valid, when errors are made to the same stimuli. In addition, further oral spelling errors are made to stimuli which are spelt correctly in written form.

J.E. also obtained a written spelling age of 10 years 7 months on the Schonell (test A). Her oral spelling age on this test (on the same day) was 8 years 7 months. Like, H.M. her oral spelling was worse than her written spelling, but the discrepancy for J.E. is more marked. In order of increasing word difficulty the errors made by J.E. are listed in Table 25.Sixteen stimuli are written correctly but not spelt aloud correctly. Three are spelt aloud correctly but not written correctly. Of the written errors, 6 are phonologically valid (46%). There are two misorderings. Of the oral errors, 10 are phonologically valid (38%). If the words which produce errors on both tasks are examined, then of the relevant 10, six written errors are phonologically valid and three oral errors are phonologically valid. Thus not only is J.E.'s oral spelling worse than H.M.'s oral spelling, despite equivalent written spelling, but there is a suggestion that oral spelling errors tend to be less accurate phonologically.

Rhyme Fluency

Once more , as a preliminary to the rhyme fluency task,a fluency task was given. In one minute, H.M. named 21 animals and J.E. named 27. In the category "things" H.M. named 32 in a minute and J.E. names 30.

As with R.B., twelve individual words were presented and a minute

STIMULUS	WRITTEN RESPONSE		ORAL RESPONSE	
loud	✓		LOWED	(p)
ground	✓		GROND	
lowest	lowerst	(p)	LOWERST	(p)
amount	✓		AMONT	
noise	✓		NOIES	
dancing	✓		DANCEING	(p)
damage	✓		DAMAJE	(p)
else	eles	(o)	ELES	(o)
through	✓		THOGH	
entered	enterd	(p)	ENTRED	(p)
cough	✓		COGH	
spare	spar	(p)	✓	
daughter	✓		DAUGHT	
edge	✓		✓	
search	serech		SHEACH	
freeze	✓		FREZE	(p)
avoid	✓		AVODE	
duties	dutyes		DUTYS	(p)
recent	✓		REASOT	
instance	✓		INSTANC	(p)
assist	assit		ASSIT	
readily	redaly		REALY	
guess	✓		GUES	
attendance	✓		ATTENDANT	
description	disindtion		DESCRIPTON	
welfare	wealthface		✓	
various	✓		VARIOS	(p)
genuine	guiene		GUEINE	
interfere	interfear	(p)	INFER	

(p) : phonologically valid; (d) : derivational; (o) :misordering

TABLE 25

J.E.'s written and oral spelling errors on the Schonell

was given for each word so that J.E. and H.M. could attempt to produce a series of rhymes. J.E. and H.M. were able to produce rhymes to each word. In total, they produced a good number each, but although their category fluency was roughly equivalent, H.M.'s performance was much better than J.E.'s on rhyme fluency. H.M. did make one incorrect response, but J.E. made as many as 11 incorrect suggestions. Responses are listed in Table 26, with errors given in brackets.

A number of J.E.'s errors appear to revolve around a lack of distinction between n and m. These two sounds differ by only one phonetic feature. Both are sonorant, voiced and nasal but m is a labial and n is an alveolar (Fromkin 1978). Four errors do not result from confusions of these two sounds : 'tot' is given as a rhyme for 'shop', 'nag' is given as a rhyme for 'crab' and both 'win' and 'tin' are given as rhymes to 'ring'. In the first of these, a word with terminal /t/ is produced instead of a word with terminal /p/. /t/ and /p/ also differ by only one distinctive feature. /p/ is a labial and /t/ is an a alveolar. In the second example, a word with terminal /g/ is produced instead of a word with terminal /b/. /g/ and /b/ also differ by only one phonetic feature. /b/ is a labial and /v/ is a velar. In the final two errors words ending in /n/ are produced instead of words ending in /n/. Once again only one phonetic feature differs. /n/ is an alveolar and /n/ is a velar. Both sounds are sonorant, voiced and nasal.

Auditory Rhyme Pairs

The pairs of rhymes described previously (p 18-19), were presented orally to H.M. and J.E., They had to decide whether each pair rhymed. Both girls were impaired on this task of auditory rhyme recognition. H.M. made 14 errors to the 48 pairs. One rhyming pair in the set

RESPONSES ON THE RHYME FLUENCY TASK

H.M.	
hate → late, bait, fate, skate, date, ate, gate, mate wait, Kate.	10
bone → phone, Joan, groan, own, known, moan, sown, loan	8
nine → swine, vine, sign, line, fine, dine, brine	7
shop → lop, cop, flop, slop, top, stop, sop	7
fear → near, here, beer, deer, gear, steer, weir	7
crab → lab, stab, fab, dab, grab, nab	6
hen → pen, glen, fen, den, men, when	6
cold → bold, old, fold, sold, told	6
ring → ding, thing, ting, sing, bring	5
stitch → hitch, ditch, itch, nitch (fetch)	4
duck → stuck, muck, luck	3
wool → bull, full	2
Mean per word = 6	71

J.E.	
fear → here, mere, rear, jeer, tear, peer, weir	7
cold → hold, bold, told, old, mold, fold	6
duck → tuck, luck, pluck, muck	4
shop → hop, stop, top, pop (tot)	4
hen → pen, ten, Ben, when, (hem,gem)	4
stitch → hitch, bitch, witch, pitch	4
hate → bait, slate, Kate, mate	4
bone → tone, clone, phone, (comb)	3
wool → pull, bull, cool	3
ring → bring, king, ping (win, tin)	3
crab → tab, lab, jab (nag)	3
nine → pine, fine, (time,lime,dime,mime)	2
Mean per word = 3.9	47

TABLE 26

P23 was considered not to rhyme : 'hate'-'late'. Six stimuli in the set P13 (where the first and final sounds were held in common) were considered to rhyme : 'duck-deck', 'nine-nun', 'hen-hymn', 'ring-rung','stitch-starch','hate-hat'. Since there are twelve pairs in this set and exactly half were considered to rhyme and half not, performance on this group is random. This is also true for the set P12 (where the first and central sounds were held in common but not the terminal sounds). Here seven pairs were falsely judged to rhyme: 'shop-shone', 'nine-knife', 'hen-head', 'ring-rip','bone-bore', 'fear-feed', 'crab-cram'.All of the pairs where no sound was held in common e.g. 'hate-duck', were correctly judged not to rhyme. It should be noted that H.M. only made one error when the same words were employed in the rhyme production task. Yet rhyme recognition is poor. For example, given the word 'ring' H.M. correctly produced the rhymes 'ding', 'thing', 'ting', 'sing', 'bring' and makes no errors. Yet, presented with the pairs 'ring-sing', 'ring-rung'. 'ring-rip', and 'ring-fear' she judges that all are rhyming pairs except for 'ring-fear'. An even more extreme example is provided by the target 'hate'.H.M. produced ten correct rhyming responses for this target on the rhyme production task. Yet on the recognition task she judged that 'hate-late' did not rhyme and 'hate-hat' did.

It has been seen that J.E.'s performance on the rhyme production task was poorer than H.M.'s and that errors were more prevalent. J.E. was also impaired on rhyme recognition. One rhyming pair : 'nine-line' was initially judged not to rhyme although this was self-corrected. Five of the pairs in the set P13 were falsely considered to rhyme: 'duck-deck', 'nine-nun', 'stitch-starch','bone-bib', 'crab-crib' Thus, as with H.M., J.E.'s performance on this group is random. But J.E.'s performance is much better than H.M.'s on the group P12. H.M. had made seven false positive responses on this group of twelve. J.E. made only one error (to 'shop-shone'). Like H.M., she correctly

judged that none of the pairs in the group,with no sound in common, rhymed.Thus J.E.'s total number of errors was seven.

Processing of individual letters

H.M. and J.E. were asked to name, sound and write to dictation the letters of the alphabet.

H.M. named all upper case letters correctly. Naming lower case produced p ⟶ "Q". j was named only when it had been drawn on the table with a finger. There were two errors in sounding upper case letters : Y ⟶ /ɛ/, X ⟶ /zɔ/. The same two errors occurred when lower case letters were sounded.

J.E. named all upper case letters correctly. Naming lower case letters produced b ⟶ "P" ⟶ "D". There were four errors in sounding upper case letters and four errors sounding lower case letters.

S ⟶	"/zɔ/"	D ⟶ "/bɔ/" ⟶	"/dɔ/"
X ⟶	——	U ⟶ "/ʌg/" ⟶ "U" ⟶	✓
s ⟶	"/zɔ/"	q ⟶ "/kyɔ/" ⟶	"/kwɔ/"✓
u ⟶	"/yɔ/"	b ⟶ "/p /"	

H.M. spelt all letter names and sounds correctly, although the sound /dzɔ/ was written g where j would have been more probable. J.E. wrote all the letter names correctly but wrote four letter sounds incorrectly : "/ʌ/" ⟶ a, "/dɔ/" ⟶ b, "/ɜɔ/" ⟶ i, "/kɔ/" ⟶ q.

The orientation and rhyming tasks for the subset of letters were also given to H.M. and J.E. They were overall correct, but H.M. judged that the name of the letter p did not rhyme with "E", on both of its appearances. J.E. judged that the names of the letters Y and I rhymed with 'E' on both of their occurrences.

Thus for both girls the transcoding of individual letters is imperfect.

Lexical Decision

The written stimuli on the balanced word and non-word lists were presented for lexical decision. On the three-letter and five/six-letter lists H.M. made six false positive responses, accepting non-words as words : tup, hencil, chait, sutter, inlect, barrot. J.E. made only one error, accepting mab as a word. On the short stimuli from the Coltheart list H.M. also made a number of false responses : pand, nater, foop, moman, streed, gouse, cimy, doney, noor, and fime, There are 25 short non-word stimuli on this list so when ten are judged wrongly performance is close to chance. When the stimuli were given orally and judged H.M. made three false positives to 'nater', 'pand', and 'foop'. (She may have thought of panned, as in'panning for gold' and 'natter').

J.E. made three false positives when judging the written short stimuli of this list : streed, gouse, doney. Although she made lexicalisations to a further five stimuli on this list when asked to read them, she judged these five to be non-words on the lexical decision task. When the stimuli were presented orally J.E. also judged 'nater' to be a word.

The longer stimuli on the Coltheart list, the reading responses to which are listed on pages 140 and 141, were also presented for lexical decision.

	Read Correctly		Lexical Decision from print		Lexical Decision from oral pres.	
	J.E.	H.M.	J.E.	H.M.	J.E.	H.M.
Words (n=20)	3	3	17	16	18	18
Non-words(n=20)	1	2	12	13	15	14

For these long and unusual stimuli there is no difference between the ability to judge from aural and written input whether they are words or non-words. Reading aloud of the stimuli is much poorer.In the lexical decision tasks chance is a score of 10, indicating for print non-words are not judged significantly above chance but words are judged more accurately than chance. ($X^2 = 4.09, p<0.05$).

Summary

Background

J.E. and M.H. are both 17 year old girls from professional families. Neither girl has any known neorological abnormality. H.M. is left-hamded and J.E. right-handed (but there is familial left-handedness). J.E. has a family history of reading disorders. Both girls have at least average intelligence and vocabulary. They have no speech abnormalities.

Non-word Reading

1. There is significant impairment in the ability to read non-words in comparison to matched words.
2. Many of the errors to words are lexicalisations,
3. Many of the errors to non-words, particularly if the stimuli are long, have word sub-components.
4. There is a suggestion that non-words homophonic with real words are read more easily than those not homophonic with real words. This effect reaches significance for H.M. There is also a suggestion that, for H.M., visual similarity may not be necessary to produce this effect.

Word Reading Aloud

1. The error data are summarised on p 151. Errors are predominantly paralexias. Over half of J.E.'s paralexias are derivational. Over half of H.M.'s paralexias are visual. Both girls make visual, derivational and visuo-semantic errors.
2. Neologistic responses occur sporadically, particularly to long

words, when they often contain word sub-components.

3. Spelling-to-sound regularity does not significantly influence the ability to read words aloud. H.M. is significantly influenced by imageability and frequency. J.E. is not significantly influenced by any linguistic dimensions investigated.

4. There is impairment in reading function words in text.

5. There is no significant confusion in the comprehension of homophones.

6. Reading performance for J.E. is significantly impaired when stimuli are presented with the letters typed in the reverse order, prohibiting global strategies. H.M. is not significantly impaired on this task but is probably aided by unusual strategies.

7. J.E. is able to comprehend the meaning of some words that she cannot read aloud or reads aloud in error.

Spelling

1. The spelling analysis is summarised on p 164. Words tend to be spelt better than non-words. Many non-words are lexicalised.

2. Both girls make many phonologically accurate spelling errors.

3. More phonologically accurate spelling errors are made than phonologically accurate reading errors.

4. J.E. is much poorer at reading her own spellings than at reading the correct spellings. Almost all misspellings that are read correctly are for stimuli which are read correctly when spelt correctly. Phonologically valid misspellings are not easier to read than correct spellings.

5. For H.M. oral spelling errors have the same level of phonologically accuracy as written spelling errors. For J.E. there is a suggestion that oral spelling errors are less accurate phonologically.

Performance on a rhyme recognition task is poor . J.E. is also poor

at a rhyme fluency task, although H.M. performs adequately.

Individual letter analysis is somewhat impaired.

In lexical decision, performance is correct for many stimuli that were read incorrectly.

Cases 5 and 6 : A.H. and M.H.

These two younger subjects have a similar pattern of performance and will be presented together.

Case Histories and Psychological Background

A.H. is a ten year old boy from a professional family. There are no siblings. Case notes indicate that at birth there was some concern about slowness to breathe but there was no other evidence of abnormality. Developmental milestones and speech development were within normal limits. Hearing and vision are normal. Gross and fine motor function is normal on history, as is behaviour except for some depression at failure. There is no family history of learning problems although A.H.'s mother whose first language was Welsh had early difficulties translating between English and Welsh. A.H.'s first and only language is English.

Prior to the psychological testing to be reported, A.H. was examined by Dr Judith Hockaday, consultant in Paediatric Neurology at the John Radcliffe Hospital , Oxford. A.H. was noted to be anxious and depressed but was neither inattentive nor figity and was alert and co-operative on all tests. Responses were quick. No neurological abnormality was found. Imitation of gesture was poor. Handedness was mixed. A.H. usually, but not always, writes with the left hand. Neither parent is left-handed, but the father's brother is left-handed.

M.H. is also a ten-year-old boy from a professional family. He has one brother and one sister. There were no early adverse factors. Developmental milestones appeared normal. First concern over poor reading and bad writing was at age six. There is a family history of reading and spelling difficulties. The father learnt to read late, at age 9. At the time this was attributed to reaction to the death of his father. The mother had early difficulties with both reading

and spelling and has residual spelling difficulties now. One of the father's cousins was late to develop speech. M.H.'s elder brother has also been tested. He has extensive reading and spelling problems. There is one sister who is unaffected.

M.H. was examined by Dr Judith Hockaday, who found no significant neurological abnormality, although there was mild dyspraxia in sequential finger movements. M.H. writes with his right hand although he is mixed handed. The mother is also mixed handed. She writed with her right hand as the result of pressure at school but continues to do other tasks (e.g. cutting with scissors) with the left hand. Her mother, M.H.'s grandmother, was ambidextrous. M.H.'s father is strongly right-handed with no left handed relatives.

Both A.H. and M.H. were first tested in the Neuropsychology Unit in December 1982 when standardised test results and preliminary reading and spelling data were obtained. Both boys were ten years two months old. More detailed investigation was conducted in the following months. Neither child has ever been noted to have any speech abnormality and none was observed in any of the test sessions.

Tested on the Wechsler Intelligence Scale for Children, the following age scaled scores were obtained :

Verbal Tests	A.H.	M.H.	Performance Tests	A.H.	M.H.
Information	12	10	Picture Completion	15	14
Similarities	14	19	Picture Arrangement	14	10
Arithmetic	8	18	Block Design	12	15
Vocabulary	19	12	Object Assembly	12	11
Comprehension	16	14	Coding	9	6
(Digit Span	7	8)			
(A.H. 5 forward, 2 backward, M.H. 6 forward, 3 backward)					
(10 is an average subtest score, range = 1-19, S.D. = 3)					
Verbal I.Q.	123	128	Performance I.Q.	117	118
Full Scale I.Q.	123	126			

Both of the full scale I.Q. scores are in the superior range. A.H. was also given Ravens Coloured Progressive Matrices. His score on this test was above the 95%ile for age. A.H. has an exceptionally high vocabulary. He attains the highest possible score for his age on both the WISC vocabulary subtest and the Peabody Picture Vocabulary Test. On the Peabody Picture Vocabulary Test a raw score of 111 is obtained. This is at the 99 %ile for age . M.H. also scores well on the Peabody, attaining a score at the 98%ile for age. M.H. is also exceptionally good at arithmetic.

Against these backgrounds both boys display specific difficulty with reading and spelling.

	A.H.	M.H.
Schonell single word reading age	8.2	8.6
Schonell single word spelling age	7.8	7.7
Neale Analysis of reading (Text) Accuracy	8.2	8.6
Comprehension	10.8	10.11

A.H. was assesses over a period of one month. M.H.'s assessment extended over a seven-month period. During that time reading and spelling scores remained static. No improvement or alteration in the pattern of performance could be detected.

Non-word Reading

The three balanced word and non-word lists were given to both A.H. and M.H. The following results were obtained.

	Words		Non-words	
	A.H.	M.H.	A.H.	M.H.
3 letter list	13/14	14/14	8/14	5/14
5/6 letter list	13/15	15/15	4/15	6/15
Coltheart list	25/25	25/25	6/25	8/25
Total	51/54	54/54	18/54	19/54

For both boys there is a marked discrepancy between the ability to raed words and matched non-words. The impairment in reading non-words is consistent on all lists and is statistically significant (A.H.: smaller difference: $X^2=41$, $p<0.001$).

M.H. made no errors reading the word stimuli. A.H. made only three errors : dig ⟶ "fig", glass ⟶ "grass", paper ⟶ "page". All three are paralexias. Two are visual paralexias and one is a visuo-semantic paralexia.

Of the many errors to non-words, the majority were lexicalisations (see table 27). There were also a number of neologistic responses (see table 28).

The two homophonic non-word lists were also presented for reading aloud. On the Coltheart/Patterson list A.H. read only four of the forty stimuli correctly. Two were homophonic with real words and two were not. M.H. read nine of the forty stimuli : five were homophonic with real words and four were not.

On the Temple homophonic list the following results were obtained

	A.H.	M.H.
Homophonic and visually similar to real word	4/12	7/12
	6/24	10/24
Homophonic and visually dissimilar to real word	2/12	5/12
Non-homophonic	1/24	1/24

On this list non-words homophonic with real words were read better than non-words not homophonic with real words. For M.H. the difference reached significance (M.H. $X^2 = 7.55$, $p<0.05$). Because of the very low performancelevels the results are not conclusive but the data are suggestive, indicating visual similarity does not necessarily account for the homophone effect.

A.H.	M.H.
dop → "dope"	dop → "drop"
mab → "mad"	mab → "mad"
faper → "flapper"	faper → "flapper"
mun → "mum"	mun → "man"
garl → "grub"	garl → "gale"
streed → "stream"	streed → "steed"
ede → "Ed"	ede → "ailed"
cimy → "simple"	cimy → "chimney"
doney → "donkey"	døney → "dønkey"
noor → "navy"	noor → "noon"
plass → "pass"	mot → "mop, no mud"
fince → "fine"	gen → "gun"
pand → "pained"	fip → "flip"
cag → "cab"	fex → "fix"
chold → "show"	lig → "leg"
heam → "heap"	doptor → "doctor"
charch → "chapel"	chait → "charriot"
	inlect → "insist"
	trock → "track"
	sutter → "stubble"
	boak → "brook"
	foom → "form"
	fape → "flap"
	gouse → "goose"

TABLE 27

LEXICALISATIONS TO NON-WORDS ON THE BALANCED LISTS

A.H.		M.H.	
jat	→ "jakt"/dzækt/	tup	→ "trub"/trʌb/
fex	→ "feg"/fɛg/	zan	→ "san"/sæn/
gen	→ "ged"/gɛd/	lorse	→ "lorus"/lɒrʌs/
zan	→ "zad"/zæd/	klower	→ "kilowa"/kɪloɷɑ/
klower	→ "klonger"/klɔŋɚ/	upple	→ "uppelle"/ʌpɛl/
doptor	→ "dopt"/dɒpt/	fim	→ "fime"/faɪm/
chait	→ "clat"/klæt/	cag	→ "ga"/gɑ/
inlect	→ "inklel"/ɪnklɛk/	chold	→ "chode"/tʃoɷd/
upple	→ "umpapple" /ʌmpæpəl/	foop	→ "flope"/floɷp/
gemon	→ "gremon"/grɛmən/	heam	→ "hay.ann"/heɪæn/
trock	→ "trocker"/trɒkə/	floon	→ "flowrun"/floɷrʌn/
hencil	→ "hencik, hencliff"/hɛnsɪk/,/hɛnklɪf/		
nater	→ "nadder" /nædə/		
poad	→ "poden"/poɷdən/		
moman	→ "moban"/moɷbə n/		
boak	→ "blork"/blɔk/		
foom	→ "foomp"/fɷmp/		
gouse	→ "glorp"/glɔp/		
schoom	→ "skormy"/skɔmeɪ/		

TABLE 28

NEOLOGISTIC RESPONSES TO NON-WORDS ON THE BALANCED LISTS

The two homophonic non-word lists provide further examples of non-word reading errors both lexicalisations (see table 29) and neologisms (see table 30). A few of A.H.'s errors suggest that there may be perseveration. On the earlier three-letter list the only error which A.H. made to a word was dig → "fig". This was made just after reading fex as "feg"/fɛg/. On the Coltheart-Patterson list the response soal → "sowed" was followed by brone → "browd" /broɷd/. The response taks → "talse"/tɑls/ was followed by throan → "false". After the error braik → "bran", five responses later bair → "bran", and then, two later, barl → "bran". On the Temple list the response flere → "fled" was followed by sheb → "shed". Trends of this nature were not evident in the data of M.H.

Single Word Reading : Error Analysis

As before, four lists were used in the error analysis : the Temple list; the Coltheart regularity list (1979); the Stanovich and Bauer list (1978) and the Derivational list, totalling 434 words in all. A.H. read 269 correctly, refused 2 and made 183 errors. M.H. read 310 correctly, refused 12 and made 112 errors. Of the erroneous responses paralexias predominated over neologisms. One hundred and seven (59%) of A.H.'s errors and 81 (72%) of M.H.'s errors are paralexias. Of the paralexias 15% of A.H.'s are derivational and 16% of M.H.'s are derivational.

A.H.	M.H.
information → "inform"	information → "informant
image → "imagine"	image → "imagine"
weigh → "weight"	weigh → "weight"
holder → "hold"	jewel → "jewels"
classes → "class"	mechanic → "machine"
refresh → "fresh"	management → "manager"
teach → "teacher"	examine → "exam"(long delay) ....."ine"

A.H.			M.H.		
loze	→	"loose"	loze	→	"lose"
woom	→	"wood"	woom	→	"worm"
flere	→	"fled"	flere	→	"flesh"
grele	→	"grant"	grele	→	"gentle"
wich	→	"which"	wich	→	"which
soal	→	"sowed"	soal	→	"saw"
phroo	→	"flow"	phroo	→	"pause"
throan	→	"false"	throan	→	"form"
blud	→	"bull"	fide	→	"tide"
antor	→	"ant"	shoo	→	"show"
otum	→	"ought"	flore	→	"flower"
voor	→	"who"	voor	→	"fruit"
tume	→	"chew"	fite	→	"flip"
solemm	→	"sew"	scort	→	"scout"
scort	→	"scot"	wond	→	"wound"
spoo	→	"stew"	skoe	→	"smoke"
rond	→	"rod"	hoal	→	"hostel"
goom	→	"gruel"	brait	→	"brat"
sheb	→	"shed"	ploo	→	"poll"
scowt	→	"scowl"	waid	→	"rallied"
roze	→	"Ross"	trude	→	"trust"
dort	→	"dot"	taks	→	"task"
murld	→	"moored"	bol	→	"blow"
woar	→	"word"			
floo	→	"fool"			
stawk	→	"stank"			
mobe	→	"mowed"			
horl	→	"hoard"			
peese	→	"peace"			
wute	→	"watt"			
braik	→	"bran"			
dode	→	"doll"			
bair	→	"bran"			
barl	→	"bran"			
chuze	→	"class			
moov	→	"moo"			

TABLE 29

LEXICALISATIONS TO THE HOMOPHONIC NON-WORD LISTS

A.H.		M.H.	
fide	"fid"/fɪd/	polemm	"plowan/ploʊən/
polemm	"plimps"/plɪmps/	scuge	"chawshen"/tʃɔʃ n/
apil	"apeth"/æpɛθ/	korde	"kodi"/koʊdi /
scuge	"skwanz"/skwɔnz/	otum	"otu"/ɒtʌ/
flore	"frons"/frɔnz/	niste	"nistay"/nɪsteɪ/
heer	"heelv"/hilv/	grene	"geeyin"/greɪn/
korde	"koms"/kɒmz/	vissil	"vislil"/vɪslɪl/
niste	"disment"/dɪsmənt/	skie	"skite"/skaɪt/
grene	"grens"/grɛnz/	riste	"ristel"/rɪstəl/
vissil	"fims"/fɪmz/	phogo	"prodo"/proʊdoʊ/
phogo	"phoge"/foʊdz/	heeb	"hab"/hæb/
heeb	"deed"/dil/	rond	"rand"/rænd/
ankor	"ank"/æŋk/	goom	"gloon"/glʊn/
pholo	"frow"/froʊ/	fich	"finsh"/fɪnθ/
scule	"scud"/skʌd/	pholo	"powdil"/poʊdəl/
pume	"premb"/prɛmb/	scule	"slaw"/slɔ/
etum	"eeta"/itɑ/	sheb	"shub"/θʌb/
skoe	"sloke"/sloʊk/	pume	"pum"/pʌm/
opil	"oplin"/ɒplɪn/	wissil	"wiyzil"/waɪzɪl/
dorde	"dooled"/duld/	opil	"opili"/ɔpɪlɪ/
hefe	"ven"/vɛn/	glud	"glid"/glɪd/
brait	"braint"/breɪnt/	dorde	"driteu"/drɪtə/
flure	"funt"/fʌnt/	hefe	"heff"/hɛf/
ahms	"ashments"/æʃmənts/	flure	"flun"/flʌn/
gaks	"gants"/gænts/	dort	"dat"/dæt/
rild	"rilth"/rɪlθ/	floo	"flo"/floʊ/
porce	"prons"/prɒnz/	stawk	"stoowk"/stʊwk/
brone	"browd"/broʊd/	gaks	"gasa"/gæsæ/
waid	"wan"/wæn/	rild	"rill"/rɪl/
korp	"norp"/nɔp/	porce	"posi"/pɒsɪ/
dake	"dak"/dæk/	brone	"bron"/brɔn/
fraze	"fraz"/freiz/	mobe	"mobey"/moʊbeɪ/
trude	"trub"/trʌb/	horl	"horial"/hɔrɪəl/
boaled	"broalth"/broʊlθ/	peese	"pess"/pɛs/
taks	"talse"/tɔls/	fraze	"fraz"/freɪz/
leke	"lee"/li/	wute	"rut"/rʌt/
ile	"flell"/flɛl/	braik	"brak"/bræk/
brooze	"broze"/broʊz/	dode	"dodi"/dɒdə/
		boaled	"bollid"/bɒləd/
		leke	"klay"/kleɪ/
		barl	"baru"/bærə/
		chuze	"chuss"/tʃʌz/
		ile	"lil"/lɪl/

TABLE 30
NEOLOGISTIC RESPONSES TO THE HOMOPHONIC NON-WORD LISTS

A.H.(cont.)		M.H.(cont.)	
govern	→ "governor"	refusal	→ "refuse (long delay)..."al"
arrival	→ "arrive"	reporter	→ "report"
jumper	→ "jump"	arrival	→ "arrive" (long delay)..."al"
banish	→ "banishment"	certain	→ "certainty"
splendid	→ "splendour"	high	→ "height"
children	→ "child"	choir	→ "chorus"
quick	→ "quickly"		
spend	→ "spent"		
grow	→ "grown		

On three of the errors M.H. partially self-corrected by adding the isolated prefix several seconds later, but he never blended the root and affix together.

There are several visuo-semantic paralexias

A.H.		M.H.	
click	→ "tick"	arrangement	→ "agreement"
blast	→ "blase"	bowl	→ "barrel"
thinness	→ "thickness"	truth	→ "trust"
circuit	→ "circle"	argue	→ "agree"
county	→ "country"	county	→ "country"
		liquor	→ "liquid"
		sherry	→ "shandy"

The vast majority of the paralexias are visual : 81 (76%) for A.H. and 59(73%) for M.H. These are listed in tables 31 and 32 . All of M.H 's paralexias have been listed. A.H. also made the unclassifiable paralexias :

mimic	→ "menace"	manage	→ "major"
calm	→ "corn"	sour	→ "sew"
cough	→ "corn"		

TABLE 31 : PARALEXIC RESPONSES OF A.H.

dumb → "dump"
average → "avenger"
hop → "hope"
chlorine → "calling"
manace → "merchant"
secretary → "secret"
cheery" → "cherry"
examine → "explain"
sharp → "ship"
height → "health"
certainty → "create"
lose → "lows"
aide → "allied"
dew → "drew"
fuse → "furs"
broad → "board"
patient → "pattern"
sunshine → "shine"
anchor → "archer"
corner → "corn"
deceit → "decide"
cautious → "cottons"
revise → "receive"
politics → "polite"
borough → "both"
check → "cheek"
thorough → "through"
soul → "soup"
trout → "thought"
flood → "food"
duel → "due"
sort → "soft"
chaos → "chose"
gnaw → "gun"
heir → "her"
liquor → "inquiry"
toll → "tall"
ninth → "neither
barge → "brag"
tour → "tower"
chasm → "chaos"

throat → "throw"
since → "silence"
clue → "club"
choir → "core"
management → "magnet"
mope → "mop"
kite → "kitten"
refusal → "refunds"
caution → "continue"
competition → "complaint"
refuse → "refer"
advice → "advance"
alone → "along"
divine → "driven"
among → "along"
calm → "claim"
barge → "brag"
nation → "natural"
invitation → "invention"
shiny → "shin"
honesty → "hostess"
true → "tune"
revision → "reverse"
entertain → "entrant"
bury → "borrow"
mile → "mine"
distress → "dress"
prove → "provide"
slate → "shared"
broad → "burrow"
sign → "since"
gauge → "gran"
cliche → "chin"
guess → "glass"
honest → "hostel"
suck → "stuck"
tone → "ton"
sweat → "sweet"
trough → "through"
whom → "worn"

scorn → "score"	instance → "intrument"
mob → "mop"	orchestra → "orchard"
moth → "mouth"	chlorine → "Caroline"
clear → "cleaner	these → "their"
influence → "inflation"	dumb → "dump"
fir → "fit"	disgrace → "disagreed"
cheery → "cherry"	patient → "patterned"
barge → "badger"	unjust → "injure"
gross → "grows"	thorough → "fought"
distress → "district"	barge → "barage"
lose → "loose"	trough → "trot"
cough → "cow"	flood → "food"
spear → "spread"	broad → "bored"
sort → "spot"	sew → "saw"
gauge → "garage"	subtle → "stubble"
amusement → "astonishment"	cautious → "cartons"
betray → "duty"	political → "polite...ly
compete → "complete"	persuasion → "person"
manage → "manual"	caution → "curtain"
breadth → "breath"	along → "alone"
boost → "boast"	couch → "coach"
divine → "driven"	fuse → "fuss"
broad → "board"	chaos → "choice"
elite → "elect"	shove → "shone"
gnaw → "game"	guess → "geese"
heir → "here"	honour → "horror"
marine → "margarine"	metal → "mental"
phrase → "praise"	sweat → "sweet"
whom → "worm"	entertainment → "enter"... "entrainment"

TABLE 32 PARALEXIC RESPONSES OF M.H.

For later comparative purposes it is of interest to note how many of the above responses are valid paralexias. For A.H., there are 10 such responses : hop → "hope", choir → "core", mope → "mop, lose → "lows", check → "cheek", heir → "her", tone → "ton, sweat → "sweet", tour → "tower". For H.M., there are 7 such responses: cheery → "cherry", lose → "loose", couch → "coach", fuse → "fuss", chaos → "choice", heir → "here",sweat → "sweet".

Although paralexic responses predominate, both A.H. and M.H. make many more neologistic responses than J.E. and H.M. in the preceding section. A.H. is more prone to such reponses than M.H. The neologistic responses are listed in table 33.

Again for later comparative purposes it is of interest to note which of the neologistic responses are valid. For A.H. there are 12 such responses : ambition → /æmbɪtɒn/, this → /ðis/, worth → /woɑrθ/, host → /hɒst/, variation → /veɪreɪðɔn/, essay → /eɪse /, yacht → /jɑkt/, pint → /pɪnt/, aisle → /eɪsɪl/, cafe → /kɑf/, pint → /pɪnt/, touch → /toɑtʃ/. For M.H. there are 5 such responses : adjective → "adjective", purchase → "purchase", digest → /dɪgɔst/, steak → /stik/, chassis → /tʃæsɪs/.

The error classification is summarised in figure 9.

A.H. and M.H. were both requested to read the function word list. M.H. made no errors but A.H. made three function word substitutions : them → "then", that → "what", and it → "if". M.H. did exhibit function word difficulties in text. For example, on the third passage of the Neale, Form C, he made 11 errors. Five were function word substitutions(45%). On the same passage A.H. made 14 errors. Seven were function word errors (50%).

A.H.	M.H.
ambition → "ambiton"/æmbɪtɒn/	ambition → "a.biton"/eɪbɪtɒn/
digest → "diggess"/dɪgɘ/	digest → "diggest"/dɪgɘst/
audience → "inedgess"/ɪnɛdzɛs/	audience → "A.fons"/eɪfɒnz/
betrayal → "bentral"/bɛntrɘl/	betrayal → "betrol"/bɛtrɒl/
approve → "arolve"/ærɔlv/	approve → "approtт"/æprɒt/
protein → "porteen"/poʊtin/	protein → "porten"/poʊtrɛn/
adjective → "adject"/ædzɛk/	adjective → "adjective"(stress)
chapter → "chapper"/tʃæpɘ/	chapter → "chapper"/tʃæpɘ/
persuade → "shadin"/ʃædɘn/	persuade → "pershooled"/pɘʃuld/
strewn → "streel"/strɪl/	strewn → "stewn"/stjun/
mortgage → "morgive"/mɔgɪv/	mortgage → "motrage"/mɒtreɪdz/
debt → "deebunt"/dibʌnt/	debt → "drept"/drɛpt/
steak → "speaked"/spikd/	steak → "steek"/stik/
aisle → "aisill"/eɪsɪl/	aisle → "aileez"/eɪlɪz/
cafe → "caff"/kæf/	cafe → "caff"/kæf/
chassis → "hass"/hæs/	chassis → "chassis"/tʃæsɪs/
strict → "strik"/strɪk/	purchase → "purchase"(stress)
influence → "infanch"/ɪnfæntʃ/	borough → "blowt"/bloʊt/
mechanic → "menchar"/mɛntʃɘ/	circuit → "cirsisten"/kɪrsistɘn/
pat → "plat"/plæt/	cult → "cuttle"/kʌtl/
motion → "montter"/mɒntɘ/	splendid → "slewt"/slʊt/
this → "this"/θɪs/	government → "glovement"/glʌvmɘnt/
solemn → "solement"/soʊlmɘnt/	bake → "blake"/bleɪk/
instance → "intran"/ɪntrɘn/	banishment → "blad"/blæd/
shady → "shadly"/θeɪdleɪ/	govern → "lovern"/lʌvɘn/
recent → "rench"/rɛntʃ/	refreshment →"refusement"/rɘfjusmɘnt/
ashamed → "ashmad"/æθmæd/	politics → "polites"
worth → "woreth"/woʊrθ/	banish → "banglish"/bæŋglɪθ/
depth → "deepthness"/dipθnɘs/	entertain → "entrain"/ɛntreɪn/
compete → "compet"/kɒmpɛt/	aide → "evised"/ivaɪzd/
entertainment→"enchiment"/ɛntʃɘmɘnt/	align → "aling"/æleɪŋ/
destruction → "decons"/dɘkɒnz/	
wisdom → "winshoo"/wɪnʃu/	A.H.
certain → cretor/krɛtɒ/	foul → "floul"/flɘʊl/
scarce → "secca"/sɛkʌ/	host → "host"/hɒst/
stupid → "sotopid"/sɔtɒpɘd/	orchestra → "orchet"/ɔtʃɛt/
subtle → "subti"/sʌbtɘ/	variation → "varayshon"/veɪreɪθɘn/
gross → "grok"/grɒk/	essay → "eesay"/iseɪ/
spade → "sade"/se d/	relation → "reeshon"/riθɘn/
throng → "thor"/θɔ/	doubt → "doupit"/daʊpɪt/
stomach → "stomchan"/stɔmtʃær/	shove → "showv"/θoʊv/
ration → "ratshen"/rætθɛn/	capsule → "casure"/kɑzjur/
furnish → "freshment"/frɛθmɘnt/	yacht → "yakt"/jækt/
amusement → "asment"/æzmɘnt/	pint → "pint"/pɪnt/
betray → "batra"/bætrɑ/	kept → "rept"/rɛpt/
complaint → "complan"/kɒmplæn/	elite → "eatell"/itɛl/
sharpness →"shareness"/ʃeɪrnɘs/	phrase → "phrastelly"/fræstɘleɪ/
gentleness → "gentleless"/gɛntɘlɛs/	plague → "plang"/plæŋ/
persuasion → "prenso"/prɛnsoʊ/	flood → "flewed"/flʊd/
breadth → "bethi"/bɛθɘ/	snob → "sombi"/sɒmbɘ/
calmness → "conmens"/kɒnmɘnz/	summit → "sumt"/sʌmt/
argue → "agroove"/ægroʊv/	pint → "pint"/pɪnt/
arrangement → "orifment"/ɒrɪfmɘnt/	touch → "towch"/toʊtʃ/
examination → "citom"/sɪtɒm/	cult → "cirette"/sɪrɛt/
complain → "complan"/kɒmplæn/	

TABLE 33 Neologistic responses of A.H. and M.H.

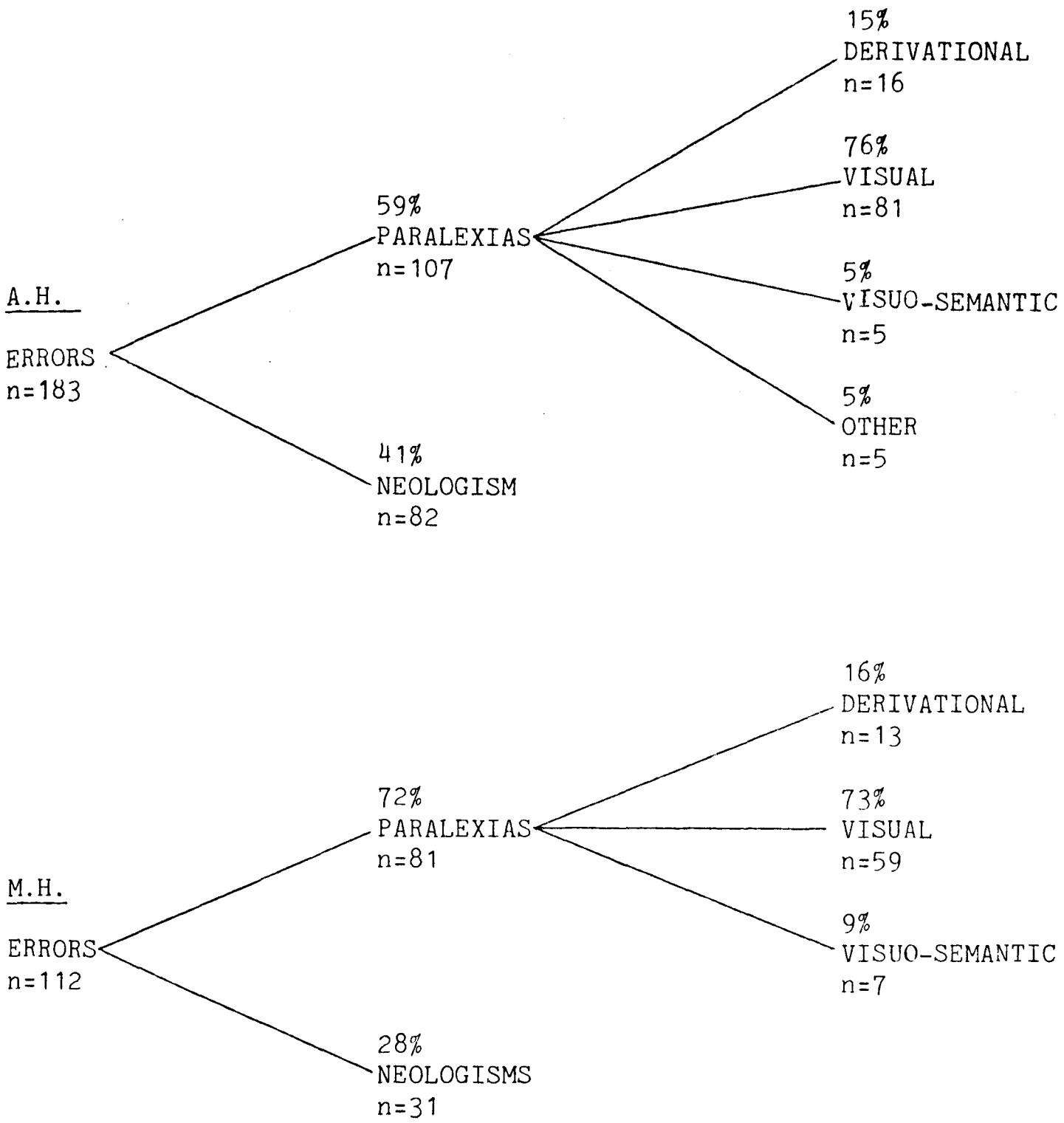


FIGURE 9

ANALYSIS OF THE READING ERRORS OF M.H. AND A.H.

The effect of linguistic dimensions

Both A.H. and M.H. were given the three lists that test for regularity effects. The following results were obtained:

		REGULAR	IRREGULAR	
Coltheart et al (1979)	A.H.	19/39	18/39	n.s.
	M.H.	29/39	22/39	n.s.
Stanovich and Bauer	A.H.	31/50	26/50	n.s.
	M.H.	43/50	31/50	*
Temple	A.H.	14/26	13/26	n.s.
	M.H.	18/26	15/26	N.S.
*: significant $X^2=6.28$, $p<0.05$				

A.H. did not show a significant regularity effect on any list. M.H. showed a significant regularity effect only on the Stanovich and Bauer list. The validity of this effect in isolation from effects on other lists is probably limited, since Stanovich and Bauer is only balanced for frequency and length and its irregular section contains a number of words which occur infrequently in the textbooks of ten year olds: aisle, align, chaos, chasm, chassis, elite, liquor, marine. This tests's selection for use with ten year olds may in retrospect have been inappropriate.

The stimuli on the Temple list were also used in the investigation of other linguistic dimensions with the following results :

	High Imageability	Low Imageability	X^2
A.H.	27/40	21/40	1.3
M.H.	32/40	25/40	2.19

	High Frequency	Low Frequency	X^2
A.H.	28/40	20/40	2.55
M.H.	32/40	25/40	2.19
	Long	**Short**	X^2
A.H.	13/30	23/30	5.62*
M.H.	16/30	23/30	2.63

Only the length effect reaches significance for A.H.

Reading of Homophones

The list of twenty homophonic word pairs was randomly ordered and presented for reading aloud. A.H. read 32/40 correctly and M.H. read 37/40 correctly. The boys were also asked to say what each word meant. Homophone confusion occurred on only 4/32 of the correctly read stimuli for A.H. and 4/37 of the correctly read stimuli for M.H. Given the prevalance of visual paralexias for both children, the occurrence of a few homophone confusions is not surprising. However , for neither child is the incidence significant.

Distorted Typescript

Twenty-five word stimuli were presented in four different conditions for reading aloud. The effect of the different presentations was as follows :

	A.H.	M.H.
NORMAL TYPESCRIPT	16	19
HANDWRITTEN TYPESCRIPT	10(X^2=2.88)	15(X^2=0.82)
REVERSED LOWER CASE,e.g. egral	2(X^2=17*)	8(X^2=8.04*)
REVERSED UPPER CASE,e.g. EGRAL	1(X^2=20*)	8(X^2=8.04)

* : $p<0.01$ The values of X^2 given is brackets indicate whether observed values differ significantly from the score with normal presentation.

For both children there is a non-significant drop with the handwritten presentation. Reading of reverse order stimuli is significantly impaired for both children. It had originally been intended to conduct this test with a list of 80 words. The sections on the normal and handwritten list were successfully completed, but when the first reverse type list was encountered A.H.'s performance became so very slow and laborious that it was abandoned after the first 25 words. A.H. seemed aware that his performance was inadequate and appeared baffled by it. Thus prohibiting the use of a global strategy for reading, almost eliminated A.H.'s performance and significantly reduced M.H.'s performance. R.B., the surface dyslexic described in the previous section, had been unimpaired on this task.

Spelling

Both A.H. and M.H. have spelling ages at least two and a half years below age level, and even further below the level expected on the basis of I.Q.

Non-word spelling

Two of the balanced word/non-word lists were spoken aloud for spelling to dictation. On the three-letter list, A.H. spelt 14/14 of the words correctly and 12/14 of the non-words. The non-words errors were: "ked" → ged and "fex" → fexs. M.H. also spelt 14/14 of the words correctly and spelt 11/14 of the non-words. His non-word errors were : "mab" → map, "jat" → gat, "ked" → ged. All of the non-word errors were thus close to being correct. On the five-six letter list, performance was much poorer. A.H. spelt only five of the words correctly and three of the non-words. M.H. spelt nine of the words correctly and eight of the non-words. A.H.'s poor performance with the non-words indicates that phonic skills in spelling are limited. Non-word errors were :

A.H.

"lorse" → lose	"trock" → tok
"trown" → tron	"inlect" → ilet
"faper" → fape	"barrot" → battor
"hencil" → hacel	"plass" → pllas
"chait" → catt	"gemon" → genm
"upple" → upley	"sutter" → sater

Of the ten word errors only two were phonologically valid : "truck" → truk and "lemon" → lemen. The remaining errors were :

"paper" → paple	"carrot" → carrtor
"doctor" → dortore	"insect" → inset
"horse" → house	"brown" → bown
"pencil" → pecIle	"fence" → fencs

A comparison with the results of reading indicates that spelling of non-words is no better than reading of non-words.

M.H.'s performance was somewhat better than that of A.H. His seven non-word errors were :

"lorse" → lorer	"chait" → get
"trown" → tron	"inlect" → inlek
"hencil" → pencil	"barrot" → braet
"doptor" → doctor	

These responses include three lexicalisations. Half of the word errors were phonologically valid : "paper" → papper, "fence" → fens. "lemon" → lemen. The other three were : "chair" → chir, "carrot" → coret, and "horse" → hoser. Comparing these results with reading responses indicates that spelling of non-words is no worse than reading of non-words (as was found with A.H.)

Word Spelling

The 160 word list was dictated to A.H. and M.H. for written spelling. The handwriting of both boys is extremely poor and letters are often difficult to discriminate. Since the author is extremely familiar with this word list it was found that when attempts were made to mark the boys' spellings there was a tendency to interpret very poorly formed scribbles in favour of the stimulus word. Therefore, to provide a more objective measure, three fluent adult readers were asked to interpret the spelling. They had no prior knowledge of the stimulus words.Each adult reader was requested to identify the letters and then, if possible, to suggest what the original stimulus word might have been.

There was fairly good agreement between the adult readers. In most cases. where there was disagreement about individual letter identification, at least two out of three adults agreed and this

interpretation was selected. Using this information it was possible to mark the number of correct spellings and the number of phonologically valid errors. To assess the rest of the spelling errors the readings of the adults were again used. When at least two of the three adults determined the correct word, despite spelling errors, the error considered a 'good approximation'. If only one of the adults could identify the stimulus word from the spelling error it was considered a 'poor approximation'. For a number of items none of the adults could determine which target word had been dictated. In some cases the representation of the word was so poor that either the adults produced a variety of incorrect suggestions for the target or they were unable to select any word that even resembled the letter string. However, for some errors all three adults selected the same erroneous target. These errors were classified as paragraphias.A subset were classified as derivational paragraphias and another subset as function word substitutions.

The spelling analysis is summarised in Table 34. Of the 160 spelling responses of A.H. there were 97 errors. These were subdivided as follows : eighteen (19%) were phonologically valid:

"joyful" → joyeful	"portion" → porshon
"whistle" → whisel	"stress" → stres
"solemn" → solem	"instance" → instans
"chemist" → cemiste	"knob" → nob
"naughty" → nawtayie	"worth" → werth
"engine" → enjan	"chorus" → choris
"doubt" → dout	"fir" → fur
"write" → right	"one" → wan
"shown" → shine	"mope" → mop

Nineteen errors were not phonologically valid but were good approximations, that is, at least two out of the three adults recognised what word the spelling represented :

	A.H.	M.H.
Number of errors	97	97
Phonologically valid	18(19%)	39(40%)
Good approximations	19(20%)	14(15%)
Poor approximations	19(20%)	14(15%)
Paragraphias	18(19%)	6(7%)
Derivational Paragraphias	3	0
Function Word Substitutions	2	0
Bizarre	23(24%)	24(25%)

TABLE 34

SPELLING ANALYSIS

M.H. makes significantly more phonologically valid spelling errors than A.H. ($X^2 = 6.4, p < 0.01$)

"children" → chindlen
"secretary" → sectery
"record" → reorde
"nation" → natoin
"invitation" → invtashon
"ashamed" → aschamd
"orchestra" → orchirest
"essay" → esyay
"brother" → borther
"peach" → pheach
"chapter" → chaper
"influence" → infuns
"throat" → throt
"angel" → agle
"disgrace" → discrace
"clue" → cluy
"digest" → dicest
"purchase" → purech
"health" → heath

A further 19 errors (20%) were poor approximations, i.e. only one adult judge could deduce the stimulus item.

"deceit" → desed
"clear" → clare
"source" → soce
"corner" → cornell
"scorn" → scon
"thunder" → thurner
"variation" → varashon
"confess" → onfes
"stomach" → stumc
"debt" → dete
"honesty" → onstey
"stress" → stres
"average" → aveje
"bright" → bight
"daughter" → dater
"mimic" → mipick
"archer" → atcher
"north" → noth
"station" → satation

There were 17 (18%) paragraphias. Of these, three were derivational in nature :

"child" → childenre (interpreted by all judges as children)
"join" → jonte (interpreted by all judges as joint
"strange" → starger(interpreted by all judges as stranger)

One such error may have been a derivational paragraphia but was not included as such because the adult readers did not agree in their interpretation : "weigh" → wight. Among the paragraphias there were two function word substitutions : "there" → they,"either" →

<u>arother</u> (interpreted by all judges as another).

The remaining paragraphias were :

"jewel" ⟶ <u>jelly</u>	"injure" ⟶ <u>infer</u>
"short" ⟶ <u>shot</u>	"hid" ⟶ <u>hind</u>
"recent" ⟶ <u>resent</u>	"wine" ⟶ <u>wire</u>
"design" ⟶ <u>dines</u>	"cold" ⟶ <u>could</u>
"choir" ⟶ <u>chore</u>	
"cheery" ⟶ <u>chery</u>(interpreted by all three judges as <u>cherry</u>)	
"fancy" ⟶ <u>facese</u>(interpreted by all three judges as <u>faces</u>)	
"enjoy" ⟶ <u>engem</u>(interpreted by all three judges as <u>engine</u>)	

There remained 23 errors (24%) which were bizarre, i.e. for which none of the three judges could determine the stimulus word or agree upon another word which it represented.

"mechanic" ⟶ <u>micain</u>	"champion" ⟶ <u>chapin</u>
"possible" ⟶ <u>osbelle</u>	"anchor" ⟶ <u>gncer</u>
"shiver" ⟶ <u>shivey</u>	"shady" ⟶ <u>shadel</u>
"audience" ⟶ <u>onjes</u>	"since" ⟶ <u>siney</u>
"relation" ⟶ <u>reachon</u>	"ought" ⟶ <u>otey</u>
"mattress" ⟶ <u>materres</u>	"ration" ⟶ <u>ranjon</u>
"dumb" ⟶ <u>dudle</u>	"neighbour" ⟶ <u>cable</u>
"ambition" ⟶ <u>ambijor</u>	"chlorine" ⟶ <u>cloryer</u>
"press" ⟶ <u>perss</u>	"menace" ⟶ <u>mens</u>
"energy" ⟶ <u>enjye</u>	"image" ⟶ <u>injay</u>
"adjective" ⟶ <u>ojiceft</u>	"shiny" ⟶ <u>shince</u>

M.H.'s errors were analysed using the same system. He made 97 errors in the 160 word list. Of these 39(40%) were phonologically valid, a significantly higher proportion than for A.H. ($X^2=9.93, p<0.01$).

"strict" → stricd	"dumb" → dum
"throat" → throt	"average" → avarij
"angel" → anjel	"bright" → brit
"echo" → ecow	"since" → sinc
"neighbour" → naber	"chlorine" → cloren
"sight" → site	"corner" → coner
"gentle" → gentel	"short" → shot
"injure" → injer	"ought" → ort
"stomach" → stumek	"whistle" → wicel
"mimic" → mimeck	"hope" → hop
"mope" → mop	"shone" → shon
"motion" → moshion	"solemn" → sollem
"weigh" → wa	"chemist" → cemist
"shady" → shadey	"knob" → nob
"peach" → pech	"jewel" → juill
"worth" → werth	"mattress" → matres
"essay" → esay	"mate" → mait
"debt" → det	"deceit" → deseat
"harsh" → hash	"variation" → vereashon

Fourteen were good approximations :

"ambition" → andishon	"children" → childen
"daughter → datter	"sunshine" → sunsine
"fresh" → vresh	"enjoy" → enjor
"archer" → arjer	"adjective" → adjetith
"there" → ther	"ashamed" → asamd
"confess" → conves	"strange" → strang
"design" → decine	"ration" → rastion

Fourteen errors (15%) were poor approximations:

"either" → iver	"cold" → cool
"disgrace" → dicras	"image" → imish
"secretary" → setare	"unjust" → imish
"energy" → anijy	"scorn" → skon
"naughty" → nortiy	"school" → scooh
"chorus" → cores	"record" → recold
"honesty → onatey	"chapter → capter

Paragraphias were effectively absent. There were no responses that appeared to be derivational paragraphias or function word substitutions. The few paragraphias that occurred looked predominantly like artifactual products of incorrect spelling attempts. Only three such errors were apparent:

"rip" → rib(a b-p confusion)
"doubt" → dot (almost phonological)
"anchor" → anger

Three other errors were interpreted by all the adults as paragraphias:

"audience" → ordens (interpreted as orders)
"purchase" → porich (interpreted as porrige)
"health" → hether (interpreted as heather)

The remaining 24 errors were bizarre:

"these" → ves
"mechanic" → mccein
"influence" → invens
"joyful" → jovol
"write" → witer
"clue" → clow
"digest" → disent
"champion" → capion
"shown" → shon
"child" → ?ild
"invitation" → invertion
"engine" → ensin
"choir" → crior
"portion" → corstion
"menace" → meachis
"cheery" → chaee
"thin" → vin
"possible" → poapol
"patient" → panent
"instance" → ?tans
"recent" → rerent
"shiny" → siney
"fancy" → facey
"orchestra" → oreter

Thus although the reading patterns of A.H. and M.H. are very similar and their spelling pattern is quantitatively similar, qualitatively the patterns are significantly different. M.H. makes

significantly more phonologically valid misspellings than A.H. A.H. makes derivational paragraphias and function word substitutions when spelling, which M.H. does not.

One may also compare reading and spelling performance on the Temple list of 160 words.

	A.H.	M.H.
Read correctly	107/160	126/160
Spelt correctly	63/160	63/160
Phonologically valid misreadings	13%	9%
Phonologically valid misspellings	19%	37%

Thus for M.H. there is a marked discrepancy between the ability to spell phonologically and the ability to read phonologically. For A.H. this descrepancy is not so marked.

Reading of Misspellings

Adult fluent readers had attempted to decipher and interpret the spellings and misspellings of A.H. and M.H. It was therefore of interest to know how well the boys could utilize their own codes. They were thus requested to read aloud their own written spellings. They were not asked (as the adults had been) to identify the single letters involved. Not were they asked to speculate about the intended target. They were simply asked to read aloud the pages of spellings they had written.

When the word list had been presented correctly spelt, A.H. had read 107 stimuli correctly and M.H. had read 126 correctly. Reading their own representations A.H. was able to read 72 of the same word list whereas M.H. was able to read 92 correctly. Thus, unlike R.B.

(in the previous section) both A.H. and M.H. are overall poorer at interpreting their own representations than at interpreting correct spellings. This is entirely consistent with their previous performance : it has been noted that A.H. and M.H. are poor at reading non-words, many of their misspellings are non-words. It is therefore not surprising that they have difficulty reading them.The tendency to lexicalise non-words will however enable some of their misspellings to be read correctly if the visual resemblance to the target is sufficiently great.

Of the 160 spellings, 63 of both A.H.'s and M.H.'s were correct. Although they were overall poorer at reading their own versions, the spellings that they read included a number of misspellings. The spelling errors have been rated as phonological, good approximations, poor approximations, paragraphias and bizarre. In each of these categories some were reread correctly (see table 35).

A.H. was able to read correctly spelling errors which fell in all of the categories except 'bizarre'. There were only three stimuli which were read incorrectly when presented correctly spelt but were read correctly when misspelt by A.H. :ashamed, chapter, and orchestra. In the original presentations these were read as "ashmad", "chapper", and "orchet". All the other correctly read misspellings applied to words which could be read correctly when spelt correctly in the first place. A.H.'s spelling code thus in no way fascilitates his reading performance. The three spelling errors which he reads correctly, although he had failed to read their corresponding stimulus words correctly were all good approximations. In no instance was a word misread when spelt correctly, spelt with phonological accuracy, and then reread correctly. Thus, A.H. differs from R.B. in this respect. Six responses rated by the adults as paragraphias were nevertheless read correctly by A.H. This might suggest that the category of paragraphias is poorly conceived. It is therefore

A.H.

Phonological (n=18)

"chemist" → cemiste
"naughty" → nawtayie
"engine" → enjan
"whistle" → whisel
"joyful" → joyeful
"write" → right
"one" → wan

Good Approximations

"ashamed" → aschamed
"orchestra" → orchirest
"record" → reorde
"brother" → borther
"chapter" → chaper
"health" → heath

Poor Approximations

"thunder" → thurner
"debt" → dete
"archer" → atcher
"north" → noth

Paragraphias

"child" → childenre
"short" → shot
"fancy" → facese
"wine" → wire
"join" → jonte
"hid" → hind

Bizarre

M.H.

Phonological (n=36)

"injure" → injer
"solemn" → sollem
"shone" → shon
"chemist" → cemist
"dumb" → dum
"shady" → shadey
"bright" → brit
"knob" → nob
"since" → sinc
"peach" → pech
"sight" → site
"corner" → coner
"debt" → det
"gentle" → gentel
"ought" → ort

Good Approximations

"enjoy" → enjor
"ration" → rastion
"daughter" → dattar
"there" → ther
"children" → childen
"sunshine" → sunsine

Poor Approximations

"naughty" → nortiy
"unjust" → unjush
"school" → scooh
"record" → recold
"chapter" → capter
"either" → iver
"cold" → cood

Paragraphias

"rip" → rib
"health" → hether

Bizarre

"child" → ?ild
"invitation" → invertion
"champion" → chapion
"thin" → vin
"harsh" → harch

TABLE 35

SPELLING ERRORS WHICH WERE REREAD CORRECTLY

worth recording the rereadings of the other spelling errors classified as paragraphias to indicate that the category is valid for a number of stimuli :

Dictated Word	Spelling	Rereading
jewel	jelly	jelly
injure	infer	injella/ɪnjɛlʌ/
recent	resent	rest
resign	dines	dundren/dʌndrən/
cold	could	corn
choir	chore	cor/cɔ/
cheery	chery	cheer
enjoy	engem	engine
strange	starger	stranger
there	they	they
either	arother	or

One of the most interesting sequences of responses is "either" which is spelt as arother (similar to another) , which in turn is read as "or". In each case the substitution is of one function word for another, but there is also visual similarity in the replacements.

M.H. was able to read correctly spelling errors which fell into all the categories, including bizarre errors. Although it appears that A.H. is reading a particularly large quantity of phonologically accurate misspellings correctly, it should be noted that this category of error was very large. As a percentage of the total number of phonologically accurate errors, M.H. reads approximately the same number correctly as does A.H. The percentages of correct rereadings for each category are as follows :

	A.H.		M.H.	
Phonological	7/18	39%	15/39	38%
Good Approximations	6/19	32%	6/14	43%
Poor Approximations	4/19	21%	7/14	50%
Paragraphias	6/18	35%	2/6	33%
Bizarre	0/23	0%	5/24	19%
Total	21/97	24%	36/97	37%

M.H. is somewhat better at rereading his misspellings than A.H. This is particularly noticable in the category of poor approximations and bizarre responses. But M.H. was a little better than A.H. at reading the original stimuli when typed. He read 126 in comparison to A.H.'s 107.

As for A.H., there are three stimuli which M.H. reads incorrectly when correctly spelt, but reads correctly from his own misspellings. These are dumb, originally read as "dump", debt originally refused and unjust originally read as "injure". Thus, just as for A.H., M.H. reads correctly most of those misspellings which represent words which he could read correctly when typed normally. In this, both boys differ from the developmental surface dyslexic R.B.

Just as there are a number of words which are misspelt but are then read correctly, so there are a number of words which are spelt correctly but reread incorrectly. For A.H. these words are : peach (reread as "peace"), mop (reread as "mob"), both(reread as "moth"), rip(reread as "rib"), strict (reread as "strange"),bad (reread as "bud"), them (reread as "then"), chimp (reread as "champing"/tʃæmpɪŋ/), hop (reread as "hope"), pat (reread as "bat"), unjust (reread as "injure"), ripe (reread as "rip"), barge (reread as "large")

harsh (reread as "sharps"), and shone (reread as "some").

For M.H., these words are: stress (reread as "streets", hid (reread as "hit"), hop (reread as "hope"),mat (reread as "matter"), barge (reread as "badge"), ripe (reread as "rip").

All of the stimuli spelt correctly by M.H., and reread incorrectly, had, in the original presentation been read correctly except for barge which had been earlier misread as "badger". Most of the stimuli spelt correctly by A.H. and reread incorrectly had in the original presentation been read correctly. However strict had been read before as "strik"/strɪk/, pat had been read as "plat"/plæt/, hope had been read as "hop", and barge had been read as "brag".

Spelling of homophones

The forty stimuli on the Homophone word list were dictated, to both A.H. and M.H., with explanatory sentences. A.H. spelt fourteen words correctly. Nine of the 26 errors were homophonic spellings. Thus for M.H. the level of homophonic spellings is much lower than the level of correct spellings but for A.H. the level of homophonic spellings approaches the level of correct spellings and is indicative of some homophonic confusion in spelling.

Oral spelling

A.H. was asked to spell aloud the stimuli on the Schonell graded spelling test A. With written response he had attained a spelling age of 8 years 5 months. With oral response his spelling age was lower : 7 years 8 months. There were fourteen errors.

"your" → "U-O-U-R-"	"write" → "R-I-G-H-T"
"flower" → "F-L-O-U-E"	"amount" → "A-M-O-U-T"
"seem" → "S-I-M-E"	"noise" → "N-O-S-E"
"loud" → "L-A-U-W"	"remain" → "R-E-A-M"
"ground" → "G-U-R"	"hoped" → "/hɔ/-O-P-E"
"lowest" → "L-O-S-T"	"worry" → "W-O-R- /y/"
"brain" → "B-R-A-N"	"dancing" → "D-A-I-N-C"

M.H. was not given this test.

Rhyme Fluency

As a preliminary a fluency test was given. A.H. named 16 animals in a minute and 22 things. M.H. named 14 animals and 23 things.

Both A.H. and M.H. had difficulty with the rhyme fluency task. They both made made many errors and for both there were stimuli for which no rhyme could be produced in a minute. Responses are listed in table 36. Errors are given in brackets.

The level of production of A.H. and M.H. is much lower than that for R.B., the surface dyslexic, although vocabulary scores for A.H. and M.H. are at least as high as those for R.B., as are fluency levels. This will be discussed later.

Auditory Rhyme Pairs

This test was only conducted with A.H. and not with M.H. A.H. performed poorly. He made twelve errors. Three were false rejections in the P23 group. The pairs "shop-crop", "bone-phone", and "crab-stab" were rejected as non-rhymimg. The other nine errors were false positives. Five were in the P13 group : "duck-deck", "hen-hymn", "cold-killed", "stitch-starch", and "hate-hat". Three were in the P12 group : "shop-shone", "nine-knife", and "crab-cram". The final false acceptance was in the randomly paired group. The error was to the one pair in this group that had one sound in common : crab-cold.

Processing of individual letters

Individual letters were named and sounded :

	A.H.	M.H.
Name lower case	21/26	25/26
Name upper case	21/26	26/26
Sound lower case	24/26	21/26
Sound upper case	23/26	17/26

RESPONSES ON THE RHYME FLUENCY TASK

A.H.	
shop → stop, lop, flop, mop, plop, hop (hope)	6
duck → buck, luck, muck, pluck	4
nine → pine, wine, fine, line (rhyme,can)	4
wool → full, cool, pool (hole)	3
hen → pen, Ken	2
ring → ping, thing (line)	2
bone → own, phone (comb, home)	2
fear → here, ear	2
hate → late	1
cold → (load, flowed, could)	0
stitch →	0
crab →	0
Mean per word = 2.2	26
M.H.	
hen → ten, pen, when, den, Ben	5
ring → bring, ding, thing, something	4
bone → stone, groan, moan, loan (dome)	4
hate → date, late, mate	3
duck → luck, muck	2
shop → hop, mop (hope)	2
stitch → bitch, ditch (match,church)	2
cold → old (load)	1
wool → bull (will)	1
crab → dab	1
fear → (cheaper, chatter, mother, brother)	0
Mean per word = 2.3	28

TABLE 36

A.H.'s errors were :

Lower Case		Upper Case	
w named as	/ʌ/	Y named as	W
z "	/zə/	C "	kiss
c "	kiss	M "	W
p "	pli/plə/	K "	kiss
n "	/nə/	L "	—
p sounded	—	M sounded	—
H sounded	—	K sounded	—
		P sounded	pli/plə/

M.H.'s errors were :

Lower Case			Upper Case		
u named as		N	Y sounded as		L
x sounded as		/sə/	Z	"	s
v	"	/fə/	G	"	/dz/
c	"	/sə/	R	"	R
m	"	M	E	"	E
ż	"	Z	L	"	L
			V	"	/fə/
			C		/sə/
			X	"	—

On the letter tasks involving the subset of letters and judgement of tail direction, letter orientation and rhyme of sound (p19), A.H.'s only errors were on the rhyming section. On one out of their two occurrences Q and O were judged to rhyme with C, and V and P were judged not to rhyme with C. M.H. did not perform these tasks.

All the letter names and sounds were orally dictated to both A.H. and M.H. A.H. wrote all the letters correctly. There was also one corrected error /tə/ $\rightarrow$ ≠ t/ M.H.'s only errors were to the letter u. The sound /ʌ/ was written as o; the name U was written as Y

Lexical Decision

The three balanced word and non-word lists were presented in written form for lexical decision. On the three-letter list A.H. accepted four non-words as being words: dop, het, fip, zan.On the five/six letter list he accepted three : trown, hencil, and trock, and rejected a word : truck. On the short stimuli of the Coltheart liat, A.H. made no errors and judged all fifty stimuli correctly. M.H. accepted two non-words on the three letter list : het and fip, and four on the five/six letter list : lorse, klower, sutter, barrot. He also accepted seven on the Coltheart list : nater, mun, gouse, toble, cimy, doney, and noor. No word was ever rejected by M.H.

Thus both children, particularly M.H., show a tendency to accept as words a number of stimuli which are non-words. They also perform better at the lexical decision task than they did at reading aloud and make correct lexical decisions about stimuli which they fail to read correctly.

Summary

Background

A.H. and M.H. are both 10 year old boys from professional families. Neither has any significant neurological abnormalities. A.H. is left-handed and M.H. is mixed-handed. M.H. has a strong family history of reading disorders. Both boys are of superior intelligence with good vocabularies. Their reading and spelling are impaired to a similar degree. They have no speech abnormalities.

Non-word Reading

1. There is significant impairment in the ability to read non-words in comparison to matched words.

2. There is a suggestion that non-words homophonic with real words are read more easily than those that are not homophonic with real words. There is also a suggestion, at least for M.H., that visual similarity

may not be necessary to produce this effect.

Word Reading Aloud

1. Error data is summarised in Figure 9 (p 192). Errors are predominantly paralexias. There are both derivational and visuo-semantic paralexias. Most paralexias are visual.

2. Spelling-to-sound regularity does not significantly influence the ability to read words aloud. The only linguistic dimension that significantly influences performance is length, and this is only for A.H.

3. There is no significant confusion in the comprehension of homophones.

4. Reading performance is significantly impaired when stimuli are presented with the letters typed in the reverse order , thus prohibiting global strategies.

Spelling

1. There is no marked difference in the ability to spell non-words in comparison to words, although there is a trend in favour of non-words.

2. M.H. makes significantly more phonologically valid spelling errors than A.H. (37% compared to 19%). A.H. makes function word substitutions and derivational paragraphias when spelling. M.H. does not.

3. For M.H. there is a higher incidence of phonologically correct spelling errors than phonologically correct reading errors. For A.H. the discrepancy is small.

4. A.H. and M.H. are much poorer at reading their own spellings and misspellings than at reading the same stimuli when correctly typed. Almost all misspellings that are read correctly are for words read correctly if spelt correctly. Phonologically valid misspellings are not easier to read than the original stimulus.

Performance on rhyme fluency tasks and rhyme recognition tasks is poor.

Individual letter transcoding is somewhat impaired.

In lexical decision there is a tendency to accept many non-words as words. However correct decisions were made for a number of stimuli that had previously been read incorrectly.

DISCUSSION
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Developmental Phonological Dyslexia

Four children have been described, all of whom display the following characteristics:

1. At least average intelligence.
2. No apparent neurological abnormality.
3. No speech abnormality.
4. At least average vocabulary.
5. Impaired reading of non-words in relation to reading of words.
6. Lexicalisation errors in reading of non-words.
7. Incorrect non-word errors in reading of non-words.
8 Larger numbers of paralexic than neologistic errors.
9. Derivational paralexias.
10. Visual paralexias.
11. Visuo-semantic paralexias.
12. No regularity effect , that is, words with regular spelling-to-sound pattern are read no more easily than those with irregular spelling to sound patterns.
13. Impaired reading of function words in isolation and/or in text.
14. Impaired reading of words typed with their letters in reverse order but not of handwritten words.
15. Impaired spelling.
16. Impaired transcoding of individual letters.
17. Impaired performance on rhyming tasks.
18. Correct lexical decision about some non-words which produced lexicalisations.

This list includes the integral features of acquired phonological dyslexia outlined in the introduction, and also some additional features, e.g. poor performance on rhyming tasks. The similarity between the pattern of performance of the children described and

the pattern of performance of acquired phonological dyslexia is such that the children may justifiably be called developmental phonological dyslexics. The above list may be considered to outline the integral features of this disorder.

The existence of children with developmental phonological dyslexia raises interesting questions about our theories of the acquisition of reading. It is often suggested that normal adults do not need to use the phonological route when reading or, at least, they do not use it to recognise, understand and pronounce familiar words. However, the route could obviously be useful when an adult encounters an unfamiliar word that is in his oral but not his sight vocabulary. Additionally, Patterson (1982) has suggested that the route may be needed to analyse function words and affixes. Similarly the route may be required to mediate the efficient acquisition of literacy in alphabetically written languages. Yet the existence of developmental phonological dyslexia implies that a "reasonably" competent level of reading attainment (e.g. to an age level of 12 years in the case of J.E., on individual words) is possible with only minimal phonics.

In particular, three questions arise :a) How have the children learnt to read? b)What is wrong with their phonological routes to reading? c)What are the resultant limitations upon their reading skills?

How have the children learnt to read?

Adults with acquired phonological dyslexia are described as having lost the ability to use the phonological reading system; children with developmental phonological dyslexia have failed to develop an efficient phonological reading system. Their reading must thus develop in the absence of an ability to segment and process unfamiliar words

and attain their meanings via their pronunciations. An example of how an unfamiliar word may be mastered is given for H.M. The proposal is based on H.M.'s own intuitions and on our current information processing models of reading.

H.M. encounters a new word, e.g. perspective. It is not within her sight vocabulary and her phonic skills are not sufficiently well developed to permit reading aloud. She asks somebody what it says. Since there is nothing wrong with H.M.'s expressive speech or comprehension skills and her vocabulary is good (WISC subtest score at 84%ile for age; Peabody Picture Vocabulary Test at 81st percentile for age), she probably recognises the word. If not, she will ask its meaning; as has been noted her ability to learn words orally must be good as she is one S.D. above the mean for her age in vocabulary knowledge. She then treats the word perspective as a Chinese logogram and learns an association between its visual configuration and the meaning and auditory pattern which she already knows. One would thus predict her obtained frequency effect as a consequence of differential opportunity for learning and consolidation. Words with more salient meanings are also easier to learn and hence a slight imageability effect is apparent in the words she has acquired The orthographic regularity of the word is irrelevant to its aquisition by holistic association and so there is no regularity effect in her reading. Similarly, length is an irrelevant feature.

A related line of reasoning may be applied to the acquisition process of the other three children. All have good expressive speech and comprehension and wide vocabularies. Like H.M.,none of them show significant regularity effects. None of the other children show frequency and imageability effects that reach significance but all show trends in that direction. A.H. is the only child to show a length effect. M.H. also shows a trend in this direction that

just falls short of significance. This may be related to the greater reliance which the younger children place on the defective phonological route since their other reading systems are less well established.

On all the lists containing non-words H.M. and J.E. do better than A.H. and M.H. The number of non-words read correctly -

	H.M.	J.E.	A.H.	M.H.
Balanced lists(n=54)	29	30	18	19
P/C homophonic list(n=40)	14	18	4	9
Temple homophonic list(n=48)	19	23	7	13
Total(n=142)	62	71	29	41

Since H.M. and J.E. are older, one may assume that the functioning of the phonological route has developed with age to a higher level. Yet despite this H.M. and J.E. make fewer neologistic responses than A.H. and M.H. This could result from an increased capacity to produce stimuli that are meaningful, or it could result from the development of their other reading sub-systems (based upon whole words) which exceed the development of the phonological system , so that although their phonological systems are better than those of M.H. and A.H. their other routes are nonetheless preferred. A.H. and M.H. have only developed their reading systems based upon whole words to a lower level and so are forced to use their phonological routes more to cope with unfamiliar stimuli even though their phonological systems are very sparsely developed.

If, as Patterson (1982) suggets, the phonological route is necessary for the efficient reading of affixes, and adults when reading text make more derivational errors because of reduced use

of this route in text reading, then one might expect that J.E. and H.M. (although older and with better developed phonological routes) will, because of the more effective development of other reading systems, make more derivational errors than M.H. and A.H. This proves to be the case.For all four children the same stimuli were used in the error analysis. The incidence of derivational errors is as follows:

	Errors	Derivational Errors	%
H.M.	69	11	16
J.E.	46	24	49
A.H.	183	16	9
M.H.	112	13	11

For J.E., the large number of derivational errors is particularly dramatic.

In what ways is the phonological route impaired?

By looking in more detail at the reading of non-words and the neologistic reading responses the nature of developmental failure of the phonological route may be elucidated.

Non-word reading and neologistic errors

In the section on surface dyslexia an expanded model of the phonological route was presented within which various stages were delineated : parser, translator, blender, and lexical check.

Focusing on the translator, it was noted that for surface dyslexics many of the neologistic reading errors were valid (R.B.:36% N.G.:99%). This indicated that translation rules had been acquired although, in the case of R.B., the route was still not functioning with perfect efficiency. When the neologistic reading errors of the

phonological dyslexics were presented, relatively few valid errors were noted.

	no. of neologistic responses	no valid	% valid
A.H.	76	12	16%
M.H.	31	5	16%
J.E.	5	1	21%
H.M.	17	4	23%
(R.B. surface dyslexic	162	58	36%)

For all the phonological dyslexics the incidence of valid neologistic responses is low. A.H. and M.H. have the same chronological age, reading age, and spelling age as R.B. but they produce far fewer neologistic errors than she does and those that are produced are likely to be invalid.

So, within the phonological route, the translator is only very poorly developed. Correspondence rules based upon any size of unit are poorly established.

In the section on surface dyslexia it was noted that N.G. who had a highly developed phonological route still made errors in reading very long regular words where segments appeared to 'drop out'. Examining the attempts of the phonological dyslexics to read non-words one can see that long stimuli also create more difficulties than short stimuli. Thus on the list of three-letter non-words, the number of non-words read correctly are :

H.M. : 11/14, J.E. : 10/14, A.H. : 8/14, M.H. : 5/14

Whereas on the Coltheart list the result is:

H.M. : 9/25, J.E. : 11/25 A.H. : 6/25, M.H. : 8/25

H.M. and J.E. were also asked to read the long stimuli on the Coltheart

list and here performance fell to almost zero. So there is great difficulty with long non-words. This may be because with a greater number of elements to process and a high probability of failure on each element the chances of the whole stimulus being processed correctly are lower.

It is difficult to obtain specific evidence of parser and blender impairment for the phonological dyslexics, since one needs to examine valid neologistic responses or responses that are valid except for the omission of an element. Such errors are not abundant for any of the developmental phonological dyslexics, as the previous discussion indicates.

There is a further difficulty in attempting to determine the extent of functioning of the phonological route from reading non-words and neologistic error responses. Obviously non-words which are read correctly provide little information about developmental failure. Many of the non-words which are read in error are lexicalised. That is, despite the fact that the stimulus is a non-word it may not be treated as such. All lexicalisations may result from inappropriate readings by other systems. However, in addition, in many neologistic responses it appears that some system other than grapheme-phoneme translation may have played a part. This is particularly well illustrated in the neologistic responses to the long Coltheart stimuli on p140 and 141. Here it is evident that many of the responses contain word sub-components. These are underlined on p140 and 141. Examples are:

H.M.

cenectricities ⟶ "cenelectricals"

campatibinility ⟶ "cap.at.ability"

cirsemicular ⟶ "cri.semicircular"

J.E.

electrifationic ⟶ "electrification.onic"

ramifationic ⟶ "ramification.inic"

compatibinility ⟶ "combat.elation"

In some cases the word element does exist in the stimulus and it appears that this has been selected and then some familiar affixes or very familiar letter string endings (eg tion) has been added:

e.g. H.M. imparsonious ⟶ "im.parson.tion"

J.E. incocidental ⟶ "in.coi.dental"

For other errors is is clear that a word resembling the non-word stimulus has influenced the response. The stimulus cannistilalic looks like cannibalistic (in fact on the Coltheart list the stimulus is cannistibalic, a rearrangement of segments of cannibalistic, but a clerical error led to the use of the stimulus cannistilalic here). Neither H.M. nor J.E. say "cannibalistic" but both include a b appropriate for "cannibalistic":

H.M. ⟶ "cannistibalic"

J.E. ⟶ "cannibistal"

Similarly , lumilinations is a rearrangement of illuminations. J.E. produces the response "lumination", a large segment of illumination which resembles the target.

gracontulation resembles congratulation. H.M. reads this as "grat.contulation" that is, she has remoulded segments of congratulation to produce a response resembling gracontulation.

There are at least two possibilities for how this might have occurred. The whole word congratulation may have been segmented, reshuffled and reblended, with the addition of an extra t. Alternatively, H.M. may have in store segments of the word congratulation (and indeed of many other words). These large segments may be activated if stimuli resembling them are presented for reading aloud. Rather than relying on individual letters or small orthographic chunks to process unfamiliar stimuli, larger orthographic units are employed.A method of acquisition that relies on large units results in a strategy of trying to process unfamiliar stimuli in large morphemic segments. Thus just as the surface dyslexic bases his analysis on segments which are too small, so the phonological dyslexic may base his analysis on segments

which are too big. The use of large units of processing means that for many non-words, lexicalisation is the most logical strategy to produce a vocal output that resembles the stimulus. That does not mean that the child never detects the difference between the visual configuration he is attempting to process and the visual configuration associated with the word he has produced. Indeed performance on lexical decision indicates that there is often awareness that the non-word stimulus is not a word at all, even when the attempted reading was a lexicalisation. That is, the child knows that the target is not a word but the predisposition to process whole words as single units means that lexicalisation (producing a similar looking word) is the best attempt the child can make at the task.

Occasionally this mode of reading does pay off. Thus both H.M. and J.E. read the non-word forgivunable, which they read as "forgive.un-able". The processing of the non-word as two large word segments results in a correct vocalisation.

This tendency to use morphemic units to read long unfamiliar stimuli raises two points. First, if the children tend not to use the phonological route (even when they are instructed that the stimuli are non-words), then this further suggests that the partially developed phonological system is used very little in reading real words. Secondly, if fully neologistic errors seldom occur(which is particularly true of the cases H.M. and J.E.) then it is extremely difficult to study the precise problem involved in their phonological processing. That is, if beyond a certain age and development of the direct and semantic routes , the child cannot be persuaded to use the impaired phonological route, how can one observe what is wrong with it?

Pseudo-derivational Errors?

It has been noted in the error analysis for the phonolgical dyslexics, that derivational errors are a prevalent error subtype. It has also been noted that many of the neologistic errors have subcomponents, based on large orthographic units or morphemic units. A combination of these two factors may explain the incidence of a particular group of errors which, although not derivational, may be called "pseudo-derivational". A derivational error occurs when a base lexical item is read corretly and an affix is dropped, added or sibstituted, e.g. nourished ⟶ "nourish" (J.E.). However, letters which sometimes function as an affix, may also occur in words where they do not play that role. For some of these words the removal or substitution of the letter group produces a word : e.g.

recover ⟶ "discover" (H.M.)

corner ⟶ "corn" (A.H.)

secretary ⟶ "secret" (A.H.)

shiny ⟶ "shin" (A.H.)

For some words which do have affixes the substitution of an alternative affix may produce a neologism if the affix is not normally paired with that root morpheme, e.g.

unjust ⟶ "injust" (H.M.)

gentleness ⟶"gentleless" (A.H.)

The addition of an affix may have a similar effect :

shade ⟶ "shadely" (A.H.)

Neologistic responses may also be produced by the substitution or deletion of letters which may form an affix but do not do so in the word in question, e.g.

despair ⟶ respair (J.E.)

deprive ⟶ "reprive" (J.E.)

conscience ⟶ "conscient" (H.M.)

adjective ⟶ "adject" (A.H.)

approve ⟶ "approt" (A.H.)

In all of the above examples the base lexical item or the letters which are "pseudobases" are read correctly and affixes or "pseudoaffixes" are added, substituted, or deleted.

There are other errors where the affix or "pseudoaffix" is read correctly but the base or "pseudobase" is read in error. The result may be a word or a non-word :

thinness ⟶ "thickness" (A.H., H.M.)

arrangement ⟶ agreement (J.E., H.M.)

gabled ⟶ gallowed (J.E., H.M.)

In the above examples the substituted bases share both visual and semantic features with the target bases. This need not be true :

disgrace ⟶ "disagreed" (H.M.)

distress ⟶ "distreet" (H.M.)

subtle ⟶ "subtickle" (H.M.)

insolent ⟶ "insolvent" (H.M.)

sharpness ⟶ "shareness" (A.H.)

government ⟶ "glovement" (M.H.)

refreshment ⟶ "refusement" (M.H.)

Finally, there are errors where several of the above phenomena co-occur:

furnish ⟶ "freshment" (A.H.)

depth ⟶ "deepthness" (A.H.)

The errors in which the base or pseudobase is read correctly are qualitatively similar to a number of errors which have been made by a patient with an acquired disorder of reading who has been studied by Dr John Marshall and myself. The patient ,Y.N. has a reading disorder which is deep dyslexic in quality (see next section), although her incidence of semantic errors is small.

Derivational errors are a conspicuous faeture of Y.N.'s reading. She also made the following errors:

portion → "port"	lush → "lushed"
corner → "corn"	round → "rounders"
portion → "pore"	join → "joiner"
recent → "received"	record → "cordion"
confess → "fession"	design → "sign"
fancy → "fance"	

It would seem that the mechanism that produces these errors in both developmental and acquired cases is very similar to the mechanism that produces derivational errors.

The responses suggest that affix stripping (Rubin, Becker and Freeman 1979)in these dyslexics takes place initially for all stimuli, regardless of whether the letter combinations are true affixes or not. At some later stage, where root morphemes are re-attached to their affixes, a recombination failure may occur.When an appropriate affix is substituted, omitted or added, a derivational error results. But if only derivational errors are to result some system must be operative which permits only legal recombinations. Thus child → "children" but not child → "childly". The recombination system fails or has failed to develop in the developmental cases, particularly A.H. If affixes are processed in the phonological route, as Patterson suggests, it may be that the mismatches characteristic of this system when impaired (in the translator in terms of the model outlined earlier), produce the wrong affix for recombination.

It is not clear whether, whenever there are derivational errors, pseudo-derivational errors always occur. That is, does one impairment produce derivational errors and a further impairment produce pseudo-derivational errors, or are both reflections of the same impairment in the phonological route? Unfortunately, few papers give extensive data on individual word errors. However, for four deep dyslexic

patients, lists of word errors are given in the appendix to Coltheart, Patterson and Marshall (1980). Derivational errors are a notable feature of deep dyslexia. If pseudo-derivational errors are part and parcel of the same phenomenon one should be able to find pseudo-derivational errors amingst the erroneous responses of these patients. The copus was accordingly examined :

For each patient there were responses which might be classified as "pseudo-derivational". for example:

tackle ⟶ "tacks"(P.D.)	insomnia ⟶ "obsomnia (P.D.)
excavation ⟶ "cavation"(P.W.)	abhor ⟶ "horrent" (P.W.)
mystic ⟶ "sterious"(P.W.)	banality ⟶ "ban" (P.W.)
postage ⟶ "poster"(D.E.)	arrest ⟶ "rest" (D.E.)
attribute ⟶ "tribute"(D.E.)	comb ⟶ "combine" (D.E.)
arrest ⟶ "rest" (D.E.)	bough ⟶ "bought" (D.E.)
cause ⟶ "caution" (D.E.)	count ⟶ "country"(K.F.)
instep ⟶ "stepping" (K.F.)	gentle ⟶ "gentleman"(K.F.)

In addition a smaller error corpus is available for the acquired phonological dyslexic W.B. (Funnell 1983). Among the errors reported are :

disposal ⟶ "sposal"	admired ⟶ "admiral"
carried ⟶ "carriage"	conscience ⟶ "science"

It should be noted that Patterson (personal communication) accounts for some of the above errors by articulatory difficulties.

What are the resultant limitations of reading skills?

From the full error data presented and the ensuing discussion a number of limitations are readily apparent :

1. The mode of acquisition of new words means that those with very similar visual configurations will sometimes be confused. Thus, visual paralexias are prevalent.

2.There is also difficulty learning the difference between words which have both a visual and a semantic similarity. Thus words with the same root morpheme may be confused, and derivational paralexias may be produced. Additionally, visuo-semantic errors may be produced.

3. The presence of pseudoderivational errors suggests that derivational errors do not occur simply because of confusion of words with the same root morpheme. The absence of a well-functioning phonological route seems to lead to specific difficulty in processing affixes and strings of letters which sometimes function as affixes.

4. The phonological route's restictions also contribute to difficulty with function word reading. This and the derivational errors may be more marked in text when the imperfect phonological route may be used even less.

5. The efficient mastery of new words is dependent upon individual word instruction to enable the necessary holistic association. Reading acquisition is therefore harder than for the normal child and unfamiliar vocabulary creates much greater problems.

6. Even when reading is well established unfamiliar names of places and people and scientific terminology will cause problems.

Stimulus distortion

In the section on surface dyslexia, it was noted that R.B., who tends to read in an analytical fashion, was not impaired when requested to read words typed with their letter in the reverse order. In contrast, the developmental phonological dyslexics were impaired. Both of the younger children, A.H. and M.H., (although of the same chronological and reading age as R.B.) were significantly and

dramatically impaired by presentation of both reversed lower case and reverse upper case typescript. For A.H., the decline in performance was particularly marked and resulted in almost total failure. The older child, J.E., was able to read some of the stimuli presented in this way but her performance was also significantly poorer than with normal presentation. The explanation for the difficulties encountered by these three children follows from what has been argued. If reading depends on a gestalt recognition system and the gestalt itself is dramatically altered in shape and character by realignment of the letters, then the reading system faces a severe recognition problem. For the young children, the difficulty is more or less insurmountable Deprived of the ability to use their whole word reading system, they have no means of recognising the stimuli. J.E., although dramatically impaired, does read some reversed stimuli. She has two advantages over A.H. and M.H. Her phonological system is better established, as shown by her (albeit limited) ability to read non-words.Thus her attempts to read in an analytical fashion, though not necessarily successful will provide her with clues to which A.H. and M.H. have little or no access.

Second, since J.E. is older, she is more experienced in coping with problem solving tasks and developing compensatory strategies for her disability. It is probable that J.E.'s performance is affected by these factors and almost certain that H.M.'s performance is thus altered. As noted earlier, H.M. did not show a significant impairment in her overall score on this reversed task, although latencies were dramatically lengthened. As discussed, (p158-9), she made great use of self-generated visual and kinaesthetic cues. Attempts to prohibit these produced the response : "I can't do it without moving my hands". Later, she used a strategy which required her to close her eyes for around 15 seconds, clearly not a normal part of the reading process.

Spelling

Although all four of the cases presented have similar patterns of reading performance there is considerable variation in their patterns of spelling. In the introduction, it was noted that for acquired phonological dyslexia there is no characteristic associated spelling defect, although spelling is always impaired. The data relating to the spelling patterns of the four developmental cases are summarised in table 37.

Newcombe and Marshall (1980) have proposed a model in which there are separate phonological routes for reading and spelling. The units of correspondence in their model are graphemes and phonemes. Their argument is as follows : The most frequent sound associated with the grapheme ei is /eɩ/ but the most frequent grapheme to be written for the phoneme /eɩ/ is not ei. Thus,logically, the two systems of grapheme-phoneme conversion and phoneme-grapheme conversion must be distinct. This argument also applies to systems in which the unit of correspondence is larger than the grapheme and the phoneme. Thus the most frequent reading of eigh is /eɩ/ but the most frequent spelling of /eɩ/ is not eigh.

The acquired phonological dyslexic R.G. (Beauvois and Derouesne 1979) was significantly better at writing nonsense words than at reading them, suggesting that the phonological route for reading may be impaired while the phonological route for spelling remains relatively intact. This would indicate that the neurological substrates for the systems were distinct. One route could be severely disrupted without the other necessarily being affected.

All four children make phonologically accurate spelling errors. The incidence is particularly marked for H.M. and M.H. One might expect therefore that they would be significantly better at spelling nonsense words than at reading them. One could then conclude that the children provide further evidence for the dissociability of the

H.M.

Schonell spelling age : 10 years 7 months

Spelling of nonsense words:24/29

(Reading of nonsense words:20/29)

Phonologically valid spelling errors 51% (including complex correspondences)

Derivational paragraphias

J.E.

Schonell spelling age:10 years 7 months

Spelling of nonsense words:21/29

(Reading of nonsense words:19/29)

Phonologically valid spelling errors 37%(including complex correspondences)

A.H.

Schonell spelling age : 7 years 8 months

Spelling of nonsense words:15/29

(Reading of nonsense words:12/29)

Phonologically valid spelling errors 19%

Derivational paragraphias

Function word substitutions

M.H.

Schonell spelling age:7 years 7 months

Spelling of nonsense words :19/29

(Reading of nonsense words 11/29)

Phonologically valid spelling errors 37%

TABLE 37

SPELLING PATTERNS OF THE DEVELOPMENTAL PHONOLOGICAL DYSLEXICS

phonological routes for reading and spelling. In this case, the conclusion would be that the phonological route for spelling has been able to develop despite the failure of the phonological route for reading.

All of the children are slightly better at spelling nonsense words than at reading them, but this in itself is not conclusive. It is usually agreed that spelling real words is harder than reading them and it is true of all reading disabled children reported that their spelling is worse than their reading. When confronted with nonsense stimuli, however, certain constraints are lifted. Spelling no longer requires the same degree of sepecificity. If asked to read the stimulus bleen only the response /blin/ would be acceptable. If asked to spell 'bleen' the responses bleen, blene, blean, blein, blien, bleene, bleane, would all be valid and marked correct. It may thus be that spelling non-words is intrinsically easier than reading them correctly.

However, there is another argument which may be proposed in favour of the developmental dissociability of the phonological routes for reading and spelling. H.M. and J.E. have similar patterns of reading performance, as do A.H. and M.H. H.M. and J.E. also have the same spelling age, as do M.H. and A.H. Both H.M. and J.E. made 45 errors on the 160 word Temple list, used for the spelling analysis and both A.H. and M.H. made 97 errors . So in reading each couple is very similar both quantitatively and qualitativevly , and in spelling each couple is quantitatively very similar. If the development of the phonological route for spelling is intrinsically linked to the development of the phonological route for reading, then since the phonological routes for reading have similar performance levels within each couple, then the phonological routes for spelling should also have similar performance levels. But, although quantitatively, overall performance is similar , qualitatively there are differences :

H.M. makes more phonologically valid spelling errors than J.E., although the difference is only significant for those that are phonologically accurate. The difference between the performance of A.H. and M.H. is more marked. M.H. makes significantly more phonologically valid spelling errors than A.H.

Thus, although because of the complexity of English orthography it is difficult to argue from an individual case that sound to print correspondences have developed in the absense of print to sound correspondences, it is possible by comparing matched couples to show that despite similar levels of print to sound correspondences, sound to print correspondences differ. Thus the development of the phonological route for reading and the phonological route for spelling are dissociable. This means that the underlying physiological substrate for the development of sound to print correspondences may be relatively intact whilst the underlying substrate for the development of sound to print correspondences is defective. Neverthless, there are some aspects of spelling which mimic aspects of reading performance. Thus both H.M. and A.H. make derivational errors in spelling as well as reading. It is of interest that J.E. whose incidence of derivational errors in reading is the largest of the four (49% of errors) makes only two spelling errors which could be interpreted as derivational ("hid" $\longrightarrow$ hide, "eat" $\longrightarrow$ ate). Even here a derivational interpretation is not mandatory.

In the phonologically accurate spelling errors of both J.E. and H.M. there are instances where simple graphemic representations have not been selected: orthographically complex letter strings have been chosen in preference. (H.M. "throat" $\longrightarrow$ throught, J.E. "whistle" $\longrightarrow$ wiscle). It is clear that the underlying code used in their phonological spelling route is not based upon simple high frequency phoneme-to-grapheme correspondences.

When reading their own misspellings, it was noted that the children did not benefit from the use of their own code. They were better at reading correct spellings than at reading their own misspellings. Those misspellings that they read correctly were made almost entirely of words which could be read correctly and spelt correctly. Just as they lexicalise non-words, so if they lexicalise those of their misspellings which are non-words and select a similar word, the answer has a high probability of being correct. Unlike R.B., the surface dyslexic, the phonological dyslexics did not benefit from phonologically accurate representations of irregular words. They did not find these easier to decode than the real spelling.

Rhyming Tasks

All four children were impaired on the rhyming tasks : rhyme fluency (a production task) and auditory rhyme pairs (a recognition task). Performance is summarised below:

	Rhyme production	Rhyme recognition (error data)		
		P23(duck-stuck)	P13(duck-deck)	P12(duck-dull)
H.M.	1 error, 71✓	1	6	7
J.E.	11 errors, 47✓	1	5	1
A.H.	10 errors,26✓,3F	3	5	3
M.H.	10 errors,28✓,1F	-	-	-
(R.B. surface dyslexic)	0 errors 40✓	0	2	0

F: failures

H.M. was markedly more impaired on rhyme recognition that on rhyme production . The input task was thus much harder than the output

task. This is similar to the dissociation between reading and spelling, where the output of phonologically accurate spellings seems easier than attempting to read real words phonologically. For the other children tested there were marked impairments on both tasks.

Since children with reading disorders usually speak normally, they are able to perform the tacit or implicit segmentation required to develop language. However it has been argued that they may lack the ability to perform overt or explicit phonemic segmentation and this is purportedly why they fail to learn to read properly.(Bradley and Bryant 1978,1983)

The table above indicates that this is not true for all chuldren with developmental dyslexia, but it may be true for a subgroup.The child with developmental surface dyslexia can explicitly segment but the children with developmental phonological dyslexia cannot. One may compare A.H. and R.B. directly since they are the same chronological age and reading age. On the rhyme recognition task, A.H. is correct on 25/36 trials and R.B. is correct on 34/36 trials. This difference is statistically significant ($\tilde{X}=6.00, p<0.05$).

Thus the impairment observed in the development of a phonological route for reading, in phonological dyslexia, may be part of a more generalised impairment in the ability to perform explicit phonological segmentation.

An examination of H.M.'s performance shows that the impairment can affect input phonology in general but does not necessarily affect output phonology. H.M. makes many phonologically accurate spelling errors and she also performs well on the rhyme production task , failing to produce a response on no words and making only one error.Her total output is also high. There is thus little evidence of failure in the phonological skills required by these output tasks. Performance is only mildly impaired on the input tasks of reading and rhyme recognition.

In short, developmental phonological dyslexics may be impaired in explicit phonological skills but this impairment may in some cases be restricted to input rather than output tasks.

DEEP DYSLEXIA

INTRODUCTION
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The first description

In 1966 John Marshall and Freda Newcombe described an apparently novel case of acquired dyslexia consequent upon a penetrating missile wound. The patient, G.R., showed no evidence of specific intellectual deficit outside the field of language. He had no generalised memory loss, although short term memory span for words, numbers, and letters was low. Speech was telegrammatic, with some loss of function words but was coherent and devoid of jargon. There was no articulatory defect. There was a mild impairment in speech comprehension.

The striking feature of G.R.'s performance was the occurrence of of semantic paralexias, when reading individual words, e.g. antique → "vase", canary → "parrot". Although semantic paraphasias were also observed in naming and writing to dictation, semantic paralexias predominated. These errors were found in the reading of sentences, but of more interest, when single words were presented out of context, over half of the reading errors were semantic paralexias. The remaining errors were classified as visual,e.g. next → "exit"; visual completion,e.g. gentle → "gentleman", or visual+semantic, e.g. sympathy → "orchestra". A part of speech effect was apparent where concrete nouns were read more accurately than adjectives which were read more accurately than verbs. Reading of function words (prepositions, adverbs, pronouns, question markers, and conjunctions) was very poor. There was a strong tendency for the erroneous responses to be nouns. Semantic errors ranged from synonyms,e.g. sick → "ill", to responses sharing only one or two semantic features with the stimulus, e.g. bad → "liar".

The reading syndrome exhibited by G.R. has since been named deep dyslexia (Marshall and Newcombe 1973). Its characteristics have been further investigated in both G.R.'s case and many other cases. An historical investigation of the literature reveals descriptions of similar cases (in a number of languages) dating as far back as the last century (Marshall and Newcombe 1980). Table 38 lists the first references to the 39 cases of deep dyslexia known to have been reported in the literature.More detailed historical investigation would most probably reveal further cases prior to 1966.

Integral Features

As with G.R., the most striking characteristic of all deep dyslexic patients is the occurrence of semantic errors when reading aloud individual words.The incidence of this error type varies from about 5% of errors in some patients,e.g. K.F.(Shallice and Warrington 1975) to almost 60% in others, e.g. G.R.(Marshall and Newcombe 1966). Most of the other errors fall into one of the following categories : visual errors, e.g. cheat → "chest"; derivational errors, e.g. children → "child"; function word substitution, e.g. them → "us"; visuo-semantic errors,e.g. question → "query"; visual + semantic errors,e.g. their → "earl" (via heir); circumlocutions, e.g. enemy → "I know it....something....different countries fighting together.....spy." Kapur and Perl(1978), Patterson (1978) and Nolan and Caramazza (1982) found that patients rated their visual errors as correct more frequently than they so rated their semantic errors, In contrast, Newcombe and Marshall (1980) found that both semantic and visual errors received confidence ratings which varied across the entire scale. Reading responses in deep dyslexia are almost always words. Responses also tend to be words which the patient can read (Nolan and Caramazza,1982).

1.	1895	Pitres (cited by Öbler 1984)	
2.	1930	Franz	
3.	1930	Beringer and Stein	
4.	1931	Low	
5.	1935	Kotani - Cited by Sasanuma(1980)	
6.	1940	Sakamoto - Cited by Sasanuma(1980)	
7.	1948	Goldstein	
8.	1953	Simmel and Goldschmidt	
9.	1955	Faust	W.E.
10.	1965	Ohashi - Cited by Yamadore(1975)	
11.	1966	Marshall and Newcombe	G.R.
12.	1972	Brown	
13.	1974	Sasanuma	
14.	1975	Yamadori	
15.	1975	Shallice and Warrington	K.F.
16.	1975	Andreewsky and Seron	
17.	1975	Marin,Saffran and Schwartz	H.T.
18.	1975	Marin,Saffran and Schwartz	V.S.
19.	1976	Whitaker	H.C.E.M.
20.	1977	Schwartz,Saffran and Marin	W.S.
21	1977	Schwartz,Saffran and Marin	B.L.
22.	1977	Niki and Ueda - Cited by Sasanuma (1980)	
23.	1977	Saffran,(pers.comm.) - Cited by Coltheart(1980)	J.R.
24.	1977	Patterson and Marcel	D.E.
25.	1977	Patterson and Marcel	P.W.
26.	1978	Kapur and Perl	P.D.
27.	1980	Shallice and Coughlan	P.S.
28.	1980	Kremin	L.E.C.
29.	1981	Allport and Funnell	S.K.
30.	1981	Allport and Funnell	B.B.
31.	1981	Allport and Funnell	R.W.
32.	1981	Caramazza, Berndt and Hart	M.M.
33.	1982	Friedman and Perlman	F.D.
34.	1982	Kirshner and Webb	Case 1
35.	1982	Kirshner and Webb	Case 2
36.	1982	Kirshner and Webb	Case 3
37.	1982	Rickard	B.N.
38.	1982	Rickard	R,W.
39.	1982	Rickard	Y.N.
40.	1983	Pinto	

Table 38 First references to cases of acquired deep dyslexia.

With respect to linguistic dimensions, deep dyslexics show an effect of word frequency, word concreteness, and word imageability (Richardson 1975). Marcel and Patterson (1979) have shown that imageability is more crucial than concreteness. Deep dyslexics also appear to show an effect of part of speech where nouns are read more easily than adjectives,which are read more easily than verbs. However, it has recently been shown that this effect is an artefact of imageability differences between verbs, adjectives and nouns, (Rickard, 1982; Allport and Funnell,1981 ; Nolan and Caramazza, 1982). Whether the difference between the ease of reading content words and the ease of reading function words is also an artefact of imageability effects is unclear.

Non-lexical derivation of phonology from print is impossible in deep dyslexia. The patients are unable to read pronouncable non-words, e.g. gip, plag. Their responses to these stimuli tend to be omissions or lexicalisations, e.g. plag ⟶ "flag". Although in lexical decision tasks normal readers take longer to reject non-words that are homophonic with real words ,e.g. flore, deep dyslexics do not show this effect (Patterson and Marcel 1977). The lexical derivation of phonology from print is also impaired (Coltheart 1980). They are unable to judge, except on the basis of visual similarity, whether printed words rhyme (Marin et al 1975).

Deep dyslexics can understand more words than they can read aloud correctly. Although it has not been extensively investigated, whether a word can be read aloud may depend on its context (Low 1931, Andreewsky and Seron 1975, Coltheart 1980). Finally,deep dyslexics always have two associated deficits in addition to the impairment of reading (Coltheart 1980). They have an impaired auditory-verbal short term memory which can be detected by poor performance on digit span tests; they are also dysgraphic when writing either spontaneously or to dictation.

Theoretical Explanations

There is a greater diversity in the theoretical explanations that have been proposed for deep dyslexia than there is for any of the other syndromes of acquired dyslexia. Outlines of the most prominent theories follow.

Shallice and Warrington(1980)

In contrast to the syndromes of surface dyslexia and phonological dyslexia which Shallice and Warrington characterise as single component syndromes, deep dyslexia is viewed by them as a multi-component syndrome. Shallice and Warrington are particularly struck by the variability in the error patterns in deep dyslexia. Partly to account for this they posit two different forms of deep dyslexia. In each there is an impairment of the phonological route and one further impairment the site of which differs in the two forms.

In the first type of deep dyslexia, certain classes of visually presented words, e.g. abstract words, are unable to achieve adequate semantic representations. Thus concrete words are read more accurately than abstract words. Furthermore, there are comprehension deficits for abstract words. Shallice and Warrington assume that word detectors can activate differentially the semantic representations of more than one word. In some cases when an abstract word is presented for reading, the semantic representation of the correct abstract word cannot be adequately triggered. The semantic unit corresponding to a visually similar, more concrete word then becomes the most strongly activated unit. This unit dominates the semantic representation of the original stimulus thereby producing a visual error. They do not believe that visual errors result from earlier misprocessing at the level of word detectors, since this would predict that visual errors would occur equally frequently for all classes of words , whereas

there is some evidence that the relative proportions of visual errors differ as a function of part of speech (Marshall and Newcombe 1966). Semantic errors are also explained in terms of a failure of semantic access. Semantic errors in the first form of deep dyslexia should either be highly semantically similar to the stimulus (e.g. pencil ⟶ "biro") or lacking in precision unless abstractly defined (e.g. fiction ⟶ "acting"). In order to differentiate stimulus and response an abstract comprehension system would be required. Shallice and Warrington claim that patients with this form of deep dyslexia have low rates of semantic errors.

In the second type of deep dyslexia, there is an output difficulty from the verbal semantic system. Shallice and Warrington assume that abstract and concrete words are differentially 'localised' within the semantic system. If one part of the system is damaged, performance will reflect predominantly the functioning of the other. This may trivially account for the similarity of the semantic/syntactic pattern of word reading failure in this type of deep dyslexia and the previous type.However, in this type of deep dyslexia, semantic errors are nominal errors. Semantic processing is adequate but the appropriate verbal label cannot be obtained. In many types of aphasia, nominal errors, as Shallice and Warrington point out, show only a loose semantic connection between stimulus and response(Lhermitte and Beauvois, 1973). Patients with this second form of deep dyslexia,Shallice and Warrington claim,make a larger number of semantic errors relative to visual errors than those with the previous form. They consider that one advantage of this subdivision of the deep dyslexias is that it can account for the variation in the incidence of semantic errors between patients. But, they do not explain why they think that patients with the first type of deep dyslexia should make fewer semantic errors than those with the second.

Shallice and Warrington also suggest that there may be a third form of deep dyslexia which results from damage to the verbal semantic memory itself. These patients would have associative agnosia and damage to the phonological route in reading.

Morton and Patterson(1980)

The explanatory model favoured by Morton and Patterson is given in figure 10. The hypothesised functional impairments in deep dyslexia are located in the dotted areas (It should be noted that Morton and Patterson employ the term 'parser' in a way that differs from its use in relation to the models of surface dyslexia.For Morton and Patterson,it refers to syntactic parsing.) Morton and Patterson posit five impairments in deep dyslexia:

1. A malfunction of the grapheme-phoneme route which accounts for the inability to derive non-lexical phonology from print and also for the absense of neologistic responses.

2. The direct connection from visual input logogens to output logogens is broken, so that patients should never read a word they do not understand.

3. The semantic representations of some words, particularly abstarct words are impaired, accounting for visual paralexias, omissions and some misses in lexical decision. For some words (e.g. abstract words and words with close synonyms) the semantic code does not uniquely specify an entry in the output logogens. Semantic errors result and are not detectable by the patient.

4. Some logogens have heightened thresholds. This accounts for some omissions and for the semantic paralexias which the patient can identify as errors.

5. Linguistic ("syntactic") processing is impaired giving rise to derivational paralexias and function word errors.

Additionally there may be difficulty in accessing the response buffer.

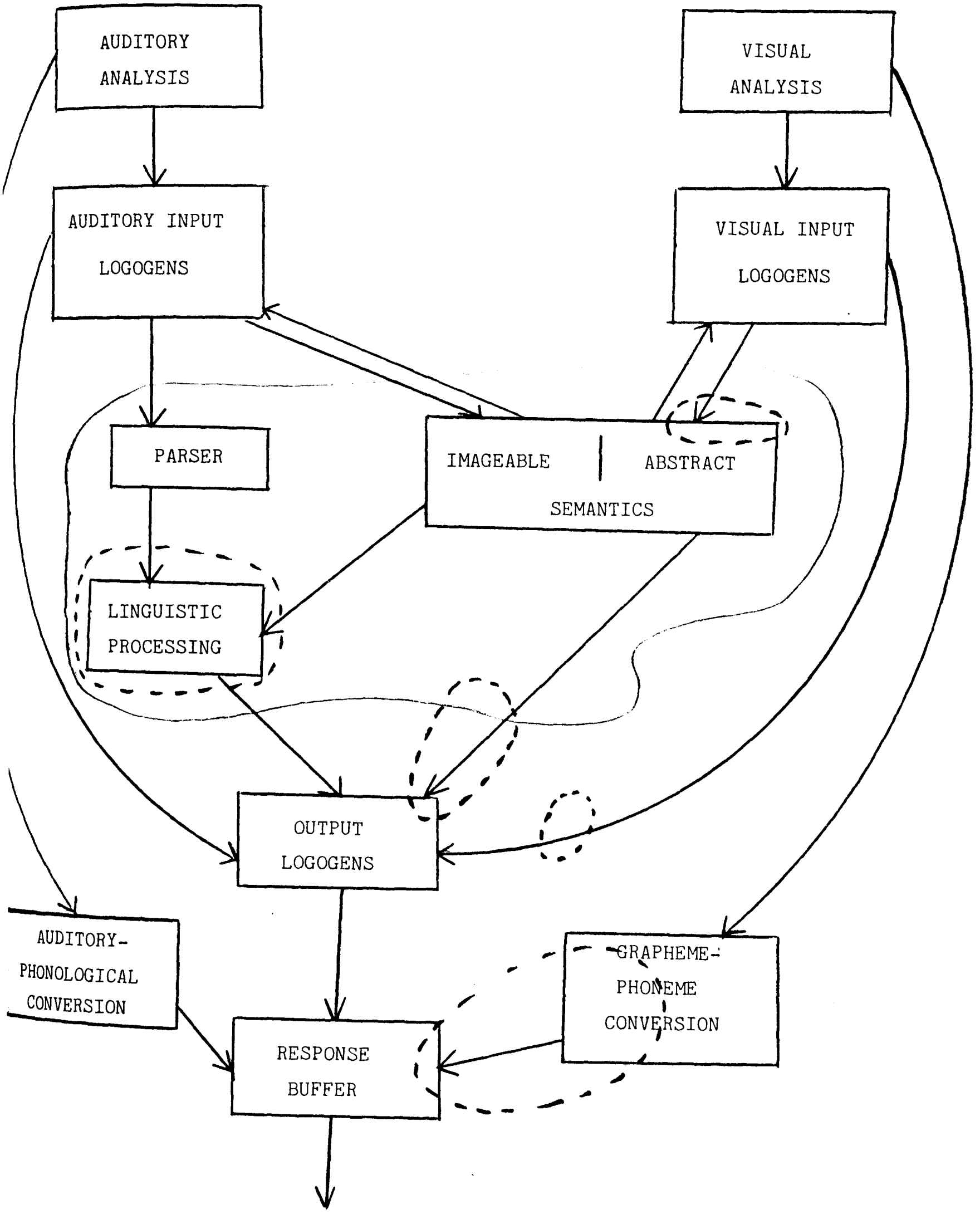

FIGURE 10

THE READING MODEL OF MORTON AND PATTERSON (1980).

Hypothesised functional lesions in deep dyslexia are marked by dotted areas.

Morton and Patterson's model posits the largest number of 'functional lesions' in deep dyslexia but it also attempts to account for the widest number of features in deep dyslexia.

Newcombe and Marshall (1980)

Newcombe and Marshall conjecture that the semantic system is intrinsically unstable and that peripheral devices (such as grapheme-phoneme conversion systems) act as stabilising mechanisms to prevent errors. They suggest that in reading,the product of the input logogen system activates not only the correct semantic entry but also a number of semantically related entries in the semantic system. Even minimal phonological recodong (as found in phonological dyslexia) will be sufficient to block semantic errors. In deep dyslexia, they suggest that the patients are both unable to use the grapheme-phoneme conversion system and have an exacerbated amount of instability in the semantic system. In addition, they propose that their patient, G.R., is unable to use a phoneme-grapheme conversion system with consequent semantic errors arising in writing to dictation(deep dysgraphia).

In their theory the phoneme-grapheme system is nevertheless quite separate from the grapheme-phoneme system. The underlying orthographic lexical codes used in reading are functionally dissociable from those used in written and spoken spelling.

Allport and Funnell (1981)

In contrast to the theory of Newcombe and Marshall (1980), Allport and Funnell have proposed that the same phonological and orthographic representations are used in grapheme-phoneme conversion(reading) and phoneme-grapheme conversion (spelling). Input and output phonology are both dependent upon the same underlying representations.

In terms of their model (figure 11) deep dyslexia is interpreted as resulting from a functional disconnection between orthography and phonological codes (route 5).

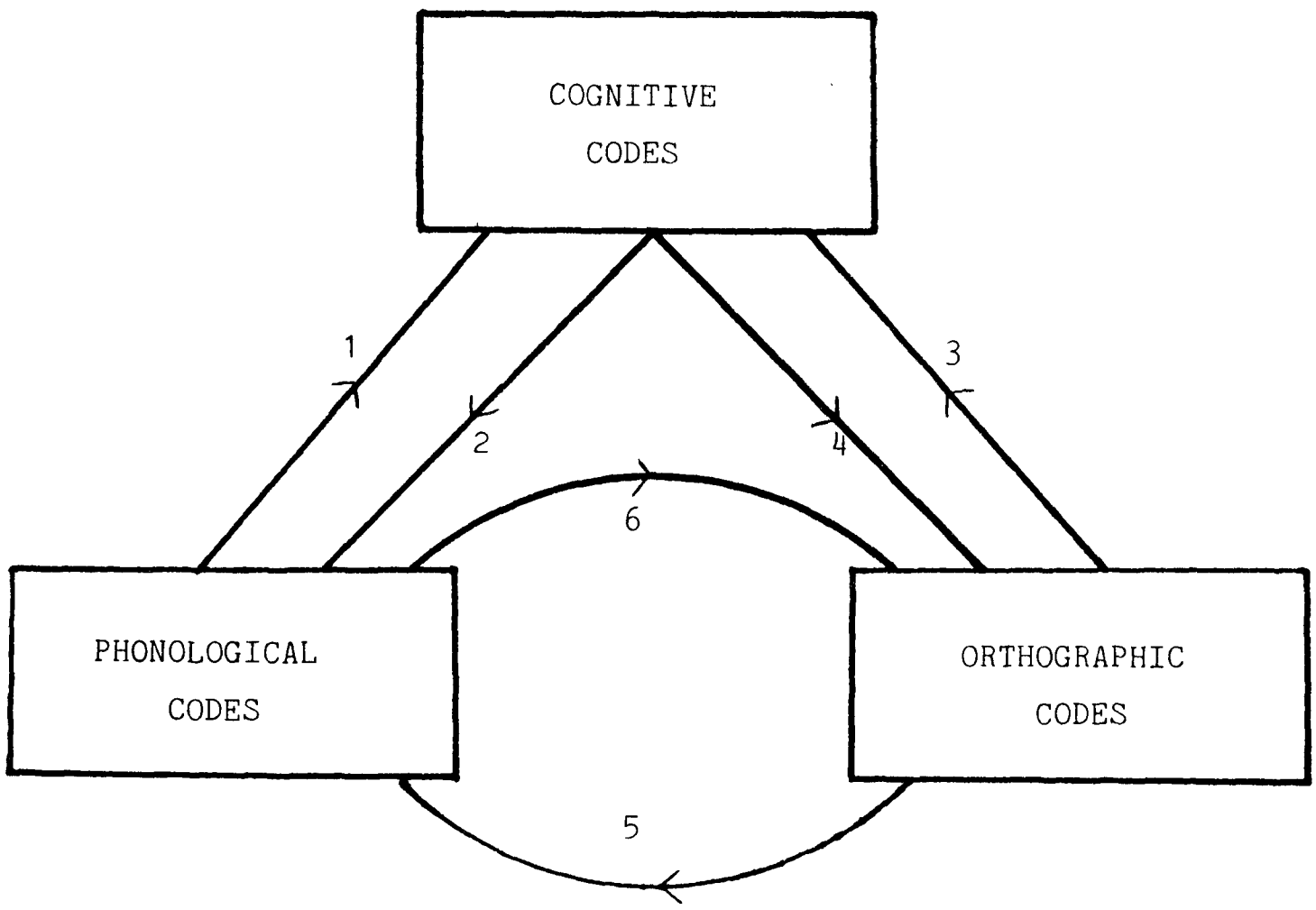

FIGURE 11

The reading model of Allport and Funnell (1981)

In some patients the impairment may be bidirectional. Similar semantic errors are then observed in writing to dictation.

Friedman and Perlman (1982)

Friedman and Perlman's theoretical interpretation of deep dyslexia is in some ways similar to that of Shallice and Warrington (1980). Friedman and Perlman believe that semantic errors reflect two different underlying disorders. In one disorder, a related but incorrect concept is accessed from the perceptual input of a written word. Naming of this (incorrect) concept will result in paralexic error. The other disorder arises when the correct concept is aroused but an incorrect spoken word is retrieved.

Friedman and Perlman also believe that the disorder is not unique to reading but is part of a more general language processing deficit. However this notion can hardly account for the fact that deep dyslexia can occur even when speech is only mildly impaired or is impaired in ways that do not correspond to the reading impairment (e.g. Low 1931; Shallice and Warrington 1975; Yamadore 1975; Sasanuma 1974; Schwartz, Saffran and Marin 1977).

Nolan and Caramazza (1982)

Nolan and Caramazza argue that the deficits observed in deep dyslexia are not modality specific but can be observed in repetition, writing and for some aspects, in naming. It had been reported that some patients do not have such extensive defivits (e.g. Newcombe and Marshall 1980) but Nolan and Caramazza assume that testing was not stringent enough to reveal the impairment.

They propose that there is one phonological processing system which is used for any process that requires phonological codes. In this they resemble Allport and Funnell (1981). Nolan and Caramazza also assume that the internal lexicon is organised in such a way that there is a gradient of recognition thresholds from concrete to abstract.

Finally, they suggest that there may be a spread of activation to related items before any entry reaches threshold in the lexicon.

They agree that deep dyslexics have disruption of the phonological processing system and they suggest that there is exaggeration of the normal threshold gradient in the lexicon. There may also be a criterion shift for some tasks. Consequently, words will be produced in response to non-words if the nonwords are similar to words with relatively low thresholds. This lowering of criterion also takes place when the threshold of a stimulus word is too high to allow the word to be produced. Another word with a lower threshold which resembles the stimulus either orthographically or phonologically will be produced. Semantic errors will occur when spreading activation causes an associated word which is more frequent or more concrete to reach threshold.Functor substitutions occur in the same way. Functors form a close knit network with high thresholds. Presentation of one functor will cause spread of activation to other functors; a shift in criterion will cause the wrong functor to reach threshold first.

Marcel (1980)

The crucial feature of Marcel's model that differentiates it from multiple route models is that words and nonwords are read by the same mechanism. Marcel's theoretical interpretation, presented in the section on surface dyslexia, may apply to other forms or reading impairment. Marcel's reading model and the hypothesised lesion in deep dyslexia is presented in figure 12. In this model, the connection between visual input lexicon and aural-oral lexicon has been lost in deep dyslexia. There is no lexical means of retrieving phonology for non-words. Since the route which accesses semantic representations is intact some words may be read. Semantic and derivational paralexias arise from this route but no responses are made to non-words words. In addition, there may be further impairments in the semamntic system or visual addresses themselves.

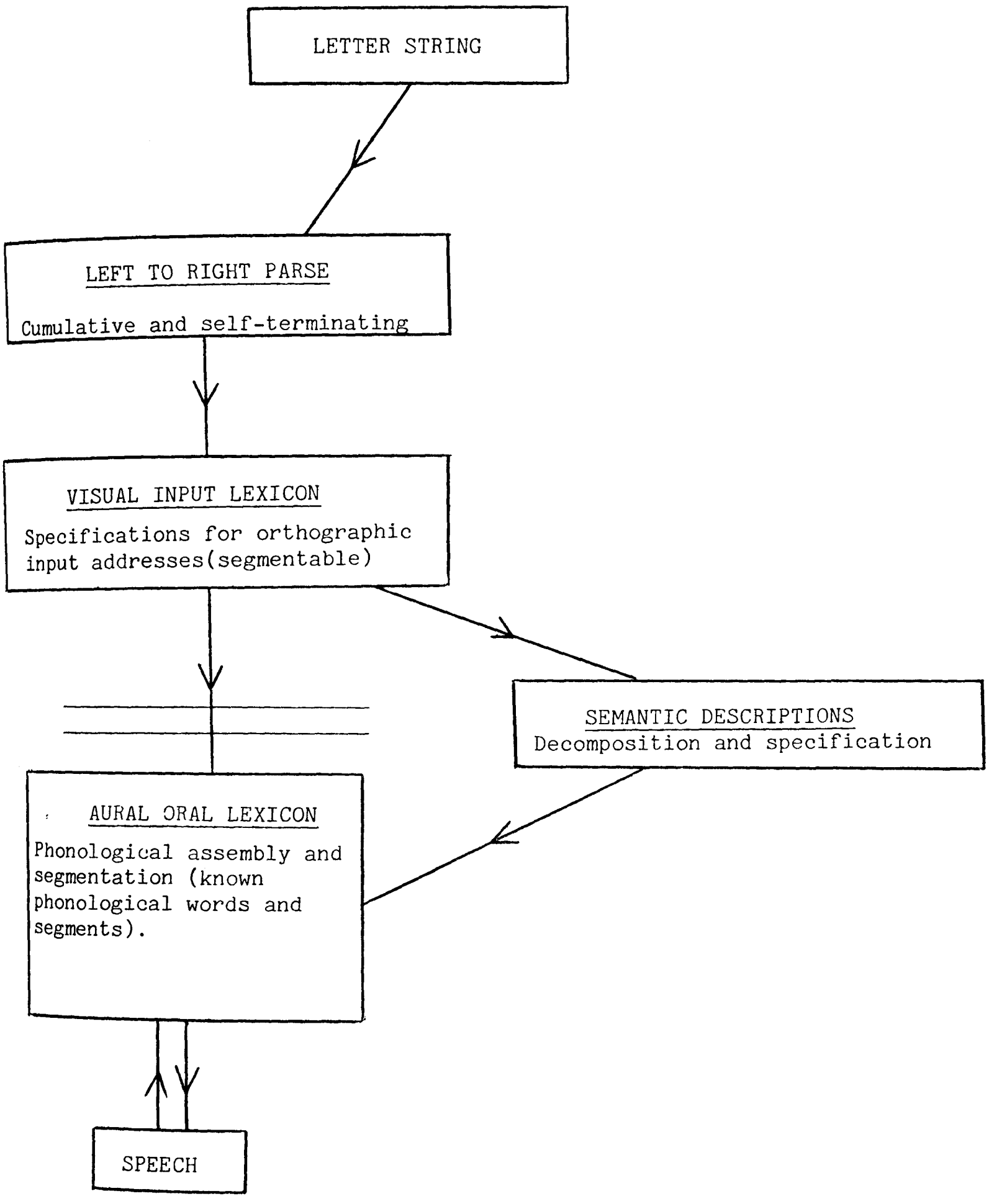

FIGURE 12:Marcel's Model of Deep Dyslexia

The Right Hemisphere Theory

1. Coltheart

It has been suggested by Coltheart (1977, 1980) and Saffran, Bogyo, Schwartz and Marin (1980) that the right hemisphere is particularly involved in the reading performance of deep dyslexics. In Coltheart's formulation, lexical access activates a set of semnatic features corresponding to the word, within the right hemisphere semantic system. The semantic information is then passed via the callosum to an output system in the left hemisphere where an entry is selected from the lexicon and a pronunciation retrieved and articulated.

Sometimes there will be small differences between the semantic representation sent from the right hemisphere and the semantic representation of the selected response item in the left hemisphere lexicon. As a result, feature loss semantic errors may be produced and also function word substitutions.

As a result of the associative organisation of the right hemisphere lexicon a number of associatively related words may be activated in response to a stimulus. Sometimes selection from this word set will be incorrect. Incorrect semantic representations will thus be transmitted to the left hemisphere and an associative semantic error will result.

If a word fails to activate sufficiently an entry in the right hemisphere, the subject may use approximate visual access and select an entry with orthographic similarity. A visual error will result. Words which lack semantic richness (poor semantic specification) in the right hemisphere will be less likely to be read correctly : abstract words and function words. If, minimally, the feature "function word" is activated the response will be within that class, i.e., a function word substitution will occur. Words with the same

route morpheme may have the same entry in the semantic system. The right hemisphere is believed to have little or no syntactic processing ability (Zaidel1978) and may be unable to select the correct affix to attach to the root morpheme. Derivational errors will result.

2. Saffran et al (1980)

The theory of Saffran et al. (1980) differs slightly from that of Coltheart. They feel that the crucial aspect is that the right hemisphere language system is designed for comprehension not production. Words are matched to stored orthographic entries in the right hemisphere. Some of these entries are incomplete (e.g. those for abstract and function words), and have no direct access to phonological codes. Their output is exclusively to the right hemisphere semantic system. For many words (e,g. concrete words) there may be widespread activation that results in selection difficulty. Selection errors are semantic errors. For other words (e.g. abstract and function words) the semantic representation is too vague to specify an output.Unlike Coltheart, Saffran et al do not claim that only the left hemisphere contains the output system. They consider that the site or sites of the output system is not a crucial factor for the theory.

Many of the features of deep dyslexia are consistent with the characteristics of the reading system of the right hemeiphere. The evidence relating to the reading system of the right hemisphere comes from tachistoscopic studies of normal individuals, investigations of commissurotomy

and observations of the course of

This work is reviewed elsewhere (

In particular, there is evidence

unable to convert print to phono

right hemisphere has selective difficulty in processing words of low imageability (Zaidel 1981). The syntactic skills of the right hemisphere are very limited. There is some evidence that the right hemisphere is particularly prone to make semantic paralexias and other semantic errors.(Zaidel 1981)

The right hemisphere theory of deep dyslexia is consistent with the uniformity of the syndrome. It also recieves some support from the work of Saffran et al (1980) . On dichotic listening tests four of their deep dyslexics showed a strong left ear advantage and three showed total supression of right ear stimuli in digit recognition. In further tachistoscopic experiments, Saffran et al also showed a left visual field advantage for lexical decision by patients with deep dyslexia.

One major difficulty for the right hemisphere theory of deep dyslecia is the existence of another population with intact right hemispheres but who are apparently unable to read. Pure alexia or alexia without agraphia was first described by Dejeurine (1891,1892). The disorder is often interpreted as a disconnection syndrome. There is generally a left occipital lobe lesion(which results in a right homonymous hemianopia) and a lesion in the splenium of the corpus callosum. Alternatively there is a left hemisphere lesion which undercuts the left occipital lobe thus preventing input of visual information to language centres (Damasio 1983)
The patients have intact right hemispheres yet are unable to read. Recently, Patterson and Kay (1982) have investigated whether reading comprehension might be superior to oral reading in pure alexia, but they have been unable to reveal any significant degree of reading comprehension prior to the letter naming strategy that the patients adopt.

Various suggestions have been proposed to account for the

reading failure in pure alexia. Brown (1981) points out that the patients do not have intact left field perception. In most cases there is initially impaired object recognition or even cortical blindness. Pure alexics have prolonged latencies for object recognition to tachistoscopic exposure. Brown notes that Wernicke reported that patients copied and traced letters poorly. Brown suggests that the left occipital lobe lesion may reduce function in the right occipital area and that this effect may be enhanced by callosal pathology. In severe cases, the resulting physiological lesion may produce cortical blindness. Intermediate cases have impaired form perception with object agnosia, prospagnosia and alexia. Mild cases retain an alexia and a perceptual deficit for words and letter stimuli. Waxman (cited by Brown 1981) has found elevated recognition thresholds for geometric shapes in the intact fields of hemianopics suggesting that hemispheric lesions affect homologous contralateral points. Neville (cited by Brown 1981) has also found an absense of N1s (the first negative waves in average evoked potentials) in the V.E.P.s(visual evoked potentials) to four-letter words over the right occipital lobe in severe pure alexics. This datum also indicates a disturbance of right occipital function.

Alternatively,Coltheart (1980) has suggested that it is the role of the splenium which is crucial. Specifically he proposes that the splenium is necessary for interhemispheric transmission of semantic representations of alphabetically printed words. Since the splenium is intact in deep dyslexia and severed in pure alexia the reading of deep dyslexics is superior. This explanation is not applicable to all pure alexics,since in some the splenium is intact (Damasio 1983)

Another criticism of the right hemisphere theory has been raised

by Besner (1981, 1983). His experiments with normal subjects suggest that there is no representation in the right hemisphere for words that denote colour, nor lexical entries for abbreviations that can be accessed by visual presentation. Deep dyslexics show considerable sparing of the ability to read both colour names and abbreviations. Besner concludes that the right hemisphere account of residual reading abilities seen in deep dyslexia is not a sufficient one.

DEVELOPMENTAL DEEP DYSLEXIA?
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Jorm(1977, 1979) has recently suggested that all developmental dyslexics are deficient in phonic skills and are poor at the phonological recoding of written words. Data presented in the preceding sections indicates that this is true for some developmental dyslexics, but Jorm considered that it was true of all developmental dyslexics and futher argued that there was no evidence for distinct sub-groups in developmental dyslexia. He accordingly speculated that the group of acquired dyslexics who were most similar to developmental dyslexics were the deep dyslexic patients. Ellis (1979) while welcoming the attempt of integrating the developmental and acquired fields, has pointed out that this analogy has little substantive basis. For many years,a number of researchers have been looking for a case of developmental deep dyslexia, but no pure case has yet emerged. This failure is of theoretical interest and raises two questions. First, why is developmental deep dyslexia not a prevalant subtype of the developmental dyslexias? Second, to what extent do some cases of developmental reading disorder nonethless resemble deep dyslexia? An attempt will be made to answer the second question first. The first question will be addressed in the discussion.

The developmental case of Johnston (1983) bears some resemblance to deep dyslexia. This case will be presented in summary. There then follow new case descriptions of two children who are reading without phonology.

Johnston (1983) describes an 18 year old girl,C.R., (IQ 75), who has normal fluent speech. Reading performance was very poor. British ability scales reading was 6 years 2 months. Johnston claims that words of high imageability were read better than those of low

imageability and that comprehension of low imageability words was poorer than comprehension of high imageability words.However, tha data set of a child with reading age of 6.2 is very small and the conclusions relating to imageability are based on the results with a very small number of words. In fact, only one word with low imageability was read for the comparison and it would be more accurate to say simply that the few words that Johnston's subject has learnt to read are of high imageability.

Non-word reading was very poor (1/25 correct) although not non-existent as in most cases of aquired deep dyslexia. The non-words were not refused entirely; some were lexicalised, but some also produced incorrect non-word responses. Eighty-five reading errors were analysed : five semantic, two visuo-semantic, one visual + semantic, nine function word substitutions, three derivational, fifty visual and fifteen unclassifiable. Of the semantic errors two involve the same word pair : chair ⟶ "table", table ⟶ "chair" suggesting that the words may have been learnt together possibly next to a picture of a table and a chair and C.R.has not learnt to distinguish between them. It would be of interest to know how consistently these two words are confused. Another semantic error might have been classified by others as a function word substitution (down ⟶ "up"). One of the remaining two semantic errors has a visual component : office ⟶ "occupation". This does not fall within the classification "visual error" as used in this thesis since the shared letters do not preserve order, but it would be classified as visual by those who have looser criteria. The final semantic error : seven ⟶ "eight", is a number substitution.Only three examples of function word substitutions are given. All have a strong visual component, e.g. who ⟶ "how".

The case is thus somewhat unconvincing as a developmental analogue to deep dyslexia : tha data presented are very limited

and the incidence of clear semantic errors is very low. two new case descriptions of children who read without phonology will now be presented.

READING WITHOUT PHONOLOGY
****

CASE 7 :K.S.

Case History

K.S. is a nine and a half year old, right-handed boy from a right-handed family. He is the eldest of three children and was born in South Africa. K.S.'s parents are healthy. There is no family history of epilepsy, mental retardation or specific learning difficulty.

Throughout pregnancy there was nausea and vomiting for which Debendox was prescribed. Weight gain was poor. Delivery was by Caesarian section at term because of disproportion and delay in the first stage. Birth weight was 7 lbs 12 ozs. K.S. cried and fed well from the start. He had colic for the first three months but thrived and gained weight with bottle-feeding. There was a suggestion of slight floppiness. He was said to be smiling and responsive early. Motor milestones were satisfactory. He sat unsupported at 5-6m and, although he did not crawl much, he walked alone at 12m. Stair climbing and running were acquired normally without excessive falling. First words appeared at 8-9m. A large vocabulary of single words was established by 18-24m. There were some persistent mispronunciations. Short phrases appeared at 2-2½ years.

K.S.'s mother returned to work when he was 2 m old. From 2m-4 years he went daily to a child minder who spoke English and Dutch. From 4-5 years he was looked after by a maid at home who spoke Zulu and pigeon English. From 5-6 years he went to a creche where English and Africaans were spoken. He picked up a few words of Africaans. When K.S. was 6 years 5 months old the family returned to England to live.

K.S. had whooping cough at 18m, a mild illness (and had full

triple vaccine course). He later had mumps, chicken pox, and German measles. There has been no known head injury. Concern about hearing arose at 4 years. Hearing was found to be impaired and grommets were inserted. These have tended to fall out. Recent testing in January 1983 indicated that K.S. was having great difficulty with speech at less than 40-45 dbs. New grommets have now been inserted. On recent examination by Dr Judith Hockaday, consultant in paediatric neurology at the John Radcliffe Hospital, Oxford, no neurological abnormality was found. The thumbs appeared slightly abnormal with subluxed terminal joints. The second and third finger are partially joined. This may be a familial feature as it is also said to be found in K.S.'s younger sister. Speech shows poor articulation. K.S., though cooperative, was extremely distractable. and anxious.

Examination by Dr Lindenbaum of the Department of Medical Genetics, the Churchill Hospital, Oxford revealed no chromosome abnormality. Total ridge count was low although mother's count was normal.

A recent Computerised Tomography scan of K.S. was found to be normal. Skull X-ray showed no abnormal calcification or erosion and normal pituitary fossa. K.S. has a large head, at the 75%ile for age. He is also of small stature, 25%ile for age. Both parents are also small, particularly the mother. K.S.'s sleep is normal and growth is satisfactory. There are some problems in coordinating more complicated motor activities and he is unable to ride a bicycle.

Psychological Background

K.S. is a lively and affectionate boy, although he is somewhat immature and easily upset. Recent behaviour has become increasingly disturbed with temper tantrums. Since first starting school at $2\frac{1}{2}$ yrs. K.S. has always maintained that he enjoys it. He loves talking and chatters

endlessly. K.S. has poor concentration and a poor memory, is easily distractable with a short attention span. K.S. has had continual difficulties at school and has failed to learn to read.

K.S. was assessed by Dr John Richer, Principal Clinical Psychologist at the John Radcliffe Hospital, Oxford in December 1982. The following results were obtained on the British Ability Scales:

	Centile	T-score
Similarities	12	38
Recall of digits	4	32
Recall of designs	5	
Immediate visual recall	1	27
Delayed visual recall	5	33
Matching letter-like forms	3	31
Naming Vocabulary	average for $3\frac{1}{2}$ - 4 years	
Copying	average for 7 year old	
Basic Arithmetic	5	
Word Reading (zero score)	1	

Overall IQ was found to be in the mildly retarded range but it was condidered that this might not be a fair reflection because of at least two difficulties. First, a severe difficulty with shapes was found. Recall of designs, matching of complex,letter-like forms and ability to recall by name seen pictures were all at or below a five year level. Ability to copy shapes was that of an average seven year old.The second difficulty was a tendency to extreme anxiety, confusion and panic. K.S. gave up easily; he confabulated answers; he perseverated, giving answers to previous questions; he got sequences easily confused; he was careless; he gave associative answers and he showed intense displacement activities such as wringing the hands or suddenly getting up and flapping his arms.

These irrelevant behaviours had the same quality as the more agressive temper outbursts he occasionally displayed and were reminiscent of the tics of a sufferer from Gilles de la Tourette's syndrome.On occasion, the correct response was clearly possessed by K.S. but was not produced. Dr Richer states :

"During the similarities subtest I asked him what was the same about cod, shark, and pilchard. He said "food". Then for the next item I asked him what was the same about cupboard, table, bed. He said, correctly, "furniture". When I asked for an example of furniture he said "fish", the correct answer to the previous question".

An example of K.S.'s inability to shift set is given by his class teacher, Miss Pamela Wootton. She recalls watching his attempts to do the similarities subtest of the Wechsler Intelligence Scale for Children. The first item requires a response about the similarity of wheel and ball. The answer - they are both round and they both roll, is given by the examiner, if the child does not respond correctly. Thereafter K.S. attempted to find something round in common for each pair of items. For example, for the pair beer - wine, instead of saying they were similar because they were alcoholic drinks, he said that they were both served in glasses that were round if you looked down at the bottom. Partly as a result of difficulties of this sort, K.S. attained a verbal IQ of only 57 and a performance IQ of 72 on this test. It was considered that these scores were underestimates of his ability.

Not all test scores suggest that intellectual level is this poor. K.S. was administered Ravens Coloured Progressive Matrices He attained a raw score of 18 equivalent to an age scaled IQ score of 85. On the Peabody Picture Vocabulary Test, he attained a raw score of 64 equivalent to an age scaled score of 85. Both of these scores are within the normal range (low average) and indicate

that K.S.'s learning difficulties do not result from an across the board depression of function.

Reading

K.S. is unable to name or sound any of the letters of the alphabet except for K and S which are his initials and which he can sound but not name. He also names X as "cross". K.S. is unable to read any pronunceable non-words. On the Schonell single word reading test he reads two words correctly : tree and flower, attaining a reading age of 5 years 2 months.

K.S. was presented with 300 words for reading aloud. Most words were refused. Thirty words were read correctly. Nineteen of the words were highly imageable, high frequency nouns : dog, window, door, roof, chimney, river, friend, field, cat, Queen, boy, nurse, caravan, frock, zebra, cake, doll, and mother.Three of the words (10%) were colour names : blue, red, and green. Only one other adjective was read correctly: pretty and only one verb was read correctly : play Six function words were read:of, and, by, get, we, and him.

There were 77 stimuli which K.S. tried to read but which he read incorrectly. All of the erroneous responses except two were words; that is, all the errors save two were paralexias and none were neologisms. The two other errors were so $\longrightarrow$/sɔsɔ/ and she $\longrightarrow$ /sɔsɔ/, where the initial letter of each word was sounded. S is one of the letters that K.S. can sound since it is his second initial. All of the words produced as errors were high frequency, highly imageability nouns or colour names (in which instruction had been given at school) with the exception of function word responses which are of high frequency but low imageability.

Four of the paralexias (5%) were semantic:

eye $\longrightarrow$ "blue"	Peter $\longrightarrow$ "pan"
mother $\longrightarrow$ "mummy"	Mary $\longrightarrow$ "Brenda"

Two paralexias (3%) were visuo-semantic:

fresh ⟶ "flowers" garden ⟶ "green"

Two paralexias were derivational :

flower ⟶ "flowers" tree ⟶ "trees"

The largest error category were visual paralexias. Twenty-nine errors (39%) fell into this group. The scoring criterion used was that fifty per cent of the letters in the response should be in the target or vice versa, with order preserved.

neighbour ⟶ "big"	honesty ⟶ "house"
pig ⟶ "big"	horse ⟶ "house"
wig ⟶ "big"	cause ⟶ "house"
bagpipe" ⟶ "big"	shone ⟶ "house"
father ⟶ "flowers"	value ⟶ "blue"
finger ⟶ "flowers"	clue ⟶ "blue"
frog ⟶ "flowers"	but ⟶ "blue"
motion ⟶ "mother"	teeth ⟶ "tree"
mattress ⟶ "mother"	them ⟶ "tree"
moth ⟶ "mother"	they ⟶ "tree"(covered y)
mouse ⟶ "mother"	the ⟶ "tree"
children ⟶ "chimney"	king ⟶ "Kevin"
bright ⟶ "bring"	deer ⟶ "door"
rack ⟶ "frock"	from ⟶ "frock"
shiny ⟶ "in"(covered other letters)	

There were seven function word substitutions (9%). Of these five had a visual component : on ⟶ "of", my ⟶ "by", on ⟶"of", he ⟶ "the", on ⟶ "in". The two others were to ⟶ "by", and the ⟶ "and".

Nine errors were classified as visual + semantic (12%). All of the hypothesised intermediate words are words which K.S. has been taught and which he sometimes produces as reading responses.They all share at least fifty per cent of letters in common with the target

so that, had they been produced they would have been visual paralexias. In particular, we have already noted the following visual paralexias which did occur: clue → "blue", moth → "mother", mouse → "mother" and garden → "green".

The visual + semantic errors are :

clue → "red" (via blue)	
garden → "yellow" (via green)	
mouth → "mummy" (via mother)	
worth → "mummy" (via mother)	
carrot → "tent" (via caravan)	
cheery → "roof" (via chimney)	
Germany → "roof" (via chimney)	
Monday → "roof" (via chimney)	
archery → "roof" (via chimney)	

There remained 22 paralexias (19%) which did not fall into any of the above categories. Eight could have been classified as visual. if b-d confusion had been overlooked and/or the letters in common were not required to preserve order :

big → "dog"	gold → "big"
bronze → "doll"	Wednesday → "big"
both → "doll"	for → "roof"
ear → "red"	gotilla → "garden"

The remaining fourteen errors were unclassifiable :

essay → "roof"	fancy → "roof"
influence → "flowers"	hand → "house"
bat → "blue"	bat → "red"
pebble → "chimney"	digest → "green"
November → "Natalie"	tiger → "my"
knee → "window"	claw → "field"
purpose → "field"	concept → "caravan"

It has been argued by Ellis and Marshall (1978) that random pairing of stimuli will produce detectable proportions of semantic and other error types which are artefactual. In view of the number of unclassifiable errors it might be argued that K.S.'s responses are merely random and the categories into which the errors have been classified are therefore unjustifiable.

In order to show that K.S.'s responses are not random, comparison was made with pairing from random sampling. The responses which K.S. produces as paralexic errors are restricted in number. There were 33 different responses produced in all to the 300 stimuli presented to K.S. On five separate trials each of the 75 words which had produced a paralexic response was randomly paired with one of 33 possible responses. This was done from random number tables. These pairings were then analysed as above into the categories : semantic paralexias, visual+semantic paralexias (via one of the possible responses), visuo/semantic paralexias, visual paralexias function word substitutions, derivational paralexias and unclassifiable errors. Table 39shows the incidence of the different error types for K.S. and for the random samples.

In the fourth row of the table the total number or errors with a semantic component is given. For K.S. this value is 15, that is 20% of the paralexias have a semantic component. The highest value obtained in the random samplings is 5, that is, 6% of the word pairs. These two values are significantly different ($\chi^2=4.67, p<0.05$). Thus the errors that K.S. makes, which have a semantic component, cannot be entirely attributed to random factors.They are significantly above chance level.

29(39%) of K.S.'s errors are visual paralexias. The largest value obtained in the random sampling is 11 (15%). These two values are significantly different ($\chi^2=8.03, p<0.01$). In reality, K.S.'s performance is even more markedly different than these statistics

	K.S.	R1	R2	R3	R4	R5	mean	Range
S	4(5%)	1(1%)	0(0%)	1(1%)	0(0%)	1(1%)	0.6 0.6%	0-1 0-1%
v/s	2(3%)	1(1%)	0(0%)	0(03)	1(1%)	1(1%)	0.4 0.4%	0-1 0-1%
V+S	9(12%)	2(3%)	4(5%)	4(5%)	2(3%)	4(5%)	3.2 4.3%	2-4 3-5%
Total	15(20%)	4(5%)	4(5%)	5(7%)	3(4%)	5(7%)	4.2 5.6%	4-5 5-7%
V	29(39%)	9(12%)	10(13%)	2(3%)	7(9%)	11(15%)	7.8 10.4%	2-11 3-15%
F	7(9%)	2(3%)	3(4%)	1(1%)	4(5%)	3(4%)	2.6 3.5%	1-4 1-5%
D	2(3%)	0%	0%	0%	0%	0%	0	0
0	22(29%)	60(80%)	58(78%)	67(89%)	61(81%)	56(75%)	60.4 80.5%	56-67 75-89%

Error classification for K.S. compared to the classification of the random word pairs.

TABLE 39

suggest since in both of the comparisons the largest value of the random samplings was selected. In all of the error categories the responses of K.S. fall well ourside the random sampling values. Additionally amongst the random pairs classified as visual were many in which one of the pair was a two letter function word and the other member of the pair contained one of these two letters,e.g.on → "frock". These pairs fall within the definition used for visual errors but K.S. made no visual errors of this type. If these pairs are excluded from the category visual then the largest incidence for visual errors in the random sampling falls to 5(6%) an even more profound difference from the pattern of K.S.

Derivational errors are present in the data of K.S. but none occur in the random samplings. K.S. makes more function word substitutions than appear in any of the random samplings but the difference between his incidence of 7 and R4's of 4, the largest random incidence is not significant.

Finally a larger number overall of K.S.'s errors are classsifiable into the above categories. Significantly more of the random pairings are unclassifiable.

Table 40 compares the error classification for K.S. with that for 7 aquired deep dyslexic patients(data from Shallice and Warrington 1980). If K.F. is to be considered an aquired deep dyslexic then K.S. is a developmental deep dyslexic.

To summarise: the majority of K.S.'s errors may be charactersied as semantic, visuo-semantic, visual+semantic, visual,or derivational paralexias, or function word substitutions.The incidence of words with a semantic component is significantly above chance as is the incidence of visual errors. The only words which K.S. reads correctly are those of high frequency and imageability, and one or two function words. These stimuli are also produced as errors.

Text Reading

K.S.'s reading of his school books is as follows:

	SEMANTIC	VISUAL and/or SEMANTIC	VISUAL	DERIVATIONAL	OTHER
P.W.	54	4	13	22	6
G.R.	56	?	22	11(?)	11
D.E.	23	6	35	32	4
W.S.	21	17	35	4	23
V.S.	19	16	48	10	7
P.S.	10	7	51	9	23
K.F.	4	10	61	19	6
K.S.	5	15	39	3	29%

Prevalance of different error subtypes in a number of aquired deep dyslexic patients and in the developmental case K.S.

TABLE 40

1. I have a doll. She is a big doll. My doll is big.

" ✓ am ✓ ✓ . And ✓ ✓ ✓ ✓ . By ✓ ✓ ✓ ."

I have a big doll. She is big. I have a pretty doll.

"And by the ✓ ✓ . By ✓ ✓ . A has ✓ ✓ ✓ ."

My doll is Brenda. She is a pretty doll. Brenda is pretty.

" And ✓ ✓ ✓ . - and ✓ ✓ ✓ . ✓ ✓ ✓ ."

She is my pretty doll. Brenda has a pretty frock. I have

" ✓ ✓ pretty my doll Brenda. ✓ by the ✓ doll . ✓ by "

a pretty frock. Brenda's frock is green. My frock is blue.

" ✓ ✓ doll . ✓ ✓ ✓ ✓ . By doll ✓ ✓ ."

Brenda and I have green and blue frocks.

" ✓ has a by ✓ have ✓ ✓ ."

2. My doll has a house. It is a doll's house. The house has

" Brenda ✓ by ✓ ✓ . By the and a ✓ ✓ . And by ✓ and "

a red roof and chimney. My doll's house has a blue door

" blue ✓ ✓ roof . By ✓ ✓ by the ✓ ✓ "

and windows. Brenda's house is big. The roof and chimney of

" a ✓ . ✓ ✓ ✓ ✓ . My ✓ by roof has "

my doll's house are red. The door of Brenda's house is blue.

" by doll ✓ has blue. By ✓ a ✓ ✓ ✓ a ✓ ."

The window's of my doll's house are big. Brenda is by the

" And window and a ~ ~ ~ ~ . By has ~ ~ "

door of the doll's house. Brenda's house has a big garden.

" ~ ~ ~ house ~ . By Brenda doll are ~ ~ ~ ."

The garden is pretty. The garden has a big wall. In the

" And ~ has ~ . ~ house ~ ~ ~ ~ . ~ ~ "

garden are green trees. Pretty flowers are in the garden.

" house has garden tree. ~ ~ ~ ~ ~ ~ . "

The errors in the first passage are predominantly function word substitutions. There are also semantic errors that involve the four main concrete words: pretty → "doll", doll → "Brenda", frock → "doll... ..frock", frock →"doll....frock", frock → "doll". Pretty and doll are usually read correctly. Each occurs six times yet only once elicits a semantic error. In contrast frock appears four times and is only once read correctly.

In the second passage there are also many function word substitutions. There are three derivational errors: doll's →"doll", windows → "window", trees →"tree" ; a number of semantic errors: red → "blue" (twice), chimney→"roof" (twice), garden → "house" (twice), doll's → "house", house → "doll.....house", and a visuo-semantic error green → "garden". There is a frequent confusion in both passages between my and by. By is also confused with Brenda. Some combination of the two may account for the error My → "Brenda", in addition to Brenda → "By", and Brenda → "By.....Brenda".

In the two passages there are 64 errors. Function word substitutions are the largest category accounting for 44 of the errors(69%). Semantic

errors are next most prevalent, accounting for 13 of the errors (20%). There are three visual errors (5%) and three derivational errors (5%). There is also a visuo-semantic error.

Thus although on individual word presentation visual errors are the most common, in text function word substitutions become more prevalent. The increase in function word substitutions may be partly due to the much larger number of function words found in the text passages than in the individual word lists. Of the words on the individual word lists, under 30 of the 300 were function words, that is less than 10%. There are 161 words in the text passages. Of these 82 are function words, that is, around 50%. Knowledge of the context of the passages seems to reduce the incidence of visual errors which fall from 39 to 5% and increase the pure semantic error rate from 5% to 21%.

Table 41 presents a grid of the function word stimuli and responses in the two text passages. Correct responses are marked by dots and errors are marked by crosses. Only three of the function words are read correctly on at least half of their occurrences :a, is, and. Even these stimuli are not read correctly all the time and produce errors on three or four presentations. When a is read incorrectly it is always read as "the", i.e. an article substitution is made. In contrast the is never read as "a", but may be read as "and", "my", or "by". By far the most common misreading of a function word is the response "by". The word itself only occurs once when it is read correctly but over half of the errors to my, has and have are "by". Erroneous productions of "by" account for fourteen of the function word substitutions : one third of the total number of function word substitutions. There thus seems to be a response bias for "by" and possible also for "and" and "has". On most occasions the substitutions do not preserve grammaticality.

						STIMULUS									
	by	and	has	a	the	my	have	am	are	is	of	I	she	in	it
by	.	X	XXX		X	XXXX	XXX						X		X
and		.	X		XX	X				X	X	X	X		
has		X	.				X		XX	XX	X				
a		X		⋮		X				X	X	XX			
the				XXX	.⋮					X					
my					X	.									
have		X													
am							X								
are			X						..						
is										⋮					
of											.				
I												..			
she													.		
in														..	
it															

TABLE 41

FUNCTION WORD STIMULI AND RESPONSES IN THE TEXT PASSAGES

X : misreading . : correct reading

Spelling

K.S. cannot write individual letters or sounds to dictation. He cannot write any non-words to dictation. When asked to write some words spontaneously he made three responses :

reet	read back as "tree"
folo	read back as "flower"
pop	read back as "big...no, dog"

Requests to spell to dictation usually produced refusals but K.S. did attempt to spell to dictation , a few of the words which he had been taught to read. The following responses were obtained :

"door"	→ doo	"doll"	→ dll
"roof"	→ ʃoo	"mummy"	→ MooM
"and"	→ I	"my"	→ gM
"egg"	→ goo	"house"	→ hoo
"flower"	→ forf	"tent"	→ tot
"frock"	→ foo	"pretty"	→ frnf
"field"	→ fier	"he"	→ no

Although none of the attempts are correct, none are phonologically accurate and most violate the rules of English orthography, the responses are not entirely random. The responses to "door" and "dcll" are correct except for one letter. The response goo for "egg", shows an awareness that there should be two of one letter and one of another, and that the two are a g and a flat letter.

Even in this small corpus sequential or directional difficulties are apparent , e.g. "roof" → ʃoo.There is also evidence of function word confusion : "and" → I, "he" → no. There is no real evidence of semantic error, although the spelling frnf for "pretty" is a more realistic representation of one of the words K.S. has

been taught frock rather than pretty.

When writing K.S. has very poor motor control of the pen.

Naming

There is a clear discrepancy in the results reported earlier between K.S.'s performance on the test of auditory comprehension of vocabulary, the Peabody Picture Vocabulary Test (where a score equivalent to an IQ of 88 was obtained) and the B.A.S. naming vocabulary score of $3\frac{1}{2}$ years. Naming vocabulary was therefore further investigated with the Oldfield-Wingfield object naming test. Only fifteen of the thirty-six objects were named correctly, although an additional three were self-corrected. This suggests a decided anomia The qualitative nature of the misnamings is consistent with the reading data : several are semantic errors.

bed → "pillow"
lamp → "light"
comb → "brush"
basket → "bag"
screw → "nail"
bagpipe → "pipe, Uncle Dickie comes from pipe. He comes from Scotland"
anvil → "strindal"/strɪndəl/
cigarette → "smoke....cigarette"
telephone → "clock.....telephone"
clock → "one....clock"
syringe → "injection"
key → "keyring.....key"

Horseshoe, xylophone, octopus, tuningfork, anchor, stethoscope were recognised and an indication of their use was given but they could not be named. Microscope, metronome, and gyroscope were not recognised.

Work conducted with Dr John Marshall on an acquired deep dyslexia Y.N., who also makes semantic errors in naming, indicated that colours were a particularly difficult category. A colour naming test was therefore performed with K.S. K.S. tended to have more success with primary colours and black and white than other colours but even these were sometimes misnamed. The colours were presented together on a card and were pointed to individually by the examiner. K.S. was asked to name them. The colours were pointed to randomly. On 29 trials there were 12 errors.

red → "blue"..."red"	blue → ✓
green → ✓	blue → ✓
green → ✓	yellow → ✓
green → ✓	yellow → ✓
green → "orange"	yellow → ✓
orange → ✓	pink → "orange"
orange → "brown"	pink → "blue"
purple → "blue"	pink → "yellow"
purple → "orange"	pink → "blue"
purple → "orange"	navy → "blue"
grey → ✓	white → ✓
grey → ✓	white → ✓
grey → ✓	gold → ✓
brown → ✓	silver → "gold"
black → ✓	black → ✓

As a final naming test K.S. was presented with pictures of 24 common animals. Success here was better than with colours. One semantic error was made zebra → "giraffe". Another error suggests that there may be difficulties with word boundaries : deer (or reindeer) → "rein".

Fluency

K.S.'s performance on fluency tasks was poor. He named six animals in a minute and four pieces of furniture in a minute. Attempts at fluency tasks using initial letters, produced complete failure, although he seemed to understand what was required. The difficulty seemed to be in segmenting the words that were known and determining that their initial letter was. This failure of phonic segmentation is consistent with reading performance. When asked to produce words beginning with the letter s or starting /sɔsɔ/ (this extra instruction is not the normal way to administer a fluency test), he said, "sssssss.....sssssss.....sssnake...snake.... sssgiraffe....ssschair". Both of these responses were perseverative since "giraffe" had been produced in the category animals and "chair" in the category furniture that had been previously given.

Numbers

Simple mental arithmetic was very poorly performaed: 2 + 2 = "3", 4 + 1 = "6", 4 - 1 = "10", 1 + 1 = "2". No attempt was made by K.S. to use any strategy like counting on his fingers. He seemed fairly confident that he was correct.

Reading of single digits was fair. They were read correctly except that 1 could not be read, and 8 was read as "6...7...". The number 10 was read correctly but 12 and 20 were refused. Writing digits to dictation was poorer:

"1" → ✓	"2" → 5 (or possibly a reversed 2)
"3" → 6	"4" → ✓
"5" → ✓	"6" → refused
"7" → ⌐	"8" → refused

Short Term Memory

K.S. has a reduced digit span : 3 forward and 2 backwards. Spatial span on the Corsi Blocks is also very poor : 2.

Repetition

K.S. was presented auditorally with the stimuli on the 3-letter and 5/6-letter lists of balanced words and non-words,for repetition. Twenty-one were repeated correctly. There were four lexicalisations of non-words : "fex" → "fit" ; "tup" → "cup" ; "plass" → "plus" ; "doptor" → "doctor". There were three other errors : "truck" → "cruck"/krʌk/ ; "trown" → "traved"/trevd/ ; "vet" → "vit"/vɪt/.

To summarise : in addition to impaired reading, K.S. has severe dysgraphia, object and colour anomia, an inability to segment words phonically, an impaired short-tern memory, impaired number skills, and slightly disturbed repetition.

Case 8 : A.B.

Case History

A.B. is a 12½ year old right handed boy. Language comprehension and expression are impaired, probably as a result of a mild hearing loss and a more central developmental language disorder. Speech is restricted and poorly articulated. A.B. attends a school for language impaired children.

A.B. is the mother's second child. She had a "peculiar feeling throughout pregnancy". At 7½ months she had amniocentesis. The amniotic fluid was bright orange. Delivery at 36 weeks was by Caesarian section for severe rhesus incompatability. Birth weight was 7 lbs. A.B. was severely affected with heart failure. He was white and edematous. There were four exchange transfusions and A.B. was cared for in an incubator. At 48 hours he had a convulsion. He left hospital when 1 month old.

For the first 3 months he was a sleepy baby. At 3½ months questions were raised about his responses to loud noises. From this date onward the issue of hearing loss was debated and has still not been resolved At 4½ months he could move homself around and became very active. At 7 months first word appeared. By 9 months A.B. was crawling, standing with help and stretching out for objects. On developmental testing he was considered to be normal except for speech and hearing. At the end of the first year he had recurrent colds, tonsillitis and bilateral otitis media. At 14 months it was suggested that he had partial perceptive deafness, worse in the right ear than the left. He had menengotomies when he was 2¾. EEG given at three years three months showed abnormal slow wave activity with a right parietal focus.

At three years old, he had a comprehension score of 11 months and an expressive score of 18 months on the Reynell Developmental Language Scales. Expressive speech consisted of barely 20 words

and of these only about eight were clearly articulated. A speech therapist's report at this age suggests severe language decoding problems. At three years 3 months A.B. was reported to be using his own jargon. There was idioglossia, as many of his own words and phrases were consistently and appropriately used. At 3 years 4 months he was fitted with a hearing aid. At three years 5 months performance on the puzzles and simple non-verbal parts of the Binet indicated normal non-verbal skills. His usual mode of communication at this stage was by gesture with much pulling and pointing.

At 18 months he had a severe prolonged febrile convulsion. There were no further fits intil 11 years 9 months. He had occasional sensations of flickering lights. At school he complained that he could not read when work was put on the overhead projector. At night he complains that the ceiling light in the dormitory disturbs him. Recent EEG is abnormal, showing frequent bilateral bursts of high voltage slow wave or spike activity. He is receiving no medication for this. Skull X-ray is normal.

Paget-Gorman sign language was taught at one stage. It was abandoned by the family as it was used by A.B. entirely for words which could already be spoken and therefore seemed of little value.

Psychological Background

At 9 years old, on the Wechsler Intelligence Scale for Children - Revised, A.B. was found to have a performance IQ of 72. Comprehension was limited. Short sentences could be understood more easily but questions had to be put in several ways before they could be understood. Understanding seemed to hinge on catching a word or two that he could respond to. Articulation was abnormal. Tested at 12 years 9 months (by Dr Freda Newcombe) on the WISC-R his verbal IQ was 45 and performance IQ 77. Within

the performance scale the results were uneven : a very low score for object assembly and a normal score for picture arrangement, compatible with good "visual acuity" and understanding of the logical sequence of the cartoon stiries.

Before discussing reading responses it should be stressed that A.B. does not have normal speech like K.S. A.B.'s speech is characteristic of the partially deaf. Pitch is abnormal and articulation of the sounds is often poor. Additionally there may be a more central production deficit of an aphasic nature. Sometimes if A.B. is struggling to produce a word and failing, but the word is supplied to him he repeats it perfectly. This suggests that the earlier struggle was not merely articulatory. A.B. is aware of his communication difficulties. If one is clearly failing to understand him he will make persistent and repeated efforts to transmit his message, usually succeeding in the end. With respect to reading the quality of his speech means that some reading responses are neologistic and quite uninterpretable. Other responses are quite clear.

Reading

On the Schonell single word reading test A.B. attained a score of 6 years 11 months. He made 25 overt errors. Three were derivational : playing → "play", downstairs → "downstair", and picture → "pictures". One was quasi-derivational : postage → "post it". Two were visuo-semantic : smoulder → "smoking", saucer → "sugar", and one semantic : egg → "ate"

There were 8 visual paralexias :

crowd → "cloud"	appeared → "aeroplane"
train → "tree"	nephew → "newspaper"
bun → "betting"	shepherd → "shimmer"
applaud → "apple"	angel → "anchor"

Some paralexias were unclassifiable. For some of these there may have been a visual component although the resemblance between stimulus and response was limited :

dream → "swimming"	beginning → "naughty"
ceiling → "cattle"	imagine → "matches"
disposal → "teapot"	nourished → "naughty"
gnome → "going"	

Three responses were neologistic, though whether these result merely from articulatory difficulties is unclear : little → "likle"/lɪkəl/, frog → "fok"/fɒk/, diseased → "disty"/dɪstɛɪ/.

A.B. was presented with two of the balanced word and non-word lists to read aloud. Eleven of the three-letter words (n=14) were read correctly but none of the fourteen three letter non-words were read correctly. This discrepancy is significant ($X^2=15$, $p<0.01$). Of the three errors to the words two were visual :lip → "lines", hot → "not" and one was visuo-semantic : dig → "sticking". Twelve of the fourteen non-word errors were lexicalisations : gen → "again", fex → "feel", tup → "drum", zan → "zebra", lig → "lions", jat → "june", het → "hat", mab → "map", ked → "keep", mot → "met", dop → "dock", vig → "fig". Two were neologistic responses : sut → "sassin"/sæsɪn/, fip → "feem"/fiːm/.

On the 5/6-letter list eleven of the fifteen words were read correctly and none of the fifteen non-words were read correctly. All of the non-words were lexicalised.

doptor → "doctor"	lorse → "horse"
fince → "things"	trown → "crown"
klower → "kill"	faper → "things"
barrot → "bounce"	chait → "chimney"

hencil	→ "ink"	inlect	→ "Ireland"
upple	→ "apple"	sutter	→ "sitting"
gemon	→ "lemon"	plass	→ "please"
trock	→ "strong"		

One of the above errors indicated that a visual error had been followed by a semantic error : hencil → "ink". Two of the errors to words were visual paralexias : insect → "Ireland" and butter → "better", one was derivational : carrot → "carrots", and one was a neologistic response : fence → "fess"/fɛs/.

The Patterson non-word list was also presented for reading aloud. Only two stimuli were read correctly. Both were stimuli which were homophonic with real words and bore a visual resemblance to them : bair, woar.

As noted above A.B. produced sporadic semantic and visuo-semantic errors. Most of the previously described word lists were too difficult for him: therefore to investigate errors further he was given a list of 354 concrete nouns and colour names to read aloud.170 were read correctly and 22 were refused. There were thus 162 errors. Only two semantic errors were made : Autumn → "Spring", Japan → "China". There were 11 visuo-semantic errors :

Israel	→ "Ireland"	September	→ "summer"
December	→ "Spetember"	toe	→ "nose"
ear	→ "hair"	olive	→ "oil"
toe	→ "tooth"	lime	→ "lemons"
gorilla	→ "goats"	pig	→ "pink"(twice)

There were 9 circumlocutory responses or responses indicating that although the word could not be read it was at least partially comprehended :

Autumn → "august....Spring.....flowers"
lamb → "Mum's the sheep and this one's the baby one"
cloud → "clouds in the sky or sometimes a funny man"(clown?)
November → "near Christmas...October"
dog → "dok"/dɔk/.."bow-wow"
Scotland → "scossa/skɒsə/...not quite another country"
India → "Ireland...Italy...hot and a long way away"
snowdrop → "It's a flower....white ones.. slowcrumbs"
Novemeber → "nonombus/nɒnɒmbʌs/, near Christmas,October"

There were 26 derivational errors, which were almost all reading singular as plural :

tomato → "tomatoes"
potatoe → "potatoes"
carrot → "carrots"
hand → "hands"
river → "rivers"
bicycle → "bicycles"
lion → "lions"
arm → "arms"
island → "islands"
gun → "guns"
paper → "papers"
October → "octobers"
pool → "swimming pool....pools"
rain → "raining" ....."rains"
fish → "fishes"
rabbit → "rabbits"
spring → "springs"
kangaroo → "kangaroos"
train → "trains"
van → "vans"
thumb → "thumbs"
lemon → "lemons"
finger → "fingers"
picture → "pictures"
child → "children"
ship → "ships"

There were 54 visual paralexias, in terms of the criterion used earlier. These are listed in Table 42. There was one error of visual completion : police → "policeman".Four errors were of the form "It's like....":

Australia → "like August"
olive → "like castle"
Japan → "like a big very tall man" (Giant?)
China → "like a big man" (Giant?)

Spain → "spades"	ear → "her"
cheek → "sheets"	leopard → "lemons"
foot → "food"	wrist → "writings"
ankle → "axe"	Germany → "granny"
gold → "cold"	knee → "kittens"
Kenya → "kittens"	Spain → "space"
cheek → "chicken"	leg → "lake"
sheep → "ships"	foot → "floor"
rose → "road"	leopard → "lemon"
turquoise → "tower"	wrist → "words"
tongue → "tomatoes"	thigh → "thins"
Kenya → "key"	scarlet → "Scotland"
Brazil → "bridge"	Holland → "honey"
China → "Christmas"	pearl → "petrol"
grey → "crying"	lime → "time"
Greece → "green"	Holland → "holly"
shoulder → "shower"	peas → "pigs"
beans → "bear"	rice → "write"
cod → "cold"	haddock → "clock"
pork → "pots"	hail → "hills"
fog → "fox"	thunder → "thumbs"
lake → "like"	stream → "string"
crocus → "cross"	hollyhock → "holiday"
submarine → "summer"	land → "large"
answer → "sweets"	square → "squirrel"
spring → "sprays"	blood → "blonde"
poor → "door"	ball → "belt"

TABLE 42

VISUAL PARALEXIAS MADE BY A.B.

Twenty-one errors were unclassifiable paralexias:

Russia → "crumbs"	violet → "fingers"
hip → "keep"	February → "arms"
gold → "coke"	gorilla → "story"
knee → "kill"	elbow → "arrow"
shoulder → "shallow"	Canada → "carrot"
bronze → "push"	pearl → "painting"
Australia → "August"	mauve → "month"
lettuce → "islands"	lorry → "laurence"
south → "sauce"	hundred → "heart"
earth → "ends"	corner → "call"
Canada → "cents"	

12 of these preserve the initial letter.

The remaining 32 errors were neologistic. Some of these may have been articulatory. The responses are not listed as the enunciation of the neologistic responses was very unclear and interpretation of the component sounds became quite subjective.

To compare the data with the data in Table 40 (p 269) the percentage of each error type was calculated :

Semantic	2/162
Visual and/or semantic	11/162
Visual	54/162
Derivational	26/162
Other	65/162

It is clear that the incidence of "pure" semantic errors is very low. Included in the category "other" are 9 circumlocutions that have also have a semantic component.

This error analysis is based on the errors made to concrete nouns and colour names. Almost no words of low frequency or low imageability are read correctly. Some function words, which are low in imageability can be read. Errors are function words with a visual

resemblance or visual paralexias:

when → "where"	us → "use"
by → "my"	yet → "yes"
that → "thats"	and → "hands"

Individual letter reading was also investigated. A.B. could not understand the distinction between requests to sound letters and requests to name them. The alphabet was presented in random order twice once in lower case and once in upper case. A.B. chose to sound some letters and name others. On both upper and lower case presentations there were twelve errors :

P	→ "B"	p	→ "B"
X	→ "S"	x	→ "S"
K	→ "key"	k	→ "key"
G	→ "T"	g	→ "C"
L	→ "N"	i	→ "I"
Y	→ "T"	y	→ "/kwɔ/"
V	→ "F"	v	→ "Y"
J	→ "/rɔ/"	j	→ "Tay"
Z	→ —	z	→ "S"
N	→ "S"	n	→ "V"
Q	→ "O"	q	→ "B"
M	→ "/wɔ/"	f	→ "/ʌ/"

Other Tests

Spelling was so limited that no analysis could be conducted. Only two words on the Schonell graded spelling test could be spelt: in and bag.

Poor comprehension of language is apparent in spontaneous interaction. It is also revealed on standardised tests. On the Peabody Picture Vocabulary Test A.B. performs at the 5 year level.

On Bishop's TROG (Test of the Reception of Grammar), he performs at the 4 year - 4 year 2 month level. On this test the words "taller", "bigger" and "longer" were always interpreted as "equal". Passive sentences were always interpreted as active voice. "above" and "below" were interpreted as "beside".

Auditory sequential short term memory is poor. Digit span is 3 forward and 2 backward. The Corsi span is also marginally low at 4.

In fluency tests A.B. produces 8 "animals" in a minute and 9 "things" in a minute. Three words beginning with "f" were produced. In addition to correctly saying "finger","fish" and "finish your work", he also said "elephant...."no" and "futterfly" (butterfly?). For the letter "s" he said "slick","salmon","sunny", "sunshine" and also "dustbin".

DISCUSSION
****

Before the case studies were presented two questions were raised: Why is developmental deep dyslexia not a prevalent sub-type of the developmental dyslexias ? Second, to what extent do some cases of developmental reading disorder resemble deep dyslexia? The data from K.S. and A.B. has been presented in order to address the second question.

K.S. resembles patients with acquired deep dyslexia in the following ways :

1. Inability to name or sound letters of the alphabet.
2. Inability to read or pronounce non-words.
3. Most correctly read words are of high frequency and imageability.
4. Words produced as errors are of high frequency and imageability.
5. All errors are paralexias.
6. Errors with a semantic component are produced at a level significantly above chance.
7. Visual paralexias occur at a level significantly above chance.
8. Reading of text is dramatically impaired displaying in particular semantic errors and function word difficulties.
9. There is profound dysgraphia.
10. Auditory sequential short term memory, as assessed by digit span is impaired.
11. Semantic errors are produced in naming.

K.S. differs from some acquired deep dyslexics in that he can read some function words in isolation, but this is also true for G.R. (Marshall and Newcombe 1966). In text, reading does appear to differ from that of acquired deep dyslexia in that function word substitutions are very common, in addition to a number being read correctly. The incidence of purely semantic errors, for K.S., is

disappointingly low, but it lies within the range spanned by the acquired deep dyslexics. This varies from 56% for G.R. (Marshall and Newcombe 1966) to 4% for K.F. (Shallice and Warrington 1975). K.F. has been described as a deep dyslexic although there has been debate over whether her incidence of semantic errors warrants this description. If K.F. is still to be considered an acquired deep dyslexic then, on the pattern of individual word reading K.S. displays all the features of deep dyslexia and may be considered a developmental deep dyslexic.

A.B. resembles patients with acquired deep dyslexia in the following ways:

1. He is unable to read pronouncable non-words. All non-words attempted are lexicalised.
2. He makes visual paralexias and derivational paralexias.
3. Semantic paralexias are present as are semantic circumlocutions.
4. Function word substitutions are present.
5. Letter naming and sounding is impaired.
6. There is profound dysgraphia.
7. Auditory sequential short-term memory, as assessed by digit span is impaired.

A.B. is able to name and sound some individual letters which many deep dyslexics cannot do. He can also, like K.S., read some function words, but has already been noted this is not incompatable with deep dyslexia. But , for A.B., the incidence of semantic errors is so low that it falls below the range spanned by the acquired deep dyslexics. Although A.B. reads without phonology he is not a developmental deep dyslexic.

Neither of the children above, although suffering from a developmental disorder of reading would fall under the definition of specific developmental dyslexia. A.B. is partially hearing

and has been unable to develop normal speech , let alone reading. Inevitably this hearing impairment, be it peripheral or more central in origin, must affect reading development. Specifically, the impoverishment of phonological input has led to the development of a visual whole word strategy for reading. Both explicit and implicit phonological segmentation are impaired for A.B.

In addition, A.B.'s scores on intelligence tests are poor. Although these tests are notoriously insensitive at assessing intellectual level in language impaired children such as A.B., even the performance I.Q. for A.B. is somewhat low. Comprehension of both grammar and vocabulary are poor. The limited vocabulary must affect A.B.'s ability to learn to read.In the discussion on phonological dyslexia it was suggested that phonological dyslexics relied on a visually based, whole word approach to reading. Yet it is clear that their attempts are more successful than those of A.B. On p. 218, the following scenario was suggested :

"H.M. encounters a new word. It is not within her sight vocabulary and her phonic skills are not sufficiently well developed to permit reading aloud. She asks somebody what it says. Since... her vocabulary is good...she probably recognises the word."

If A.B. goes through this or a similar process he may well not recognise the word. If it is a word that he knows he may not hear it perfectly. For A.B., visually similar words will be confused for two reasons. First ,their overall visual pattern is similar and he must rely on this to identify them since his phonic skills are poor or non-existent. Second , when he is taught such words they will have similar sounding names (since words which resemble each other in visual appearance usually resemble each other phonologically as well); as a result of the hearing impairment, auditory discrimination will be difficult. Finally, A.B. has a very poor

auditory sequential short term memory, reflected in low digit span scores.

K.S. also has a history of ear problems, which may have affected his acquisition of phonic skills. In his case, implicit phonological segmentation has been possible since speech is normal, but the development of explicit phonological segmentation has been affected. It should be noted, however, that despite normal spontaneous speech, repetition is slightly disturbed.

K.S. also has an anomia which is characterised by semantic confusions. This suggests that the semantic confusions exhibited by K.S. in reading may be part of a more general semantic disorder. That is, the deficit is not modality specific. K.S. also has an impaired short term memory.

K.S. has an adequate vocabulary so one might have thought that he, unlike A.B., would have been able to establish a large sight vocabulary, via the mechanism proposed for reading acquisition in phonological dyslexia (i.e. by developing an efficient semantic or 'direct' reading route). But K.S. has an additional deficit which although not explicitly tested here, could be a factor affecting performance. K.S.'s visual recall is extremely poor. Anecdotal references to poor visual memory are scattered throughout the notes and confusions between shapes are noted. In Dr Richer's standardised test scores (p 261) this is reflected in the score for immediate visual recall at the first percentile for age. This impairment in visual memory may prevent the efficient development of 'direct' reading systems that are alternative to the phonological reading system. system.

Both children have thus failed to develop phonological reading systems, most probably due in part to their hearing difficulties past and present, although it seems likely that more central deficits

of cognitive origin may have also contributed. Unlike the cases of phonological dyslexia, the development of the phonological reading route, in K.S. and A.B., is not just impaired; it is virtually non-existent. They are therefore deprived of phonological cues when trying to identify words. In similar contrast to the phonological dyslexics, they are unable to develop even moderately competent semantic and direct routes. In A.B.'s case this may have resulted from his impoverished vocabulary and general linguistic incompetence. In the case of K.S., poor visual memory is no doubt implicated.

Thus the only two children, that the writer has observed who show some resemblance to deep dyslexics have multiple deficits, Could this account for the rarity of developmental deep dyslexia? In most theoretical explanations of acquired deep dyslexia multiple functional lesions are posited. In the developmental analogue several impairments may have contributed to producing a pattern that even resembles deep dyslexia. It seems likely that the numerous deficits which would lead to a picture of developmental deep dyslexia seldom occur together, and that when (or if) they do, the effects of the impairments result in a child who has general cognitive handicap (and who is thus not studied in detail by students of dyslexia). Both K.S. and A.B., despite their handicap, have had continued attention, remediation and instruction from special schools and remedial units. Without these, they might not have acquired the minimal reading skills that they now possess.

Acquired deep dyslexics are usually extremely handicapped individuals. All those reported by Coltheart, Patterson and Marshall (1980) have large left hemisphere lesions that produce a variety of defects in addition to the reading disorder. If the underlying neuronal substrates for the crucial systems are impaired developmentally (or input to them is reduced) there may be no viable

strategies left with which to tackle the intellectual challenge of reading and spelling acquisition.

Thus to summarise the answers to the two questions that were addressed : Children do exist who show a marked resemblance to acquired deep dyslexics. The incidence of semantic errors from these children is low, but they display all the other features of deep dyslexia. For one child A.B. the incidence of semantic errors is as high as that reported for K.F., a patient who has been referred to previously as an acquired deep dyslexic. The two children in whom the patterns similar to deep dyslexia have been observed have several specific handicaps. Developmental deep dyslexia may not be a prevalent sub-type because the multiple impairments necessary to produce the disorder seldom co-occur and when they do the child may simply fail to learn to read at all.

SUMMARY AND CONCLUSIONS

Traditional approaches to the developmental dyslexias have involved group studies, aimed at determining the underlying cognitive of peripheral impairments which may account for the disabilities; by contrast the objective of this thesis was to investigate the developmental dyslexias in the same manner as in recent studies of the acquired dyslexias. That is, detailed case studies of children with developmental dyslexia have been presented. These case reports included: investigation of the ability to read non-words; analysis of reading errors; investigation of the effects of different linguistic dimensions upon reading performance; investigation of spelling in relation to the same variables.

The experimental materials employed in these investigations included a number of newly constructed tasks. The tasks employed were summarised in Table1 (p 9). Detailed analysis of reading errors to individual words was introduced by Marshall and Newcombe (1966). The error analysis used in this thesis, concerned with developmental cases, was based upon their error categories and those used by other researchers working on acquired dyslexia. These categories include : semantic paralexias, visual paralexias, derivational paralexias, visuo-semantic paralexias, visual+semantic paralexias, and neologisms. In this thesis, the categories of valid paralexias and valid neologisms were newly introduced. These involved errors for which a rule system had been applied to derive the pronunciation of the word. The rule system is based upon grapheme-phoneme conversions,or conversions of larger orthographic and phonological units, where the conversions had to be present in more than one English word.

e.g. hive $\longrightarrow$ "hiv"/hɩv/ (ive trandlated as in give,live)

A review of the literature on surface dyslexia indicated that

the term applies not to a single syndrome but to a range of disorders. The integral features of these disorders are listed on pages 24-27. All of the disorders are characterised by over-reliance on a phonological system of reading, but the disorders differ in the extent to which the phonological system is itself malfunctioning, and the type of malfunction manifested.

The first developmental case study in the section in surface dyslexia was of a 10 year old girl, R.B. She was not significantly impaired in her ability to read non-words in comparison to words. Her reading errors were predominantly neologistic and 30% of all errors were valid. There was no significant incidence of semantic, derivational, visuo-semantic, or visual+semantic errors. Spelling-to-sound regularity significantly influenced her ability to read words. Presentation of words with letters typed in the reverse order did not reduce her ability to read them aloud. R.B. exhibited substantial homophone confusion. She is also a phonological speller and finds her own misspellings no harder to read aloud than conventional spellings. In many cases, she finds her own misspellings, which are often simplifications of irregular words easier to read than the conventional spelling.

R.B.'s reading performance is analagous to the most common of the acquired surface dyslexias. She also resembles the developmental cases of surface dyslexia described by Holmes (1973,1978), Coltheart (1982; Coltheart et al 1983) and Masterson (1983)

The second child presented in the section on surface dyslexia was a thirteen year old boy with epilepsy. A marked factor in his psychological background was the discrepancy between verbal and performance IQ. Like, R.B., N.G. is significantly influenced by spelling-to-sound regularity when reading aloud ; makes no semantic, derivational, visuo-semantic, or visual+semantic errors ; is a

phonological speller ; and exhibits considerable homophone confusion. However, his reading disorder is "purer" than R.B.'s, in that visual paralexias are absent and almost all neologistic reading errors are valid. Non-word reading is also excellent and even long unfamiliar words are read with very good accuracy. N.G. forms a developmental analogue to the "pure" case of acquired surface dyslexia, recently described by Bub et al (1984).

In the discussion of surface dyslexia, an expanded representation of the phonological route was incorporated into the reading model. The first stage of this route contains a parser which is responsible for segmenting letter strings into orthographic units or "chunks" A "chunk" is defined as the written representation of p phonemes where $0 < p \leq N$ and N is the number of phonemes in the word. A word may be parsed in a number of different ways, the preferred parsing being dependent on the experience of the reader. As contact with the printed word increases more extensive parsing rules are internalised. After parsing, the chunks are input to the translator which contains multiple potential translations. A number of different phonological forms can be assigned to any one orthographic chunk. All of the potential translations are valid; that is, such a translation would be appropriate for some words in the language. Thus the valid errors seen in the data of R.B. and N.G. may be explained in terms of the inappropriate selection between valid alternatives in the translator. If the system if functioning correctly the translation of highest token frequency will be tried first. A lexical checking system may indicate that after blending the output is not a word, in which case reselection in the translator will take place. Reparsing may also take place if the chunks which are input to the translator have no representation therein. Different malfunctions in the system will produce different symptoms of disorder.

The cases of both acquired and developmental surface dyslexia were interpreted in terms of the model. The different types of surface dyslexia were explained as manifestations of qualitatively and quantitatively different impairment in the phonological system. R.B. exhibited developmental failure in the parser where her unit size of segmentation is often too small; in the translator where mismatches produce invalid errors; in the translator where inappropriate selection from valid alternatives results in valid errors; and in the blender where sequencing errors occur. In addition, the large number of neologistic errors suggested impoverishment of the lexical checking system. In contrast N.G.'s phonological route to reading was extremely well developed.

In the discussion of surface dyslexia it was suggested that on the basis of their normal digit spans , an impoverishment of working memory cannot account for and impairment exhibited by R.B. or N.G., nor any differences between the children. It was also argued that some of the visual paralexias observed in surface dyslexia might emanate from the phonological route rather than from the semantic route.

Finally, the phonological spelling of the surface dyslexics was discussed. It was noted that more phonologically valid spelling errors are made by R.B. than phonologically valid reading errors. It was suggested that for R.B. the phonological route for spelling had developed in a limited but consistent fashion to produce a phonologically valid (but often incorrect) rule system. The phonological route for reading develops as a less consistent, more variable system consequent upon the complexities of the input, and awareness of error when processing does not produce a word.

In contrast to surface dyslexia, the syndrome of phonological dyslexia results from under-reliance in the phonological route

rather than over-reliance. There is more severe impairment of the phonological route than in surface dyslexia ; and better establishment or preservation of other reading routes. In the review of acquired phonological dyslexia, it was noticeable that there was considerable patient variability and inconsistency in test results. Differences between the test material used (even within countries) made direct comparison of performance levels difficult. The number of patients for whom extensive and detailed investigation have been carried out is also limited. Nevertheless the salient feature which emerges is that non-word reading, for all phonological dyslexics, is significantly poorer than word reading. The other integral features of the disorder are outlined on pages 120-127.

After presentation of different theoretical accounts of phonological dyslexia, four cases of developmental dyslexia were presented : two 17-year old girls and two 10-year old boys. All four children were impaired at reading non-words in comparison to reading words. The non-word errors included many lexicalisations, although correct lexical decision could be made for a number of the non-words which produce such responses. Reading errors were predominantly paralexias : visual, derivational, or visuo-semantic. Spelling-to-sound regularity did not significantly influence reading performance. There was impairment of function word reading in isolation and/or in text. Performance on rhyming tasks was overall poorer than for R.B. It was argued that these children are developmental phonological dyslexics.

There are clear-cut dissociations between the pattern of performance of the developmental surface dyslexic and the developmental phonological dyslexics. These are illustrated, in particular clarity, by a comparison between R.B. and the pair A.H. and M.H. The background data on these children are all very similar. The children are all

aged between 10.4 and 10.10, with reading ages between 8.2 and 8.7 and spelling ages between 7.6 and 7.8. Their verbal IQs lie in the range 122-128, and they all perform at the 99th percentile for age on the Peabody Picture vocabulary test. These children are thus very closely matched. If one was conducting an investigation into the effects of a particular remedial regime on reading performance one might feel justified in assigning R.B. to one training group and A.H. to another, on the grounds that both were at the same initial level. One might also feel justified in assigning all three children to the same group and comparing their performance with that of 'normal' children aged 10.4-10.10 or with reading ages 8.2-8.7. The inappropriateness of either of these assumptions is re-emphasised by the data summarised in Table 43. This table indicates that on nine separate measures there is a marked dissociation between the performance of R.B. and the performance of A.H. and M.H.

R.B. exhibits the first five features (all of which relate to reading) while A.H. and M.H. do not. A.H. and M.H. exhibit the last four features (three of which relate to reading and one to rhyming). The dissociation on the non-reading tasks (the rhyming tasks) was extensively discussed. It was suggested that some phonological dyslexics mau be impaired in explicit phonological skills, in general; in other cases the impairment may be restricted to input rather than output tasks. Surface dyslexics are unimpaired on explicit phonological skills. A number of studies have recently suggested the importance of an impairment of explicit phonological skills in the etiology of reading disorders (e.g. Bradley and Bryant 1979, Bryant and Bradley 1983). The results here suggest that the conclusions of these workers are inappropriate for some children with developmental dyslexia.

The implications of the full range of dissociations between surface

	R.B.	A.H.	M.H.
Reading significantly affected by spelling-to-sound regularity	✓	X	X
Neologistic errors significantly more prevalant than paralexic errors	✓[5]	X	X
Over a quarter of errors valid	✓ (30%)	X (10%)	X (10%)
Homophone Confusion	✓	X	X
Reading of misspelling as good as reading of conventional spelling	✓	X	X
Non-word reading significantly worse than matched word reading	X	✓	✓
Reading of reversed typed words significantly worse than reading of conventional type	X	✓	✓
Failure on a rhyme fluency item	X	✓	✓
Derivational errors	X	✓	✓

Tasks for which there is dissociation between the performance of R.B. and the performance of A.H. and M.H.

TABLE 43

and phonological dyslexica, in both practical and theoretical terms should not be under emphasised. Any investigation which aims to examine either putative underlying cognitive impairments in developmental dyslexia or the effects of treatment should be aware that averaging across subgroups may render the data uninterpretable. For the remedial teacher, the planning of intervention strategies will be altered by the knowledge of which type of reading disorder a child manifests.Even those pressure groups who have recently, once more been advocating the simplification of English spelling should take note. They argue that children with reading and spelling problems would improve if the rules upon which English spelling is based were simplified. It is apparent from the data on the reading of non-words and the reading of misspellings that,such reforms, although possibly beneficial for the surface dyslexic, would not assist children with developmental phonological dyslexia. Indeed, if the simplification produced more visually similar words, the code would be more difficult for them to master.

In theoretical terms, the dissociations are also interesting. They indicate that in dyslexia a child does not simply develop a restricted reading system but that different types of restricted reading systems may develop, to produce a similar level of overall competence. Thsse subtypes require different underlying theoretical accounts. The theoretical model proposed in the section on surface dyslexia has already been summarised with the interpretation of R.B's reading performance in its light. In the discussion on phonological dyslexia, it was proposed that, for some children, words were treated like Chinese logograms with associations being formed between the overall visual configuration and the meaning. The meaning is related to the auditory pattern (which is already known, from speaking and hearing) but in order to fascilitate association with the printed

word in the first place, the word must be repeatedly named (in association with its printed form) for the child to hear.

This has implications for the way in which the remediation of such children should progress, particularly if the remediation is taking place in the teenage years. The debate rests on whether remediation should stress strengths or weakness. In phonological dyslexia, the weakness is phonics and the strength is the ability of the child to acquire a sight vocabulary using whole word cues. It is suggested that a case may be made for concentration on strength and that phonic instruction is not the best focus of attention. The justification has several aspects. First, the child is so far from competency at phonics that even with intensive instruction and good progress it would take a substantial period of time to develop this route as a viable system for practical application. Second, the work of Curtiss (1977) suggests that there may be a critical period for the acquisition of phonic skills. If this finding generalises to reading it may already be too late by the early teenage years to attain phonic competency if it has not already been achieved. Third, if the child has reached this age without phonic mastery, while his/her peers have succeeded, then there may be an underlying defect at a cognitive or neurological level which is irreversible. Attempting phonic instruction may be like attempting to teach the tone deaf to sing tunefully. Finally, the child has already succeeded in learning many words by means of a whole word method. It is clear from the data of H.M. and J.E. that a reasonable level of reading comptetency can be achieved by this method. Both children can cope with the words which they encounter in their daily lives and although they both have difficulty with scientific trems and unfamilair names the practical ramifications are not too extensive. A number of difficulties which they encounter reading individual words (visual

or derivational paralexias) may be reduced when they read text (e.g. newspapers); the context may provide cues for self-correction. With explicit whole word instruction the phonological dyslexic might be able to expand his repertoire considerably. One of the problems for them at achool is that beyond a certain age little reading aloud takes place in the classroom and there are few opportunities to hear another student read a text which the dylexic can see.

If one was to follow the same argument of working upon strengths with the surface dyslexic, then remediation should proceed along phonic lines. However, one could foresee that utilisation of this method alone will have limited effectiveness (for English) beyond a certain age level. In the section on surface dyslexia, it was suggested that the phonological route of N.G. might already have developed its maximum potential, a point of theoretical interest since this development had apparently been possible despite the route's isolation from other reading systems.But the data also indicated that N.G. still manifested difficulty with reading. The difficulty was produced by the complexities of the English orthographic system, which are such that it is impossible to read many words correctly even if one has an advanced phonic system, such as N.G.'s. Thus,even if surface dyslexics (such as R.B.) were able to improve their phonological reading routes to the level of N.G.,they would still experience problems with many English words. One might therefore make the prediction that,if remediation is based upon strength,the phonological dyslexic will progress further than the surface dyslexic . If reading patterns reflect irreversible underlying deficits at a neorological level, then one could go further and predict that, regardless of remedial style, the long term prognosis for the surface dyslexic is poorer than that of the phonological dyslexic. The data suggest that different types of dyslexia can result in quantitatively similar performance at the age of ten. For the three dyslexics with matched backgrounds and

intelligence, but different reading disorders, performance on standardised reading tests is at the same age level, both for text and single words. It will be of interest to follow-up these children and determine whether their levels of performance on standard reading tests remains comparable. If the phonological dyslexics show long term superiority, this would be another characteristic analogous to the acquired dyslexics. Acquired phonological dyslexics generally display levels of reading performance which are higher than those of surface dyslexics.

There remains, for the phonological dyslexics, the disadvantage of having acquired a reading system with only partial phonology, The data from the developmental phonological dyslexics provides further support for the suggestion of Patterson (1982) that affixes and function words may be processed in the phonological route; the phonological dyslexic child with poor development of this system tends to make function word confusions and derivational errors. They also tend to make what were called "pseudoderivational errors". These resemble derivational errors but are linguistically invalid. The mode of acquisition of new words also implies that words with similar visual configurations will be confused, producing visual paralexias ; and those with visual and semantic similarity will be confused even more, producing visuo-semantic errors and providing another explanation for derivational errors.

It was noted that the underlying impairment in the phonological route which produces phonological dyslexia is unclear. Some of the children - the older cases among the cases presented here - can seldom be persuaded to use the system at all. For those examples where the route is used, the degree of error makes it difficult to localise specific functional sites of impairment. It was also clear that lexical mechanisms were frequently employed, even when reading

non-words. This finding suggested that, whereas the surface dyslexics often use units of graphemic analysis which are too small, the phonological dyslexics use units of analysis which are too large.

Although the spelling of developmental surface dyslexics was predictable from their reading,the spelling of developmental phonological dyslexics was not likewise predictable. This pattern mirrors that observed with acquired dyslexias. There was a dissociation between the spelling pattern of A.H. and M.H., two matched children with very similar reading performances : developmental phonological dyslexia. Although the phonological route for reading was at a similar level, one had developed a much better phonological route for spelling than the other. This suggests that the underlying physiological substrate for the development of sound to print correspondences be relatively intact while the underlying substrate for the development of print to sound correspondences is defective.

Acquired deep dyslexia has attracted more interest from researchers than either of the other "central dyslexias". The predominance of semantic errors in this condition is the focus of this attention and indeed the first reports of this phenomenom (Marshall and Newcombe 1966) were initially treated with some scepticism. It is therefore interesting that developmental deep dyslexia (with substantial numbers of semantic errors) remains tantalisingly elusive. Indeed, despite Boder's claim (1970,1971, personal comminication), to have seen many such children not one fully convincing case report of a developmental deep dyslexic has been reported in the recent literature or identified in historical papers, The sporadic "sightings" by researchers in Europe and America have proved less than convincing.

The two children, who read without phonology , reported in this thesis, make only a small number of semantic errors. For one of the

children (K.S.) the incidence of errors with a semantic component is significantly above chance, on the basis of his small repertoire of potential responses. Ths incidence of his 'pure' semantic errors, although low, is as high as that of K.F. (Shallice and Warrington 1975), an acquired dyslexic patient, previously called a deep dyslexic and about whom there has subsequently been some debate over his diagnosis. For the other child (A.B.) the incidence of 'pure' semantic errors is even lower, although circumlocutory responses are marked.

It is apparent from the introduction to deep dyslexia, that the theoretical accounts of semantic errors vary considerably. All, however, assume that the error are related to the complex interconnections in the network of associations within the semantic system. The children described here have developed only limited visual access to such a system from the printed word.

The other characteristics of acquired deep dyslexia are displayed by both children described here. They are impaired at naming and sounding letters and at reading function words. They are unable to read any non-words Most of the words the children read correctly are of high frequency and imageability. They make visual and derivational paralexias. There is profound dysgraphia. Auditory sequential short-term memory , as assessed by digit span, is low.

It was noted that both children have more than one specific deficit, which may contribute to their reading difficulty. They thereby contrast with the children described in the previous sections, who, with the exception of N.G., have no known background factor of etiological significance, other than family histories that may indicate genetic predisposition.

In theoretical terms, it was suggested that these developmental dyslexics who fail to develop a semantic reading route are over dependent upon a phonological reading route, which may itself be only

partially developed. Developmental dyslexics who fail to develop a phonological reading route are overreliant on semantic and/or direct reading systems, with consequent dependence upon whole word reading. The children who read without phonology, fail to develop any phonological reading route and have very partially developed developed semantic and/or direct routes. Their unusual pattern of disability may leave them with no intact cognitive tools with which to acquire reading competence The dearth of developmental deep dyslexics may be attributable to the combination of impairments which produces the disorder. With such multiple impairments the acquisition of any reading skills may be grossly handicapped.

This thesis has systematically compared the developmental and acquired dyslexias. The summary and conclusions indicate that the approach is fruitful for the elucidation of the developmental disorders, the further refinement of cognitive models of the reading process, amd the management and remediation of the disabilities. The research also raises further questions that require future investigation. In the concluding section, some of these perspectives will be outlined.

FUTURE PERSPECTIVES

There are at least four different areas in which future research might be directed: a) Follow-up over time of the same skills, in the same children ; b) Extension of the skills investigated and experiments conducted in the same or similar children ; c) Extended investigations to try to find analogues to other aquired disorders of reading; d) Introduction of the method of analysis employed here, to investigations of other cognitive disabilities in both adults and children (acquired and developmental).

A. The children who have already been investigated may be pursued over time and the skills assesssed here may be reassessed to map their development and growth. It has alraedy been noted that it may be of interest to follow-up the matched 10 year olds with different dyslexic disorders to observe whether the recovery paths differ quantitatively, the suggestion having been made, that the surface dyslexic might have more restricted potential that the phonological dyslexics. Reassessment will also determine whether the disorders retain their qualitative pattern. Although it seems highly improbable that a developmental surface dyslexic would develop into a phonological dyslexic or vice versa, the clarity of the syndromes might be reduced or particular integral features alter. These follow-ups would also determine which aspects of reading and spelling difficulty, if any, remain the most resistant to change, producing persistent problems. In the case of the children reading with no phonology it would be of interest to determine the extent to which their reading is able to further develop, and as it does so, whether the incidence of semantic errors also increases. Reassessments could also pursue the consistency of the differences reported on rhyming tasks. The tasks themselves could also be expanded.

B. Experimental investigations could be extended to cover other aspects of reading and spelling (as well as the rhyming mentioned above). Text reading is one example of a topic ripe for further study, both in the acquired dyslexias and in the developmental dyslexias. It was noted that the text reading of J.E. and H.M. is paragrammatic, and that for K.S. the relative proportion of different error types differed between text and single word presentation. These and other aspects of text reading require more detailed analysis.

Comprehension is another topic which should be pursued more intensively . N.G., the surface dyslexic, was noted to have severely impaired comprehension yet still was able to develop an efficent system of phonological reading. In this he may resemble children with hyperlexia (Silverberg and Silverberg 1967) who develop precocious reading skills in the absense of conventional instruction and whose ability to read aloud is in advance of their comprehension of the same material. These children are often found within autistic populations, although precocious reading has been noted in some normal children. Hyperlexic chuldren are an interesting group for further research. A case study recently reported by Aram, Rose and Horwitz (1984) indicates that their patient's reading performance is similar to N.G., although some invalid errors are made. Frith and Snowling (1983) point out that, for autistic children, pronunciation skills exceed comprehension skills, whilst in developmental dyslexia comprehension skills exceed pronunciation skills. They derive this conclusion from a group study and it is therefore unclear whether this is true for all developmental dyslexics.

The data in this thesis indicate that, for all the children studied, reading ages on the Neale test are much higher for comprehension than accuracy. Because of the way the test is administered, this does not necessarily mean that comprehension skills exceed pronunciation skills. The Neale test permits the tester to correct the child if

he fails to read a word correctly, or he is unable to respond to a word. Thus having read (or been read) the passage, the child will have heard spoken aloud even those words which he had himself been unable to pronounce. Comprehension age is based upon oral questions given after each passage. The performance of the child will depend upon his memory and comprehension of what he has heard spoken aloud, in addition to those words he read correctly. Comprehension score thus need not be affected by his inaccuracies in reading. It will be of intetest to determine whether Frith and Snowling's claim (1983) about comprehension being in advance of production applies with individual case studies of developmental surface dyslexia. If it does, this will be in marked contrast to the prevalant observation with acquired surface dyslexics, that except for the occasional word the comprehension of surface dyslexics depends entirely upon what they read aloud with accuracy.

Studies of acquired deep dyslexia indicate that comprehension of the written word often exceeds the ability to read aloud . This issue has not been addressed in acquired phonological dyslexia, but brief questioning of J.E. suggests that it will be an interesting area of study in developmental phonological dyslexia.

J.E. was asked the meaning of a few words immediately after she had made visual paralexias, or neologistic responses on the Schonell test. For some words, meaning was attributed to the response : pneumonia → "pandemonia.....everything going wrong". However, for a number of others the meaning of the original stimulus was given, despite an erroneous vocalisation:

soloist → "solicit"....."sings alone"
slovenly → "solventlу"..."scrt of lounges about...I don't really know"
preliminary → "peliminary"/pəlɪmɪnərɛɹ/....."basic"

There were also instances when the meaning of both stimulus and response was conveyed. The following conversation illustrates this:

J.E. was presented with the word colonel

J.E. : "Cologne"

C.T. : "Can you tell me what it means?"

J.E. : "Is it perfume or is it a colonel?"

C.T. : "If you had to pick one, which one would you pick?"

J.E. : "I don't know. It's either perfume or it's a sergeant"

C.T. : "Would you like to try and read it again?"

J.E. : "Cologne"

It is of particular interest that J.E. articulates the correct word when describing the meaning of the word, yet does not seem to realise that this was the original stimulus item.

This pattern of performance was characteristic when words of intermediate difficulty were presented.Easy words were read correctly harder words are treated like nonsense words. Neologistic responses arise to the latter, e.g.

scintillate → "signitate" /sɑɪnɪteɛt/

When asked the meaning of this , J.E. had no idea.

C. Further searches should be made to see whether developmental analogues can be found to the other aquired dyslexic syndromes. A recent report (Prior and Mc Cormiston 1983) suggests that there may be a developmental analogue to letter -by-letter reading.

d. The method of analysis employed here to investigate reading and spelling could be extended to include other developmental disorders of cognition. In the course of the investigations upon which this thesis is based, children have been encountered who exhibit specific developmental disorders of arithmetic and mathematics, Requests have been made by teachers for suggestions with respect to remediation when conventional methods fail. Detailed case studies of the arithmetical and mathematical skills of children with developmental disorders and

adults with disorders consequent upon brain damage may further our understanding of the specific disabilities encountered and the underlying cognitive systems involved.

REFERENCES

Allport,A. and Funnell,E. (1981).Components of the mental lexicon. Philosophical Transactions of the Royal Society of London. B 295, 399-410.

Andreewsky,E. and Seron,X. (1975). Implicit processing of grammatical rules in a case of agrammatism. Cortex 11, 379-90.

Aram,D.M., Rose,D.F., and Horwitz,S.J. (1984). Hyperlexia: developmental reading without meaning. In, R.N. Malatesha and H.A. Whitaker (eds.) Dyslexia: A Global Issue. Martinus Nijhoff. The Hague.

Baddeley,A. (1979) Working memory and reading. In, P.A. Kolers (ed.) Processing of Visible Language. Plenum Press. New York and London.

Baddeley,A. (1981) the concept of working memory : A view of its current state and probable future developments. Cognition 10, 17-23.

Baddeley,A.D., Ellis, N.C., Miles,T.R., and Lewis,V.J. Developmental and acquired dyslexia : A comparison. Cognition 11, 185-199.

Beauvois,M.F. and Dérouesné,J. (1979) phonological alexia : three dissociations. Journal of Neurology, Neurosurgery and Psychiatry 42, 1115-1124.

Bender,L. and Schilder,P. (1951) cited by Drew (1956)

Beringer,K. and Stein,J. (1930) Analyse eines Falles von 'Reiner' Alexia. Zeitschrift fur die Gesamte Neurologie und Psychiatrie, 123, 473-8

Besner,D. (1981) Deep dyslexia and the right-hemisphere hypothesis : What's left? Bulletin of the Psychonomic Society 18(4), 176-178.

Besner,D. (1983) Deep dyslexia and the right-hemisphere hypothesis : evidence from the U.S.A. and the U.S.S.R. Canadian Journal of Psychology 37(4), 565-571.

Birch,H.G. (1982) Dyslexia and maturation of visual function. In, J. Money (ed.) Reading Disability : Progress and Research Needs in Dyslexia. John Hopkins Press. Baltimore.

Boder,E. (1970) Developmental dyslexia : a new diagnostic approach based on the identification of three subtypes. School Health 40, 284-290.

Boder,E. Developmental dyslexia : a diagnostic screening procedure based on three characteristic patterns of reading and spelling. In, B. Bateman (ed.) Learning Disorders. Special Child Publications. Seattle.

Bradley, L. and Bryant ,P.E. (1978) Difficulties in auditory organisation as a possible cause of reading backwardness. Nature 271, 746-747.

Bradley,L. and Bryant, P.E.(1983) Categorizing sounds and learning to read - a causal connection. Nature 301, 419-421.

Brown,J.S. (1972) Aphasia, Apraxia and Agnosia. Thomas. Springfield, Ohio.

Brown,J.W. (1981) Review of Deep Dyslexia. Brain and Language 14, 386-92.

Bub,D.N., Canceiliere,A. and Kertesz,A. (1984) Whole-word analytic translation of spelling-to-sound in a non-semantic reader. In, K.E. Patterson, J.C. Marshall,and M.Coltheart (eds.) Surface Dyslexia. Lawrence Erlbaum. Hillsdale, New Jersey. (in press)

Caramazza,A., Berndt,R.S. and Hart,J. (1981) "Agrammatic Reading" In, Neuropsychological and Cognitive Processes in Reading. Academic Press London.

Chance,B. (1913) cited by Drew (1956)

Claiborne,J.H. (1906) cited by Drew (1956)

Claparede (1917) cited by Drew (1956)

Coltheart, M. (1977) Phonemic dyslexia : some comments on its interpretation and its implications for the study of normal reading. Paper presented at the International Neuropsychological Society Meeting, Oxford.

Coltheart,M. (1978) Lexical access in simple reading tasks. In, G. Underwood (ed.) Strategies of Information Processing. Academic Press. London.

Coltheart,M. (1980a) Deep Dyslexia: a review of the syndrome.In, M.Coltheart, K.E. Patterson and J.C. Marshall (eds.) Deep Dyslexia. Routledge and Kegan Paul. London.

Coltheart,M. (1980b) Deep dyslexia : a right hemisphere hypothesis. In, M. Coltheart, K.E. Patterson and J.C. Marshall (eds.) Deep Dyslexia. Routledge and Kegan Paul. London.

Coltheart,M. (1981) M.R.C. Psycholinguistic Database. Quarterly Journal of Experimental Psychology. 33, 497-505.

Coltheart,M. (1982) The psycholinguistic analysis of acquired dyslexias : some illustrations. Philosophical Transactions of The Royal Society, London B298, 151-164.

Coltheart,M., Besner,D., Jonasson,J.T. and Davelaar,E. (1979) phonological recoding in the lexical decision task. Quarterly Journal of Experimental Psychology 31, 489-508.

Coltheart,M., Davelaar,E., Jonasson,J T. and Besner,D. (1977) Access to the internal lexicon. In, S. Domic (ed.) Attention and Performance VI. Academic Press. New York.

Coltheart,M., Masterson,J., Byng,S., Prior,M., and Riddoch,J. (1983) Surface Dyslexia. Quarterly Journal of Experimental Psychology 35, 469-96.

Coltheart,M. Masterson,J., and Byng,S. (1984) Types of error in dyslexic reading. In, K.E. Patterson, J.C. Marshall, and M. Coltheart (eds.) Surface Dyslexia. Lawrence Erlbaum. Hillsdale, New Jersey.

Coltheart,M., Patterson,K., and Marshall, J.C. (1980) Deep Dyslexia. Routledge and Kegan Paul. London.

Critchley,M. (1970) The Dyslexic Child. Thomas. Springfield,Illinois.

Curtiss,S. (1977) GENIE: A psycholinguistic study of a modern-day "wild child". Academic press. New York.

Damasio,A.R. (1983) Pure Alexia. Trends in Neurosciences 6(3), 93-96.

De Bastiani,P., Barry,C. and Carreras,M. (1982) Phonological dyslexia in an Italian Reader. Paper presented as the European Brain and Behaviour Society, Parma, Italy.

Dejerine,J. (1891) Sur un cas de cecite verbale avec agraphie, suivi D'autopsie. Memoires de la Societe de Biologie 3, 197-201.

Dejerine,J. (1892) Contribution a l'etude anatomopathologique et clinique des differentes varieties de cecite verbale. Compte Rendues des Seances de la Societe de Biologie 4, 61-90.

Deloche,G. and Andreewsky,E. and Desi,M. (1982) Surface dyslexia, a case report and some theoretical implications to reading models. Brain and Language 15, 11-32.

Denckla, M.B. (1979) Childhood learning disabilities. In, K.M. Heilman and E. Valenstein (eds.) Clinical Neuropsychology. Oxford University Press. Oxford.

De Renzi,E. and Vignolo,L.A. (1962) The Token Test; a sensitive test to detect receptive disturbance in aphasics. Brain 85, 665-678.

Dérouesné,J. and Beauvois,M.F. (1979) Phonological processes in reading: data from alexia. Journal of Neurology, Neurosurgery and Psychiatry 42, 1125-1132.

Dérouesné,J. and Beauvois,M.F. (1984) The "phonemic" stage in the non-lexical reading process.: evidence from a case of phonological alexia. In, K.E. Patterson, J.C. Marshall, and M. Coltheart (eds.) Surface Dyslexia. Lawrence Erlbaum. Hillsdale, New Jersey.

Doctor,E.A. (1978) Studies on reading comprehension in children and adults. Unpubliched Ph.D. thesis. Birkbeck College. University of London.

Drew, A.L. (1956) A neurological appraisal of familial congenital word-blindness. Brain 79, 440-490.

Dubois-Charlier,F. (1971) Approche neurolinguistique du probleme de L'alesie pure. Journal de Psychologie, 68, 39-67.

Ellis,A.W. (1979) Developmental and acquired dyslexia : some observations on Jorm (1979). Cognition 7, 413-420

Ellis,A.W. (1982) Spelling and writing (and reading and speaking). In, A.W.Ellis (ed) Normality and Pathology in Cognitive Functions. Academic Press. London.

Ellis,A.W. and Marshall,J.C. (1978) Semantic errors or statistical flukes? A note on Allport's "On knowing the meaning of words we are unable to report". Quarterly Journal of Experimental Psychology 30, 569-575.

Faust,C. (1955) Die zerebralen Herdstorungen bei Hinterhauptsverletzungen und ihr Beurteilung. Thieme. Stuttgart.

Fisher,J.H. (1910) A case of congenital word blindness (inability to learn to read) Transactions of the Opthalmological Society 30, 216-225.

Franz,S.I. (1930) The relations of aphasia, Journal of General Psychology 3, 401-411.

Friedman,R.B. and Perlman,M.B. (1982) On the underlyong causes of semantic paralexias in a patient with deep dyslexia. Neuropsychologia 20, 559-568.

Frith,U. (1978) From print to meaning and from print to sound or how to read without knowing how to spell. Visible Language 12, 43-54.

Frith,U. (1980) Unexpected spelling problems. In, U. Frith (ed.) Cognitive Processes in Spelling. Academic Press. London.

Frith,U. and Snowling,M. (1983) Reading for meaning and reading for sound in autistic and dyslexic children. British Journal of Developmental Psychology 1, 329-342.

Fromkin,V.A. (ed.) (1973) Speech Errors as Linguistic Evidence. Mouton. The Hague.

Fromkin,V. and Rodman,R. (1978) An Introduction to Language. Holt, Rinehart and Winston. New York

Funnell,E. (1983) Phonological processes in reading : new evidence from acquired dyslexia. British Journal of Psychology 74, 159-180.

Gilhooly,K.J. and Logie,R.H. (1980) age-of-acquisition, imagery, concreteness, familiarity and ambiguity measures for 1944 words. Behaviour Research Methods and Instrumentation 12, 385-427.

Glushko,R.J. (1981) Principles for pronouncing print : The psychology of phonography. In, A.M. Leogold and C.A. Perfetti (eds.) Interactive Processes in Reading. Lawrence Erlbaum. Hillsdale,New Jersey.

Goldblum, M.C.(1984) Word Comprehension in Surface Dyslexia. In, K.E. Patterson, J.C. Marshall and M. Coltheart (eds.) Surface Dyslexia. Lawrence Erlbaum Associates. Hillsdale,New Jersey. (in press)

Goldstein,K. (1948) Language and Language Disturbances. Grune and Stratton. New York,

Hallgren,B. (1950) Specific Dyslexia ("congenital word blindness") : a clinical and genetic study. Acta Psychiatrica et Neurologica Scandinavica Supplement 65.

Hatfield,F.M. and Patterson,K.E. (1983) Phonological Spelling. Quarterly Journal of Experimental Psychology 35, 451-468.

Henderson,L. (1982) Orthography and word recognition in reading. Academic Press. London.

Hinshelwood,J. (1900a) Letter, word and mind-blindness. H.K.Lewis. Glasgow.

Hinshelwood,J. (1900b) Congenital word-blindness. Lancet 1 1506-1508.

Hinshelwood,J. (1902) Congenital word blindness, with reports of two cases. Opthalmology Review 21: 91-97.

Hinshelwood,J. (1904) A case of congenital word-blindness. British Medical Journal 2, 1303-1307.

Hinshelwood,J. (1917) Congenital Word Blindness. H.K. Lewis. Glasgow.

Holmes,J. (1973) Dyslexia: A neurolinguistic study of traumatic and developmental disorders of reading. Unpublished Ph.D. Thesis. University of Edinburgh.

Holmes,J. (1978) "Regression" and reading breakdown. In A. Caramazza and E.B.Zurif (eds.) Language Acquisition and Language Breakdown. John Hopkins University Press. Baltimore, MD.

Imura,T. (1942) Aphasia:characteristic symptoms in Japanese. Neurologica Japonica, 47, 196-218.

Ingram,T.T.S., Mason,A.W. and Blackburn,I.(1970) A retrospective study of 82 children with reading disability. Developmental Medicine and Child Neurology 12, 271-281.

Job,R. and Sartori,G. (1982) Affix processing in a phonological dyslexic patient. Paper presented as the fifth I.N.S. European Conference, Deauville, France.

Johnston,D.J. and Myklebust,H.R. (1967) Learning disabilities. Grune and Stratton New York.

Johnston,R.S. (1983) Developmental Deep Dyslexia? Cortex. XIX,133-140.

Jorm, A. F. (1977) Effect of word imagery on reading performance as a function of reader ability. Journal of Educational Psychology 69, 46-64.

Jorm,A.F. (1979) The cognitive and neurological basis of developmental dyslexia : A theoretical framework and review. Cognition 7, 19-32.

Kapur,N. and Perl,N.T. (1978) Recognition reading in paralexia. Cortex 14, 439-443.

Kay,J. and Marcel,A. (1980) One process, not two, in reading aloud: lexical analogies do the work of non-lexical rules. Quarterly Journal of Experimental Psychology 33A,397-313.

Kay,J. and Patterson,K.E. (1984) Routes to meaning in surface dyslexia. In, K.E. Patterson, J.C. Marshall and M. Coltheart (eds.) Surface Dyslexia. Lawrence Erlbaum. Hillsdale, New Jersey. (in press).

Kerr, J. (1897) School hygeine, its mental, moral and physical aspects. Journal of the Royal Statistical Society 613-680.

Kirshner,H.S. and Webb,W.G.(1982) Word and letter reading and the mechanism of the third alexia. Archives of Neurology 39, 84-87.

Kleist,K. (1934) Gehirnpathologie . Barth. Leipzig.

Kolers,P.A. (1966) Reading and talking bilingually. American Journal of Psychology, 79, 357-376.

Kremin,H. (1980) Deux strategies de lecture dissociables par la pathologie. Description d'un cas de dyslexie profonde et d'un cas de dyslexie de surface. Grammatica 7, 131-156.

Kremin,H.(1984a) Routes and Strategies. In, K.E. Patterson, J.C. Marshall and M. Coltheart (eds.) Surface Dyslexia. Lawrence Erlbaum. Hillsdale, New Jersey. (in press).

Kremin,H. (1984b) Comments on pathological reading behaviour due to lesions of the left hemisphere. In R.N. Malatesha and H.A. Whitaker (eds,) Dyslexia : A Global Issue. Martinus Nijhoff. The Hague.

Kucera,H. and Francis,W.N. (1967) Computational Analysis of Present-Day American English. Providence. Brown University Press.

Kussmaul (1877) Disturbances of Speech. Ziemssen's Cyclopaedia 14.

Lambert,A.J.(1982a) Right hemisphere language ability:I Clinical Evidence. Current Psychological Reviews 2, 77-94.

Lambert (1982b) Right hemisphere language ability :II Evidence from normal subjects. Current Psychological Reviews 2, 139-152.

Lefavrais,D. (1963) Test de l'alouette. Editions du Centre de Psychologie Appliquee. Paris.

Lhermitte,F. and Beauvois,M.F. (1973) a visual-speech disconnection syndrome. Report of a case with optic-aphasia, agnosic alexia, and colour agnosia. Brain 96, 695-714.

Low,A.A. (1931) A case of agrammatism in the English language. Archives of Neurology and Psychiatry 25, 556-597.

Luria,A.R. (1960) Differences between disturbances of speech and writing in Russian and French. International Journal of Slavic Linguistics and Poetics 3, 13-22.

Marcel,T. (1980) Surface dyslexia and beginning reading : a revised hypothesis of the pronunciation of print and its impairments. In, M. Coltheart, K.E. Patterson and J.C. Marshall (eds.) Deep Dyslexia. Routledge and Kegan Paul. London.

Marcel,A. and Patterson,K.(1978) Word recognition and production in clinical and normal studies. In, J. Requin (ed.) Attention and Performance VII. Lawrence Erlbaum. Hillsdale, New Jersey.

Margolin,D., Marcel,A. and Carlson,N. (1984) A comparison of processing deficits in dysnomia and post-semantic surface dyslexia. In, K. Patterson, J.C. Marshall and M. Coltheart (eds.) Surface Dyslexia. Lawrence Erlbaum. Hillsdale, New Jersey.

Marin,O.S.M., and Saffran,E.M. and Schwartz,M.F. (1975) Dissociations of language in aphasia : implications for normal function. Annals of the New York Academy of Science 280, 868-884.

Marshall,J.C. and Newcombe,F. (1966) Syntactic and semantic errors in paralexia. Neuropsychologia 4, 169-176.

Marshall,J.C. and Newcombe,F. (1973) Patterns of paralexia: A psycholinguistic approach. Journal of psycholinguistic Research 2(3), 175-199.

Marshall,J.C. and Newcombe,F.(1980) The conceptual status of deep dyslexia : a historical perspective. In, M. Coltheart, K.E. Patterson, and J.C.Marshall (eds.) Deep Dyslexia. Routledge and Kegan Paul. London.

Martin,R.C. (1982) the pseudohomophone effect : the role of visual similarity in non-word decisions .Quarterly Journal of Experimental

Psychology 34A, 395-409.

Masterson,J. (1983) Investigations of surface dyslexia. Unpublished Ph.D. Thesis. Birkbeck College,London.

Mattis,S. French,J.H. and Rapin,I. (1975) Dyslexia in children and young adults : three independent neuropsychological syndromes. Developmental Medicine and Child Neurology 17, 150-163.

Maxwell,A.E. (1956) A factor analysis of the Wechsler Intelligence Scale for Children. British Journal of Education and Psychology, 29, 237-241.

Morgan, W.P. (1896) A case of congenital word-blindness. British Medical Journal 2, 1378.

Morton,J. (1969) Interaction of information in word recognition . Psychological Review 76, 165-178.

Morton,J. (1979) Word Recognition. In J. Morton and J.C. Marshall (eds.) Psycholinguistic Series 2. M.I.T. Press. Cambridge, Mass.

Morton,J. and Patterson,k.(1980) a new attempt at an interpretation, or an attempt at a new interpretation. In, M.Coltheart, K.E. Patterson, and J.C. Marshall (eds.) Deep Dyslexia. Routledge and Kegan Paul. London.

Myklebust,H.R. and Johnston,D.J.(1962) Dyslexia in children. Exceptional children 29, 14-25

Nelson,H.E. and O'Connell,A. (1978) Dementia : the estimation of premorbid levels using the new adult reading test. Cortex 14, 234-244.

Newcombe,F. and Marshall,J.C. (1980) Transcoding and lexical stabilization in Deep dyslexia. In, M.Coltheart, K.E. Patterson and J.C. Marshall (eds.) Deep Dyslexia. Routledge and Kegan Paul. London.

Newcombe,F. and Marshall,J.C. (1981) On psycholinguistic classifications of the acquired dyslexias. Bulletin of the Orton Society 31,29-44.

Newcombe,F. and Marshall,J.C. (1984) Reading and writing by letter sounds. In, K.E. Patterson, J.C. Marshall, and M.Coltheart (eds.)

Surface Dyslexia. Lawrence Erlbaum.Hillsdale, New Jersey. (in press)

Nolan,K.A. and Caramazza,A. (1982) Modality-independent impairment in word processing in a deep dyslexic patient. Brain and Language 16, 237-264.

Obler,L.K. (1984) Dyslexia in bilinguals. In, R.N. Malatesha and H.A. Whitaker (eds) Dyslexia : A Global Issue. Martinus Nijhoff, The Hague.

Oldfield, R.C. and Wingfield,A. (1965) Response latencies in naming objects. Quarterly Journal of Experimental Psychology 17, 273-281.

Orton,S.T. (1925) "Word blindness" in school children. Archives of Neurology and Psychiatry 14, 581-615.

Orton,S.T. (1926) Reading disability. Genetic Psychology Monographs 14, 335-453.

Orton,S.T. (1928) Specific Reading disability strephosymbolia. Journal of the American Medical Association 90, 1095-1099.

Orton,S.T. (1937) Reading, writing and speech problems in children. New York : Norton.

Paivio,A., Yuille,J.C. and Madigan,S.A. (1968) Concreteness, imagery and meaningfulness values for 925 words. Journal of Experimental Psychology. Monograph Supplement 76(3 part 2).

Patterson,K.E. (1978) Phonemic dysleiia : errors of meaning and the meaning of errors. Quarterly Journal of Experimental Psychology 30, 587-601.

Patterson,K.E. (1982) The relation between reading and phonological coding : Further neuropsychological observations. In A. Ellis (ed.) Normality and Pathology in Cognitive Functions.Academic Press,London.

Patterson,K.E. and Kay,J. (1982) Letter-by-letter reading : psychological description of a neurological syndrome. Quarterly Journal of Experimental Psychology 34A, 411-441.

Patterson,K.E. and Marcel,A.J. (1977) Aphasia, dyslexia, and phonological coding of written words. Quarterly Journal of Experimental Psychology 29, 307-318.

Patterson,K.E., Marshall,J.C. and Coltheart,M. (1984) Surface Dyslexia. Lawrence Erlbaum. Hillsdale, New Jersey.(in press)

Pinto,M. (1983) Case study of a patient with deep dyslexia. Paper presented at the 6th European meeting of the International Neuropsychological Society, Lisbon, Portugal.

Richardson,J.T.E. (1975) The effect of word imageability in acquired dyslexia. Neuropsychologia 13, 281-288.

Richardson,J.T.E. (1975) Further evidence on the effects of word imageability in dyslexia. Quarterly Journal of Experimental Psychology 27, 445-449.

Rickard,S. (1982) Effects of part of speech and imagery in deep dyslexia. Paper presented at the fifth European meeting of the International Neuropsychological Society, Deauville, France.

Rubin,G.S., Becker,C.A. and Freeman,R.H. (1979) Morphological structure and its effects on visual word recognition. Journal of Verbal Learning and Verbal Behaviour 18, 757 -767

Rutter,M. (1978) Prevalence and types of dyslexia. In, A.L.Benton and D. Pearl (eds.) Dyslexia : An appraisal of Current Knowledge. Oxford University Press. New York.

Rutter,M. Tizard,J., Yule,W., Graham,P., and Whitmore,K. (1976) Research report : Isle of Wight Studies 1964-1974. Psychological Medicine 6, 313-332.

Rutter,M. and Yule,W. (1973) Specific reading retardation. In, L.Mann and D. Sabatino (eds.) The first review of special education. Buttonwood Farms, Philadelphia.

Saffran,E.M. (1984) Does lexicalization affect reading performance in surface dyslexia? In, K.E.Patterson, J.C. Marshall and M. Coltheart

(eds.) Surface Dyslexia. Lawrence Erlbaum. Hillsdale, New Jersey.(inpress)

Saffran,E.M., Bogyo,L.C., Schwartz,M.F. and Marin,O.S.M. (1980) Does deep dyslexia reflect right-hemisphere reading? In, M. Coltheart, K.E. Patterson and J.C. Marshall (eds.) Deep Dyslexia. Routledge and Kegan Paul. London.

Sartori,G. and Barry,C.(in preperation) Impairments of non-word reading in three Italian dyslexic patients. (cited by Sartori et al 1984).

Sartori,G., Barry,C., and Job,R. (1984) Phonological Dyslexia :A review. In, R,N. Malatesha and H.A. Whitaker (eds.) Dyslexia:A Global Issue. Martinus Nijhoff. The Hague.

Sasamuma,S. (1974) Kanji versus Kana processing in alexia with transient agrapgia : a case report. Cortex 10, 89-97.

Sasanuma,S. (1980) Acquired dyslexia in Japanese : clinical features and underlying mechanisms. In, M. Coltheart, K.E. Patterson and J.C. Marshall (eds.) Deep Dyslexia. Routledge and Kegan Paul. London.

Sasanuma,S. (1984) Surface dyslexia and dysgraphia. How are they manifested in Japanese. In, K.E.Patterson, J.C. Marshall and M.Coltheart (eds.) Surface Dyslexia. Lawrence Erlbaum. Hillsdale, New Jersey. (in press)

Sasanuma,S. and Monoi (1975) The syndrone of Gogi (word meaning) aphasia: Selective impairment of Kanji processing. Neurology 25, 627-632.

Schwartz,M.F., Saffran,E.M. and Marin,O.S.M. (1977) An analysis of agrammatic reading in aphasia. Paper presented at the International Neurpsychological Society Meeting , Sante Fe.

Schwartz,M.F. Saffran,E.M. and Marin,O.S.M. (1980) Fractionating the reading process in dementia : evidence for word specific print-to-sound associations. In, M. Coltheart, K.E. Patterson and J.C. Marshall (eds.) Deep Dyslexia Routledge and Kegan Paul. London.

Shallice,T. and Coughlan, A.K. (1980) Modality specific word comprehension deficits in deep dyslexia. Journal of Neurology, Neurosurgery and Psychiatry 43(10), 866-872.

Shallice,T. and Warrington,E.J. (1975) Word recognition in a phonemic dyslexic patient. Quarterly Journal of Experimental Psychology 27, 187-199.

Shallice,T. and Warrington,E.K. (1980) Single and multiple component central dyslexic syndromes. In, M. Coltheart, K.S. Patterson and J.C. Marshall (eds.) Deep Dyslexia. Routledge and Kegan Paul. London.

Shallice,T., Warrington,E.K. and McCarthy,R. (1983) Reading without semantics. Quarterly Journal of Experimental Psychology 35, 111-138.

Silberberg,N.E. and Silberberg,M.C. (1967) Hyperlexia : specific word recognition skills in Young children. Exceptional Children 34, 41-42.

Simmel,M.L. and Goldschmidt,K.H. (1953) Prolonged posteclamptic aphasia: report of a case. A.M.A. Archives of Neurology and Psychiatry 69,80-83.

Skydsgaard,H.B. (1942) Den konstitutionelle dyslexi. Kobenhavn.

Stanovich,K. and Bauer,D. (1978) Experiments on the spelling to sound regularity effects in word recognition. Memory and Cognition 6, 410-415.

Stephenson,S. (1907) cited by Drew (1956).

Taft,M. (1981) Prefix stripping revisited. Journal of Verbal Learning and Verbal Behaviour 20. 289-297.

Toglia,M.P. and Battig,W.F. (1978) Handbook of Semantic Word Norms. Erlbaum. New York.

Variot,G. and Lecomte,T. (1906) cited by Drew (1956).

Venezky,R.L. (1970) The Structure of English Orthography. Mouton. The Hague.

Warrington,E.K. (1975) The selective impairment of semantic memory. Quarterly Journal of Experimental Psychology 27,635-658.

Whitaker,H. (1976) A case of the isolation of language function. In, H. Whitaker and J. Whitaker (eds.) Studies in Neurolinguistics 2. Academic Press,New York.

Wijk,A. (1966) Rules of pronunciation for the English Language. Oxford University Press. London.

Witmer,L. (1917) cited by Drew (1956).

Yamadori,A. (1975) Ideogram reading in alexia. Brain 98,231-238.

Zaidel,E. (1978) Lexical organiation in the right hemisphere. In, Buser and Rouguel-Buser (eds.) Cerebral Correlates of Conscious Experience. INSERM. Symposium No. 6 North Holland Biomedical Press. Elsevier.

Zaidel,E. (1981) Reading by the disconnected right hemisphere aphasiological perspective. In, Y. Zotterman (ed.) Wenner-Gren Symposium on Dyslexia. Plenum Press. London.

APPENDIX I

MARSHALL DERIVATIONAL LIST (Stimuli given in order of presentation)

build	persuasion	report
weakness	sing	manage
management	examine	happiness
government	happy	weak
destroy	entertainment	arrange
argument	believe	amuse
remove	teacher	building
cautious	sharp	inform
refresh	wise	heat
true	persuade	belief
betray	banishment	govern
softness	strange	beg
revise	arrive	refuse
complaint	betrayal	thin
bake	caution	beauty
information	breadth	calm
sickness	strangeness	approval
complain	refusal	sick
revision	destruction	deep
soft	height	arrival
sharpness	baker	refreshment
reporter	truth	certain
depth	calmness	song
beautiful	approve	examination
gentleness	competition	gentle
teach	thinness	politics
political	beggar	arrangemnt
compete	argue	broad
removal	wisdom	furniture
furnish	certainty	banish
amusement	high	strength
hot	strong	entertain

APPENDIX II

TEMPLE WORD LIST (Stimuli given in order of presentation)

bat	shiny	stress	dim
large	rip	these	passport
kiss	orchestra	either	pat
nation	adjective	just	menace
solemn	short	strict	kit
shiver	moth	influence	mimic
anchor	was	dumb	light
at	fancy	throat	one
scorn	thunder	average	secretary
talk	variation	angel	dog
child	confess	fir	hope
weigh	mattress	bad	purchase
instance	injure	disgrace	mope
came	nothing	joyful	archer
fire	they	them	war
mug	essay	bright	cheery
chemist	strange	mechanic	thin
jelly	wine	on	there
shady	record	hid	possible
invitation	design	ambition	but
knob	ought	daughter	kite
recent	source	chimp	patient
naughty	mate	echo	health
peach	brother	since	ate
night	relation	cold	barge
corner	doubt	write	unjust
mop	cheat	hop	children
both	stomach	neighbour	energy
enjoy	debt	clue	teeth
that	join	digest	ripe
school	ration	mat	sunshine
engine	whistle	chlorine	shown
jewel	fight	press	harsh
mass	chapter	champion	shone
gentle	nip	the	north
audience	hide	sight	motion
chorus	deceit	fresh	jumper
ashamed	honesty	image	dress
worth	station	choir	this
then	clear	portion	win

APPENDIX III

CORE 80

These stimuli are included within the Temple word list.

A.	B.	C.	D.
ate *	was *	dim *	was *
dumb *$	came *	kiss *	thin *£
debt *$	both *	knob *£	talk *$
clue *£	just *	kite *$	cold *
scorn *£	image *	weigh *$	write *$
mimic £	doubt *$	cheat *£	clear *
harsh *£	press *£	shady *	large *
fancy *	shown *	angel	fresh £
shone $	north *	peach	teeth £
strict	worth	shiny	short £
unjust +£	either +$	jewel	design $
solemn $	stress £	joyful +	health $
menace £	energy +£	shiver +£	record +£
ration +$	source +$	anchor $	bright $
deceit +$	recent +	cheery +£	corner +£
honesty +$	average +	thunder +£	patient +$
ashamed £	nothing +	whistle $	station +$
ambition +$	possible +	sunshine +£	audience +$
disgrace +£	instance +£	mechanic +$	children +£
adjective +	influence +$	neighbour +$	secretary +£

For imageability , the number correct in groups A and B are compared to the number correct in groups C and D. The two groups are balanced for frequency, length, regularity and part of speech. C and D are of high imageability and A and B are of low imageability.
For frequency, the number correct in groups A and C are compared to the number correct in groups B and D. The two groups are balanced for imageability, length, regularity and part of speech. B and D are of high frequency and A and C are of low frequency.
For length, the number correct which are marked with a * are compared to the number correct which are marked with a +. The two groups (n=30) are balanced for regularity, imageability and frequency. Those marked * are short and those marked + are long.
For regularity, the number correct marked $ are compared to the number correct marked £. The two groups (n=26) are balanced for length, frequency and imageability. £ are regular and $ are irregular.

APPENDIX IV : SENTENCES USED FOR DICTATION OF TEMPLE HOMOPHONE LIST

1.	ROAD:	Our house stands near a busy road.
2.	TYRE:	My left front wheel needs a new tyre.
3.	STEEL:	My kitchen knives are made of steel.
4.	CURRENT:	It was hard to row our boat against the heavy current.
5.	DEER:	The two hunters shot and killed a deer each in the forest.
6.	PIECE:	Would you like a piece of cake?
7.	GROWN:	The weeds have grown while we were on holiday.
8.	ROWED:	John rowed the boat along the river.
9.	MALE:	Football is a game played by males.
10.	DYE:	Martha used to dye her hair red.
11.	HEEL:	I walked so far that I got a blister on my heel.
12.	STEAL:	John saw Max steal his neighbour's watch.
13.	CHEAP:	Potatoes are relatively cheap.
14.	CURRANT:	I am very fond of blackcurrant jelly.
15.	ROWS:	All the rows were full of people.
16.	SAIL:	We went to sail the boat up the river.
17.	PEACE:	At the end of the war there was peace.
18.	TIRE:	After climbing the hill I began to tire.
19.	MAIL:	She sent the letter by air mail.
20.	THROWN:	It was thrown in the corner out of the way.
21.	HARE:	We shot a wild hare and had it for dinner.
22.	BORED:	After listening to the dull conversation for an hour he became very bored.
23.	HEAL:	It is the doctor's job to heal the sick.
24.	DIE:	Without air a person will die.
25.	FLEW:	We flew to Spain on holiday.
26.	BYE:	Goodbye, I have to go now.
27.	ALOUD:	Being alone, the old man spoke his thoughts aloud.
28.	STARE:	It is rude to stare at people.
29.	GROAN:	His sore head made him groan.
30.	HAIR:	People have hair growing on their heads.
31.	ROSE:	She picked a rose from the garden.
32.	SALE:	We may get some bargains at the shop sale.
33.	DEAR:	Strawberries are rather dear to buy.
34.	THRONE:	The Queen sat on the throne.
35.	CHEEP:	The sick sparrow gave a cheep.
36.	FLU:	Last week I spent three days in bed with flu.
37.	BOARD:	I made a table out of the board.
38.	ALLOWED:	Dogs are not allowed inside the hospital.
39.	STAIR:	Each stair in the house is covered with carpet.
40.	BUY:	Where did you buy your car?

APPENDIX V

SYSTEM USED FOR PHONETIC TRANSCRIPTIONS

Symbols for transcribing English consonants

p	pie	pea		v	vie	V	
t	tie	tea		θ	thigh		
k	kye	key		ð	thy	thee	
b	by	bee		s	sigh	sea	
d	dye	D		z		Z	mizzen
g	guy			ʃ	shy	she	mission
m	my	me	ram	ʒ			vision
n	nigh	knee	ran	l	lie	lee	
n			rang	w	why	we	
f	fie	fee		r	rye	re	
h	high	he		j		ye	

Also

t	chime	cheap		dz	jive	G

Symbols for transcribing contrasting vowels in English

i	heed	he	bead	heat	keyed
ɪ	hid		bid	hit	kid
e	hayed	hay	bayed	hate	Cade
ɛ	head		bed		
æ	had		bad	hat	cad
ɑ	hard		bard	heart	card
ɒ	hod		bod	hot	cod
ɔ	hawed	haw	bawd		cawed
ʊ	hood				could
oʊ	hoed	hoe	bode		code
u	who'd	who	booed	hoot	cooed
ɔ	herd	hér	bird	hurt	curd
ʌ	Hudd		bud	hut	cut
aɪ	hide	high	bide	height	
aʊ		how	bowed		cowed
ɔɪ		ahoy	Boyd		
ɪɔ		here	beard		
ɛɔ		hair	bared		cared
aɔ	hired	hire			

Also

ju	hued	hue	Bude		cued

(The "Edinburgh" transcription, English Phonetic Texts. D. Abercrombie, 1964, Faber and Faber, London.)