GOOD READERS/POOR SPELLERS:
THE INVESTIGATION OF A DISSOCIATION BETWEEN READING AND SPELLING SKILLS IN OTHERWISE NORMAL CHILDREN

by

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Abstract

This study presents an investigation of a discrepancy between reading and spelling ability in a group of otherwise normal children who are reading at or above grade level but are spelling considerably below this level. Their performance is compared with that of a group of children who are both good readers and good spellers.

It is proposed that in order to read and spell efficiently, a dual orthographic image must be formed and stored in the lexicon, a partially specified image adequate for reading, and a fully specified image for writing and for monitoring the reading process. Results of the study support the hypothesis that the good readers/poor spellers form only a partially specified image which enables them to read well, but not to spell. Evidence is also presented which indicates that the poor spellers appear to differ from the good spellers in their reading subskills.

Spelling ability, too, appears to be made up of various subskills which may differ from individual to individual. This finding is in accord with earlier studies of reading which have shown this to be a non-unitary skill. It is, therefore, to be expected that writing, too, as the other aspect of literacy skills, will also be a multi-component skill.

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Introduction

Reading disabilities, both developmental and acquired, have attracted a considerable amount of interest over the years. Neuropsychological and linguistic research now indicates that a reading disability cannot be viewed as a unitary deficit. The surface picture presented by disabled readers may well look similar in all cases in that they all experience great difficulty in reading, but closer analysis of the deficits, and skills, underlying this disability have indicated that poor readers do not form a homogeneous group. Rather, there are numerous sub-groups that go to make up the reading disabled population.

An interest in spelling deficits has been a part of the study of reading problems, but such deficits have tended to be considered of minor importance with regard to the child's overall ability. This has especially been so if the child had no other apparent cognitive deficits. However, secondary though a spelling deficit may be to reading problems, such a deficit can in itself constitute a real handicap. Furthermore, in those cases where this deficit is unaccompanied by any apparent reading difficulties, it provides a clear indication that reading and writing, although complementary, are skills which can be dissociated. Analysis of spelling problems thus isolated has the potential to reveal how children learn to spell, and the processes which are involved in the acquisition of this skill.

There are already indications that spelling, like reading, is unlikely to be a unitary skill. The fact that spelling deficits can be found in association with various levels of other cognitive skills, including both good and poor reading ability, also supports this assumption. In addition, in view of its apparent close association with reading, which has been shown to be a multi-faceted accomplishment, it is anticipated that a closer analysis of the factors involved in spelling will reveal that it too is a non-unitary skill, and that poor spellers, like poor readers, are only alike on the surface, but that the population as a whole is made up of many sub-groups.

The poor spellers in the present study were selected on the basis of the discrepancy between their good to very good reading skills, as indicated by their scores on the standardized tests used in the school system, and their much lower level of spelling ability.

The first part of the study reviews the development of writing systems, with a brief consideration of the English orthographic system. This is followed by a review of previous and current research dealing with spelling problems, which concludes with a proposal for a model which illustrates normal spelling and reading processes. Hypotheses are presented with regard to how the poor spellers are assumed to differ from their peers in relation to the model. This will be followed by an account of the experimental work undertaken to support these hypotheses, and in the final section, the findings will be reviewed in the light of the hypotheses, and an attempt will be made to form a picture of what it is that goes to make up a poor speller who is a good reader.

Chapter 1

In Western society, basic literacy is an essential part of life. It is thus unfortunate that such a widely used language as English should present so many problems for the learner in both encoding and decoding. There has already been a considerable amount of time and energy devoted to the problem of children who cannot read. Although children - and adults - who cannot spell are also handicapped, their disability is far less of a problem to them than would be a reading deficit. Nonetheless, it does still present them with difficulties. A particularly interesting manifestation of the problem arises where the inability to spell is associated both with average, or even above average, reading ability and with good overall intellectual potential in general.

Writing systems

Before discussing the experimental work on which this study is founded, it will be useful to give a brief overview of writing systems and their history. This will include an examination of the English orthographic system, as well as some brief consideration of how it compares with more transparent orthographies such as those of Finnish and Serbo-Croat.

The primacy of spoken language is beyond dispute; no completely normal person will fail to learn to speak. Although large parts of the world's population function perfectly adequately without any recourse to written language, significant numbers also function inadequately because of their failure to acquire a written language.

The study of the process of the acquisition of spoken language has already proven itself to be a valid field of study for linguists. The study of the process of acquiring, or failing to acquire written language is also relevant to the formulation of an overall theory of language acquisition. It can no longer be accepted that written language is irrelevant to our understanding of language in general.

In a historical perspective, written language appears to have evolved through a number of stages before the modern, alphabetic system of representation was developed. The earliest written productions appear to have been direct pictorial representations of objects or situations. Out of this direct representation developed a more stylized set of symbols related by convention to objects or concepts, much of whose representational detail had been eliminated (as for example, in the hieroglyphs of ancient Egypt and the logographic characters of Chinese). The next evolutionary step was the development of syllabic representations where the symbol represented the sound of the syllable without reference to its meaning (as in the Cree and Inuit writing systems, and the kana system of Japan). Alphabetic writing is the final stage in evolution. The system is totally analytic and each symbol, ideally, represents a single phoneme of the language. The process has thus been one of refinement, beginning with the representation of concepts, culminating in the representation of the individual sounds in the language system.

This alphabetic principle of relating symbol to phoneme has never been reinvented. The alphabet, as it exists today, is based on that of the ancient Greeks who took over the Semitic type of system used by the Phoenicians and modified it to accommodate their own language. From there, the alphabet was then apparently transmitted to other parts of the world where no other efficient writing system had been established. This transmission was carried out primarily by the Romans who adopted the Greek alphabet, modified it, and carried it throughout their territories. The Cyrillic script of some Slavic languages was derived more directly from the Greek alphabet, and the Dravidian script of the ancient Brahmin civilization of India drew more closely on the original northern Semitic tradition. There are differences in the symbols used by these alphabets, but they have a common basis, and a common principle relating sound to symbol in an arbitrary way.

Ideally, an alphabet would use one symbol to represent one phoneme, and there are indeed many instances where this situation does obtain. In Spanish and Italian there is a close link between orthography and pronunciation, between grapheme and phoneme. This is also true of such widely differing languages as Finnish, Serbo-Croat and Korean. However, English, and to a lesser extent, French, have a more complex relationship between grapheme and phoneme. In French, a grapheme, or group of graphemes, almost always have the same pronunciation, though a wide variety of different graphemes and graphemic units can be used to represent a single phoneme. In English, there are 26 letters in the alphabet to represent the 44 phonemes of the language. (In effect, the 26 could be reduced to 23 since c; q and x can all be represented by one more more of the remaining letters and are thus superfluous.) The result of this is that one letter can be used to represent several sounds, and one sound can be represented by several different letters or letter clusters. Since this complexity may, on occasion, hinder even the most proficient of language users, it is of interest to examine how the situation has arisen.

English orthography

Prior to the invention of printing, which made possible the production of texts in greater numbers, which meant, in turn, that they could be more widely disseminated and so led to some standardization of the orthography, the spelling of English reflected a variety of factors. These ranged from the scribe's own particular regional dialect, to a mercenary lengthening of all words whenever possible in those cases where the scribe was paid by the line. In such cases, the longer the words, the more lines would be needed to transcribe a document, and hence the greater the scribe's remuneration. With the advent of printing, however, a degree of standardization was imposed on the orthographic system. Had the spoken language remained unchanged from then on, even had Caxton worked much of his life in England rather than Belgium, it is possible that the system would have been reasonably adequate for the English language some 500 years later. However, as it is, there are many cases where the relation between sound and spelling has become remote. Letter sequences are retained for sound sequences which no longer exist in the language, as in the case of kn- in knight, or -gh- in night.. Words with a Greek basis retain the spelling of the original, but not the sound, as in psychology, mnemonic and pneumonia. In other Greek based words, the h no longer indicates aspiration, but changes a stop into a fricative, as in theology and philosophy. False etymologies are responsible for the spelling patterns of could and would (from cypan/woldan) and isle/island (isle being derived though French, from the Latin insula; island from the Anglo-Saxon ealond). Pedantic rectitude was responsible for the insertion of silent letters intended to reflect the true origin of the word; hence dette gained a silent b to become debt, even though by the time the word came into English from French, the b of the Latin original had already disappeared. (Barnitz, 1980; Chomsky, 1970; Massaro et al., 1980; Taylor and Taylor, 1983; Venezky, 1970).

The divergence of the written from the spoken form has led to attempts to rationalize the system - though without any great measure of success. In his 18th century dictionary of English, Dr. Johnson attempted to correct and proscribe the improprieties and absurdities of the language, though in fact he succeeded in making official some of the illogical spelling patterns of the day. Noah Webster attempted to formulate an American orthography which led to some simplification. (This was not extended to place names which in many cases appear to be far removed from any obvious link between spelling and pronunciation.) This simplification has resulted in a divergence between the British and American traditions, complicating the lot of the Canadian child exposed to both the British and the American tradition and, in learning to spell, having to decide between such alternatives as programme/program, favourite/favorite, colour/color.

Until the coming of widespread, or even compulsory access to education, one of whose aims is to produce universal literacy, an inability to spell correctly was apparently no handicap. The variety of different spellings of Shakespeare's name, or Caxton's spellings of Bruges, the town where he spent a good part of his life, appear to indicate that even among the literate, there was no great degree of conformity. Today, however, most printed texts follow spelling conventions, and children are expected to learn these conventions and to conform to them.

Success in learning these conventions, however, is far from universal. The irregularity of the English orthographic system presents difficulties for many, and for some these difficulties appear to be insuperable. Problems with spelling may also be associated with reading problems, or with low academic achievement in general, but this is not invariably so. Although very few intelligent, accomplished adults are to be heard claiming that they are unable to read, there are many who proudly claim they have never been able to spell. Whatever problem this has been to them, they have overcome it. It is thus evident that an isolated spelling deficit is a minor handicap. However, it does cause difficulties, primarily in the educational and cultural environment. Children who consistently lose marks for spelling errors in their written work, may never receive the grade deserved for the content of the written work. This may have an inhibiting effect on such children who become unmotivated or limit their written work to only those words they know how to spell (although this presupposes that children know what it is they do not know). Alternatively, these children can learn to use a dictionary correctly. This, however, may prove time-consuming and frustrating.. Unless one knows how to spell the word one is looking up, it can prove difficult to track it down. Rosewell and Natchez (1971) quote a child who asked, "How on earth do you spell pearl, and don't ask me to look it up in the dictionary because I've already looked under per, pur and pir without finding it." If defeated enough times, the child is likely to become discouraged and to just guess at the spelling of the word.

A simplified spelling system, with a one-to-one correspondence between grapheme and phoneme, in both directions, would help some of the poor spellers. However, the cost would be enormous, since logically one would have to reissue all printed material in the new, improved orthography, which, when one considers how widespread is the use of English, would be a

Herculean task. When one further considers the varieties of English that go to make up the language world-wide, the problem of which to select as the standard on which to base the new orthography would be likely to create as many problems as it might solve. Furthermore, a 'regular' orthographic system, where one grapheme corresponds to one phoneme, and vice-versa, does not necessarily prevent literacy problems. Moreover, although the orthography of English does not rely on one-to-one correspondences, it is not totally unsystematic.

Some evidence that a shallow orthography (i.e. with a direct and transparent linkage between phonemes and graphemes) does not necessarily prevent reading and writing problems can be found in Kjöstiö (1980). This study was concerned primarily with reading rather than spelling problems but Kjöstiö writes, "In spite of a regular orthographic system, Finnish children have difficulties in initial reading as well as in writing. They do not discriminate long vowels and geminated consonants clearly enough, or, from the point of the child, the question may be one of memory." It would thus appear that a regular phonological correspondence is not enough, and it is likely that some visual image of the word is also needed in the lexicon. In addition, although Finnish readers appear to have few problems with the mechanics of reading aloud, the higher level skills of reading for comprehension may still present problems. For example, only 50% of grade 6 pupils in one study were judged to have "attained the level of reading and writing needed at the upper stages of the comprehensive school." (Vähäpassi, 1977; cited in Kjöstiö, 1980). This indicates that even transparency of orthography does not guarantee that learners will necessarily benefit from this crystalline quality.

As far as the English orthographic system is concerned, whilst it is not unsystematic, it is clearly very far removed from such transparent systems as Finnish, and Serbo-Croat, with their almost perfect grapheme to phoneme correspondences. The Serbo-Croat orthography differs historically from the English system, which has evolved over time, in that it was regularized by decree at the beginning of the nineteenth century by Karadic, following the dictum, "Write as you speak and read as it is written". (Lukatela and Turvey, 1980.) (Serbo-Croat differs further from English in that there are two sets of orthographic symbols for writing the same language, the Roman and the Cyrillic. Each, however, preserves the transparency of the relationship of sound to symbol.) English orthography, on the other hand, is less a phonemic system than a morphophonemic system, where transparency relates to meaning, via the morpheme, rather than to sound, via the grapheme. It is thus a system which helps the reader rather than the writer, especially once fluency has been attained.

Haas (1970) characterizes alphabetic orthographies, of which English is an example, as "an application of phonological analysis to a task of communication". Such phonological analysis allows for:

> "The reduction of infinitely many utterances to a few phonemic elements (which) is basic to the economy of alphabetic writing. This economy being its distinctive virtue, we have to acknowledge that any deviation of alphabetic writing from phonemic transcription will be some sort of loss. Yet though such 'phonographic divergence' must detract from the script's economy, it need not constitute a flaw in its overall efficiency. The 'lower level drawbacks' of phono-graphic divergence

May be balanced, and more than balanced, by 'higher level' advantages: either by the capacity of the orthography for signalling lexical and grammatical values, or by extending social and cultural use."

Carol Chomsky (1970) makes a similar point, though from a somewhat different perspective, and with a somewhat different emphasis, when she claims that the system which children construct through exposure to written language, internalizes the phonological rules that relate underlying forms to their pronunciation. The process is dependent, in part, on a recognition of the similarities in meaning between related words. The process of recognition is facilitated by an awareness of how the words are spelled, so that the system that children construct through exposure to the spoken language, enables them to interpret written language. Chomsky suggests that this factor might be capitalized upon in school, by enriching the child's language and pointing out the links between such words as nation/national, history/historian. She further suggests that teaching the links between such words as president/presidential, precede/precedent, would make plain which full vowel representation is linked to the reduced vowel schwa. However, it is possible that such clear links are more obvious to the linguist than to the child, especially when one considers the example given by Chomsky of the grade 7 child of average intelligence who was unable to draw any association from the spelling of the words sign and signature. If those of average intelligence do not appreciate the link, it does not augur well for the less able.

This is not to say that children should not be encouraged to find these connections, but that it requires a degree of linguistic sophistication and also an extensive vocabulary if it is to be effective. There are, furthermore, probably as many misleading as there are helpful pairs: e.g. pronounce/pronunciation; machine/mechanical; high/height. Moreover, these words form only a very small part of the language and most tend to be learned or unusual words.

However, Chomsky's proposal that spelling might be learned by linking it with meaning does reflect the most salient feature of the English orthographic system, its morphophonemic characteristics, as already mentioned, where both sound and meaning are linked to the graphemic representation. It is this factor that leads N. Chomsky and M. Halle (1968) to claim that far from being ill-suited to the task of providing a written symbolization for the spoken language, the English orthographic system is optimal for representing the English language, in that it represents a clear link with the underlying forms of the language. This may well be true for those fortunate enough to be aware of, or to have access to these same underlying forms of the language. It would appear that just as Jespersen claimed that the child learning to talk has to be a 'little linguist', so the child learning to write needs to be a little phonologist (with a generative bias). In Sound Patterns of English, Chomsky and Halle do admit that:

> "... it is by no means obvious that a child of six has mastered the phonological system in full ... It would not be surprising to discover that the child's intuitive organization of the sound system continues to develop and deepen as his vocabulary is enriched and as his language extends to wider intellectual domains and more complex functions."

Developing orthographic skills

Although doubts have been cast on the relevance of SPE's underlying forms to the child, this is not to deny that the child, even before the age of six, is able to make a phonological analysis of the language it hears, and to devise an orthographic system for representing it. Charles Read's studies of pre-schoolers who had taught themselves to write give evidence of this (Read, 1971). However, the children's system was based on the names of the letters themselves and on similarities of articulatory features as they were perceived by the children, rather than on any underlying forms. Thus it was much more a surface phonemic analysis. Examples of this can be seen in the children's spellings of such words as *tray* and *chicken*. The initial sounds in these words were perceived as being much more similar than the spelling would suggest and it was the affrication of both words that was selected as the salient feature for representation. The letter chosen to represent this feature was *H*, presumably because of the [č] in the letter's name. When these precocious spellers went to school, they had no difficulty learning to conform to the regular orthographic system. However, misperceptions, or misanalyses do still occur. The initial affrication of *tray* and *train* may be felt, not unreasonably, to be linked to the initial letter of the words. If *cat* is linked to [kæt], it should follow that *tray* should be linked to [črei] in the same way. If this is so then [č] should also be able to be represented in other environments by *t*. Thus M., aged 6, spelled *mischievous* as *mistufus*. However, as children gain greater experience with written language, so most will learn to spell according to the accepted system.

Read found numerous examples of the pre-schoolers' use of the name of the letter to represent a tense vowel, as in DA (day), FEL (feel), and MI (my). In representing the corresponding lax vowels, the children appeared to rely on similarities in place of articulation as the criterion on which to base the correspondence, as seen in the spelling of clock as CLIK, where vowel height has been singled out.

In a preliminary study of first graders' spelling, Treiman (1983), reports that "attention to phonetic detail ... may be characteristic of beginning spelling in general." The children Treiman studied were not precocious spellers, as Read's had been, but regular grade 1 students who happened to be in a 'language experience' programme that encouraged writing (Stauffer, 1970).

A similar use of a letter-naming strategy is also noted by Bissex (1980) in an account of her son's acquisition of the English orthographic system. For this particular child, the stage of using the names of letters to spell words, as in RUDF (Are you deaf?) lasted only a few weeks. He was also slightly older than Read's pre-schoolers when he was using this strategy.

Gentry, in a review of Bissex's work, describes this stage in the child's acquisition of orthography as 'the semiphonetic stage' and writes "... the letter naming strategy is very much in evidence at the semi-phonetic stage. Where possible the speller represents words, sounds, or syllables with letters that match their letter names (e.g. R /are; U /you; LEFT /elephant) instead of representing vowel and consonant sounds separately" (Gentry, 1982).

From this semiphonetic stage, the child moves to a phonetic stage (Gentry, 1982) where a fuller mapping of surface features onto the spelling takes place. This spelling is not necessarily conventional, and graphotactically illegal sequences appear. This is hardly surprising. The child has grasped that there is a systematic link between what is said and what is written but has insufficient experience with the written word (in the case of Bissex's son, this stage lasted from age 5:01 to 6:01) and has not yet learned which sequences are orthographically acceptable in English and which are not.

The strategy ~~of letter~~ naming which is used by beginning readers/writers has also been noted in older children who have been diagnosed as dyslexic (Cook, 1981). Here again, this is a strategy which decreases with age. In addition, Luelsdorff (1984) has documented this strategy being used by a 12-year-old 'incipient bilingual child' whose first language was German and who was learning English. In this instance, there was also interference from the letter names of the first language. For example, the boy spelled paints as pans using the English letter name for the vowel, but spelled cornflakes as cornfleks, using the German letter name to represent the second vowel.

Luelsdorff goes on to suggest that this strategy could be exploited in teaching spelling and oral reading both to native and second language speakers of English. However, this is not as appropriate as might at first appear. The correspondence of vowel name to pronunciation is far from regular in English, as becomes apparent when one looks at only two of the examples proposed by Luelsdorff, canine and zebra. The a in canine (in many dialects) is given the pronunciation of the letter's name, but the a in ravine is not. The e in zebra (in many dialects) may have the pronunciation of its medial vowel corresponding to the vowel's name, but medlar does not. In this instance, Luelsdorff's rule for pronouncing e as its own name is triggered by its being followed by 'a functionally simple consonant unit, followed by l or r and then another vowel'.) The rules given by Luelsdorff are greatly underspecified.

However, even if the rules were to be fully specified, their learnability is likely to be of a very low order. Venezky's analysis of the English orthographic system (Venezky, 1970) contains some 70 pages of rules and, perhaps more significantly, of exceptions to the rules. Hanna et al. (1966) drew up a set of rules designed to allow a computer to spell English words. Of the 17,000 words generated, rather less than 50% were spelled correctly. This was a considerably lower proportion than was spelled correctly by a group of fourth grade children tested on the same words (Simon and Simon, 1973). Therefore, even if the rules were to be taught, more is needed. In fact, most of the computer-generated misspellings were incorrect because the computer was unable to take into account the morphology and etymology of a word, which is particularly relevant to the spelling of words in English.

Since it is easier to preserve evidence of a child's efforts at writing than reading, it is not possible at this distance to tell whether the child who spelled mischievous as mistufus would have been able to read the word mischievous had he been presented with it. In view of his age, it seems unlikely. It is not unusual for one to be able to read words which might give some problems in spelling, but the reverse situation is unlikely to occur, at least in fluent readers. However, Bryant and Bradley (1980) have documented results of tests carried out with children who were able to spell words they could not read. They could write words such as bun, peg, mat and dog, but were unable to read them. They were, on the other hand, able to read such words as school, light, train and egg which they were unable to spell correctly. It was evident that in reading, the children processed the words holistically, whereas in writing, they analyzed them phonologically and knew enough about grapheme-phoneme correspondences to write these familiar and transparently structured words. When encouraged to adopt a strategy of phonological analysis in reading too, the children were able to read the words that had given them problems. Two groups of children were involved in the study, a younger group aged 6½-7, and an older group of 7-7½. It was with the younger group that the greater discrepancy between reading and writing was observed, indicating that although initially, two separate strategies may be used, a holistic one for reading and an analytic one for writing, with experience the two strategies merge and are used as occasion demands. The whole word approach is used for reading familiar words, and the analytic approach for new or difficult words, and for writing, where every letter counts.

Marsh et al. (1980) also describe the process of learning to read and write as one of a developmental change of strategy. In many instances, the strategies used apply to both reading and spelling, though not always. For example, an early strategy used by beginning readers is that of substitution of a known word which is sufficiently close, semantically and syntactically, to the unknown word. As one might imagine, this strategy is infrequent in beginning spellers. In this author's experience, children do make substitutions of other words in spelling to dictation, but these tend to be substitutions of other parts of speech - worried for worry for example - and probably reflect an attentional deficit rather than a substitution strategy.

As readers get more skilled, they are able to use a phonemic decoding strategy for words they do not recognize. In English, this strategy is perfectly appropriate for CVC words, as each letter is sounded out, sequentially from left to right. The strategy is, of course, also appropriate for spelling such CVC combinations. /

The next stage, according to Marsh and his co-workers, is the development of a hierarchical decoding strategy which is needed for such items as CVCe words where the final e modifies preceding segments in the word. Marsh and his co-workers found that knowledge of final e as a lengthener of a preceding vowel had reached ceiling by grade 5. In the present study however, although the children were aware of its correct use to indicate lengthening, it was also used inappropriately where lengthening of the preceding vowel was not required, as in methode and omite. The students would also omit final e in cases where it was needed to modify a preceding consonant, as in arang and damig (arrange and damage). They were also not fully aware of which vowels would cause c to be pronounced as [s] and were willing to spell principle (or principal) as princaple. They have not fully mastered the hierarchical entailment of certain orthographic combinations.

The most sophisticated level of reading and spelling, according to Marsh, is the stage where unfamiliar words can be read and spelled by analogy with more familiar words. There was evidence in the present study, at all grades, for the use of analogical strategies in the spelling of words, although the strategies were not always appropriate, as in the case of coulf for cough (Grade 3), wright for write (Grade 4), and hight for height (Grade 6). Analogical misspellings were, however, less frequent by grade 6, possibly because the children had learned the actual spelling pattern and did not need to use analogy.

The orthographic image

Whole word recognition is mediated by reading experience. Only by exposure to words will recognition develop. For a word to be recognized as a whole, either correctly or incorrectly, there has to be a stored image in the lexicon to which the reader refers. As reading experience increases, so more items can be added to the lexicon in a form that allows for instant recognition. For those words which formed part of the pre-literate child's spoken vocabulary, there is already an entry in the mental lexicon which has a phonological, semantic and syntactic specification. When the child begins to read, an orthographic entry has to be added to this spoken word entry. It is claimed by Ehri (1980) that this orthographic image in the lexicon produces an amalgamation of the phonological, semantic and syntactic identities and provides an economical and efficient way of storing and accessing items in the mental lexicon.

There are certain pre-requisites for being able to form such an orthographic image. The child must be able to recognize the symbols and be aware of the link between specific letters and sounds. When children first begin to 'write' they will frequently use actual letters but these will bear no relation to the sounds the children claim to be representing (Gentry, 1982). At this stage, no orthographic image has been formed, nor can it be until the links between sound and grapheme have been acquired. Once the child begins to learn the correspondence between individual letters and sounds, it has then to learn that certain letter combinations, the 'functional spelling patterns' outlined by Venezky (1970), relate to individual sounds too. In turn, this knowledge of spelling patterns shared by groups of words allows for more efficient storage. The words can be stored as groups rather than as individual items. Glushko (1981) has claimed that there is an association in the lexicon between words which share the same spelling patterns. This is evidenced by delayed response times for the naming of words with a 'regular' spelling/sound correspondence, e.g. wave, which will be delayed because of the concurrent activation of a word such as have, where the spelling/sound correspondence is irregular. The stimulus activates all the words in the lexicon which share the same spelling pattern. If one spelling pattern can have more than one pronunciation, the conflicting correspondences give rise to a delay in response time. Similarly, in a lexical decision task, Taft (1982) claims that it is orthographic similarity rather than homophony with a real word that leads to increased reaction times to pseudohomophone stimuli. Both these claims reflect an assumption that an orthographic visual image of words is stored in the lexicon.

Further evidence for the salience of an orthographic image is provided by Campbell (1983) when she reports that auditory exposure to a particular spelling pattern in a real word, will act as a prime to the production of this spelling pattern in a non-word written to dictation. It would not be surprising if exposure to a visual representation were to trigger a particular spelling pattern. However, if the prime is a spoken word, which is not transcribed but still affects the spelling pattern, this would seem to indicate that an orthographic image had been activated. It is of interest to note that one subject in the study showed no effect of priming. This was a speech pathologist whose work was concerned primarily with the phonetic analysis of the language spoken by patients, with the subsequent correction of their errors. Here her concern was only with the sounds of the language. The spelling patterns would be irrelevant. This appears to have resulted in the 'normal' response being overridden. (Before one drew too firm a conclusion from this one should ascertain that the subject could indeed spell real, unprimed words.) It is important to emphasize here that the priming item was only heard, never seen. Subjects were required to listen to a mixed list of words and non-words and were instructed to write down only the non-words they heard. The priming was thus linked to the mental orthographic image and not to a physical representation of the written word.

In returning to Ehri's work, she found that from a very early age, the subjects she studied were able to use orthography as an aid to storing speech sounds in memory (Ehri and Wilce, 1979). Ehri found that visual spelling, as opposed to oral spelling, was the most valuable cue in the recall of nonsense words. This facilitating effect develops between the first and second years of reading instruction and was found to correlate highly with a child's word recognition skills. Further evidence that it was the visual orthographic image that had this facilitating effect was suggested by the salience of silent letters in recall tasks (Ehri, 1980). If anything, the children remembered better those letters which had no sound correspondence in the stimuli than those that did have one. In another task, children were taught to read non-words which followed one of two alternate spelling patterns (e.g. wheople, weepel). One half of the group were given one set of spellings for the words and the other half received the alternate spelling pattern. The children were then asked to write the words they had learned to read. Although they were not completely accurate, the subjects tended to preserve the spelling patterns of the stimuli. Thus, for example, all the wheople misspellings preserved wh-, and all the weepel misspellings began with we-. Phonetic factors also played a part in the children's efforts to spell the words, reflecting the process of amalgamation involved in the creation of an orthographic representation in the lexicon.

Although phonemic awareness is a prerequisite for fitting sounds to symbols in learning to read and spell, there is some indication that reading and spelling themselves also lead to an increased phonemic awareness. Phonemes do not exist as separate entities in speech but rather run into one another and are affected by other phonemes in their environment. When a child learns to spell and can form an orthographic image, the symbols allow it to conceptualize a word as a sequence of separate units. This can also be misleading to beginning readers, however, since they may overgeneralize and perceive, for example, three phonemes in rich, but four in pitch, where there is one more letter. Thus not only is phonemic awareness an enabling feature with respect to reading, but reading and orthographic awareness can also be enabling features with respect to phonemic awareness (Ehri and Wilce, 1980).

Formation of an orthographic image is not, of course, confined only to people learning to read and write in English. Nauclér's study of misspellings in the spontaneous written work of Swedish schoolchildren in grades 4, 6 and 12 leads her to a similar categorization of the process involved in learning to spell (Nauclér, 1980). She states that "lexical items are likely to be specified not only semantically, syntactically and phonologically, but also orthographically, and lexical access to words and morphemes in order to perform a written message might, therefore, be accomplished directly by means of an 'orthographic key'."

Nauclér's study looked at spelling errors in relation to the doubling of vowels in Swedish. At the grade 4 level, the children appeared to have only vague ideas about doubling and would overgeneralize and use doubling where it was not appropriate. However, by grade 6, there is a considerable decrease in non-required doubling. Nauclér accounts for this by proposing "that their visual recognition of words as units with certain spelling patterns or the recognition of permitted grapheme sequences as opposed to non-permitted (i.e. sequences never seen) has increased".

Earlier studies of Swedish spelling by Cederblad (1941) and Husen (1960), both cited in Nauclér (1980), came to the conclusion that poor spellers start out from "schemes which emanate from visual ideas". Löfberg (1960), again cited in Nauclér (1980) claimed, however, that spelling errors are caused by inaccurate generalizations from spelling patterns; a specialized skill is needed, i.e. "... the ability to retain and retrieve special patterns, and this is mastered by the good spellers." These two explanations are not necessarily incompatible. Good spellers would appear to possess and to have access to a fully specified orthographic image, the 'special spelling patterns' of Löfberg. They spell correctly and can recognize misspelled words. The poor spellers often utilize a spelling pattern which has some visual link with the correct spelling of the word. For example, in the instance already cited where <u>principal</u> was spelled <u>princaple</u> there is a connection with the visual appearance of the correct spelling; hence a 'scheme which emanates from visual ideas' but not the required 'special spelling pattern' which enables the correct orthographic representation to be produced.

Uta Frith (1984) has proposed an outline of the acquisition of orthographic awareness, which she sees as a three-phase process, somewhat akin to the Piagetian model of cognitive development where progression to the next stage entails the development of new strategies which are based on the existing ones. An important difference, however, is that in the Piagetian model, the later stage strategies supersede those of the earlier stages. In Frith's model of the development of orthographic awareness, progression to the next phase necessitates the development of new strategies, but these strategies may co-exist with earlier ones, and, in fact, must do so when the learner has to interpret novel stimuli.

The three-phase model is built up as follows:

Phase I is characterized by the child's instant recognition of individual familiar words. Frith terms this the logographic phase. At this stage the word is recognized as an unanalyzed whole. Phase II, the alphabetic phase, is the stage when the child begins to recognize that there are grapheme-phoneme correspondences in the language, and that a particular letter can be used to represent a particular sound. Phase III, termed the orthographic phase, occurs when the child has internalized the orthographic representations which go beyond the simple grapheme-phoneme correspondences, and which are used for lexical recognition in reading, and for spelling the words produced in writing.

This three-phase process reflects the normal developmental progression towards the acquisition of the skills associated with literacy. However, the progression may fail, reflecting a breakdown at any one of the three phases. Failure to progress beyond phase I is likely to reflect difficulties with processing spoken language. If the child is unable to analyze spoken language adequately, it will be very difficult for it to associate an acoustic image with an alphabetic representation. However, work with deaf subjects has shown that knowledge of linguistic structure is not necessarily linked to the ability to produce spoken language in a form that a listener can understand. In a study by Hanson et al. (1983), which examined "to what extent the acquisition of linguistic principles in orthography is dependent on the spoken language", although it was found that "good spellers, more than poor spellers, were found to make use of linguistic regularities to spell words", some good deaf spellers had virtually incomprehensible speech. There was little correlation between reading and spelling ability for either deaf or hearing subjects. In the main, deaf subjects read at a lower level than did the hearing subjects. There were, however, a number of deaf subjects whose spelling ability was greater than their reading ability, which is not usually considered to be the case with hearing subjects.

At phase II, failure to progress is related to a failure to process visual language adequately. Too great a reliance is being placed on the basic alphabetic principles of single grapheme-phoneme correspondences and the orthographic principles, where units larger than a single grapheme correspond to a phoneme, are not acquired. In a language with a shallow orthography, such as Serbo-Croat, or Finnish, where the alphabetic and orthographic representations are identical, phase II would presumably be the end of the progression. In English, of course, this is not so.

Phase III initially entails considerable effort on the part of the child, but once the use of the orthographic principles of the language is acquired, it becomes automatic. However, if it is not attained, the child has to rely primarily on the alphabetic principles of the previous stage, which will adequately represent the sounds of the words, but will not necessarily produce the correct visual representation. This end phase corresponds to some degree with Ehri's amalgamation theory of word recognition, though Frith deals solely with the orthographic image per se, and does not discuss its role in the lexicon as a substitute for individual syntactic, phonological and semantic images which have been formed by the pre-literate individual.

Orthography and the mental representation of language

Knowledge of the spelling patterns of words forms part of the child's (and the adult's) mental representation of language. Good spellers appear to possess and to have access to a fully specified orthographic image which they can use in writing a word. The formation of, and access to such images would account for Glushko's findings (Glushko, 1980) and those of Taft (Taft, 1982). Access to such spelling patterns will also contribute to the ability to read and spell non-words analogously. The real word image provides a model for the non-word spelling. Poor spellers, lacking this fully specified image, or possibly lacking access to it, have to rely on a phonological strategy, inaccurately relating the spelling pattern to the word, producing, in most cases, possible, but incorrect representations of the words they cannot spell. Studies to be cited below will show this to be the case, at least in English, in all but some neurologically damaged or language disabled children. Phonologically acceptable errors make up the large part of the error corpus for both good and poor spellers. In Swedish, too, Nauclér claims that a strong phonological influence is present in the errors made by the older children in that in "only those misspellings that do not

1) alter pronunciation if the word is read aloud

2) shift the stress pattern of the word

3) result in non-permitted grapheme sequences

do the errors fail to decrease with increasing education and experience." In other words, the errors that do persist are phonologically, and orthographically possible.

Spelling has tended to be regarded as one of the subskills that developed naturally as the child learned to read. Recent work indicates that although orthographic awareness is indeed one of the subskills, it also has some far-reaching psycholinguistic implications as regards the development of metalinguistic ability in both first and second language learners, and even has relevance as an instrument of phonological change in a language. For example, Levitt (1978) claims "that the influence of orthography on phonology has been a significant factor in the development of Western European languages, of much greater importance than has generally been admitted by linguistic scientists." She cites such influences as Greek and Latin loanwords; relatinization of words leading to a change in pronunciation (as when parfitte was reanalyzed and reformed on the Latin model, so becoming perfect); phonemic distinctions which are not reflected in the orthography may disappear, as has been the case with close and open e in Italian; and orthographic distinctions may lead to a phonological distinction as in the case (in Britain) of the minimal pair whale/wail - a distinction which used to be confined to northern England, Scotland and Ireland.

Bentur (1978) in a study of literate and pre-literate speakers of Modern Hebrew found that literate speakers were more consistent in their ability to produce possible, but non-existent, derived forms from actual lexical items than were the pre-literates who had no orthographic image to cue them as to which possible derived form was the most likely. Bentur points out that this reference to orthography is optional rather than automatic, but it is an indication that orthographically based phonological rules may reflect a part of the literate speaker's mental representation of the language and should not be overlooked.

It has indeed been claimed (Elliott and Needleman, 1976), that "written language abilities may be innate, i.e. they are not produced by learning and experience but are only activated by learning and experience." If this were indeed the case, it would be reasonable to claim that orthography is an essential constituent of the mental representation of language among literate speakers.

There is some evidence that the type of orthography (whether shallow or deep) of a language may influence certain psycholinguistic processes. In a study which examined the possible coding differences in lexical decision tasks between the users of a language with a shallow orthography (Serbo-Croat) and users of a language with a deep orthography (English) it was found that a phonological code was more efficient in accessing the lexicon for the Serbo-Croatian readers, who say what they see, whilst for the English-speaking subjects, a direct visual code, rather than a phonological code was more efficient (Katz and Feldman, 1981; 1983). It was also found that using a direct visual code was a strategy employed by the mature, skilled readers of English, whilst the younger (grade 5) English speaking subjects appeared to prefer a phonological code. It thus appears that at some point between grade 5 and adulthood, a shift in strategy takes place.

In an orthographically shallow system, the phonological and visual levels of analysis will be identical, or virtually so. In a deeper morphophonological system, such as that of English, this will not necessarily be so. It is therefore advantageous, or even essential, for phonologically accessed items in English to be monitored by a direct access route. An indication that this appeared to be taking place was given in one of the tasks carried out in the present study. When presented with an unfamiliar word in a naming task, the initial response was to access the word phonologically, but some direct visual checking process also seems to be at work. For example, the word colonel proved to be a very difficult word for most of the subjects tested in the study. The children would, typically, start to sound the word out, using a one-to-one translation of grapheme to phoneme, resulting in [kəlonəl]; the older, more skilled readers would then correct this response, as a result, it seemed, of eventually accessing the word by the direct visual route.

Although it is usual to regard English orthography as confusing, at best, with regard to its use as a guide to the pronunciation of the language, it has been suggested that for second language learners, there are rules linking the orthography and phonology of English, which far from hindering foreign speakers, may even be used by them to predict the correct pronunciation of the language (Dickerson, 1978; 1980). Encouraged by the claims in SPE with regard to the English orthographic system being optimal for the language, Dickerson examines just what the learner needs to know in order to be able to predict pronunciation from orthography. The two critical factors appear to be the stress pattern of a word, and the vowel quality of its components. In the SPE system of stress assignment, the rule applies to an underlying form whose vowel quality is already specified. However, for the learner to predict vowel quality from the spelling, the stress pattern must be known. The circularity of these conditions is obviously unhelpful to the language learner. Dickerson claims, however, that this circularity can be broken.

Whilst stress allocation rules in technical linguistic treatments may depend upon vowel quality being known, for non-native speakers of the language, Dickerson proposes a set of non-technical rules which rely on the spelling pattern of two key syllables in the words in question. Dickerson claims that since the learner is thus able to place stress by use of a spelling configuration, rather than by use of vowel quality, and "because English has such a good orthographic system, learners can make accurate stress and vowel quality predictions using no more than the conventional spelling of words as a basis."

The foregoing provides some indication that orthographic knowledge may play a larger role in the mental representation of language than had been assumed in the past. There are a number of reasons for spelling ability having been categorized as being of peripheral importance. First, as already noted, a spelling deficit does not present as great a handicap as does a reading deficit. Second, spelling ability would appear to be something one either has or does not have. In the case of most children, it seems that the good spellers spell correctly with only minimal effort once the orthographic principles of the language have been acquired, whilst the poor spellers, even with maximal effort, continue to be poor spellers.

It is of interest that these poor spellers can be further divided into those with reading problems and those without. Since in a literate society, the inability to read will be a considerable hindrance, of much greater effect than the inability to spell, effort is expended on trying to improve the reading skills of the disabled, and the spelling skills are usually dragged along in the wake of this effort. Those who do not appear to have reading problems, and are thus able to function reasonably well, consequently do not demand as much time and attention for their spelling problems from their teachers. In addition to this, or perhaps because of it, these children can also learn to develop strategies to cope with their spelling difficulties. These can range, as already noted, from avoidance of words they find difficult, to learning to use a dictionary, to a decision, whether conscious or not, to pursue a course of studies, or a career, where writing is less important.

In a study carried out with a group of psychology students (Cox, 1978), who were divided into good and poor spellers, it was found that males who received a high score on the quantitative (math skills) section of the Scholastic Ability Test (SAT), received lower scores on the spelling test they were given. The students were further classified as sensitizers or repressers. (Sensitizers are defined as 'obsessive-compulsive' individuals who intellectualize and attempt to control anxiety-arousing stimuli and situations. Repressers, on the other hand, are impulsive and avoid anxiety-arousing stimuli and utilize denial and rationalization to deal with situations (Byrne, 1961; 1964).) Those classified as sensitizers were also found to be superior in spelling ability. The poor spellers thus tended to be males with high mathematical ability who were classified psychologically as repressers. Spelling thus appeared to be related to personality, and on these grounds, the poor spellers might well be likely to avoid the possibly anxiety-arousing situation of being expected to be able to spell correctly by channelling themselves into a field where their mathematical ability would outweigh any other shortcomings. It is to be noted, however, that a marked lack of spelling ability does not absolutely preclude individuals from pursuing courses of study where spelling skill would be desirable. Perhaps denial overcomes avoidance in such cases.

Defining the problem

The sub-group of poor spellers who have no apparent problems in other areas of literacy present an interesting area of study for those interested in the acquisition of the skills necessary for the development of literacy. As evidenced by work with brain-damaged patients, the partial breakdown of language skills may be the most rewarding source of information on what factors go to make up the 'normal' undamaged system. If one is to study how literacy skills develop, it is not necessarily revealing to study only the skilled readers and writers. Nor, on the other hand, is it always useful to study those cases where all aspects of literacy skills are at a level lower than would be expected. In such cases, it may be difficult to separate out which factors are causal and which correlational.

However, if one has a group which is only partially disabled, as are the children who read well but spell below grade level, it may be possible to use this dissociation to determine just what is involved in writing words down on paper, as opposed to what is involved in reading these same words. Breakdown in one modality, without an apparent parallel breakdown in the other, indicates that reading and writing are not merely mirror images of the same process, but are rather two separable, but related, aspects of one process. It is the intention of this study to examine this discrepancy in a group of elementary school children in grades 3, 4 and 6 who read at or above grade level, but whose level of spelling ability is considerably below this level of achievement.

Although an awareness of spelling problems is not new, in the past there has been a tendency to associate such problems with a generally low overall level of scholastic ability, or even as recently as 1980, to link spelling problems to "poor teaching and a comic-book habituation" (Mosse, 1980). If it were really the case that all problems could be laid on the shoulders of incompetent teachers one would expect to find whole classes who were unable to spell. This is not generally the case. Rather, one finds a wide range of ability in most classes, with a few students at each end of the spectrum of ability, and with the majority clustering at a mean close to the actual grade level norm.

One of the first considerations to be taken into account is to determine how the group of good readers/poor spellers differ from their peers who can both read and spell adequately. Obviously, the poor spellers make more errors, as measured by standardized spelling tests. Apart from the number of errors, however, one needs to examine what types of error are made and whether there is any difference between the poor spellers and the good spellers in this respect, or whether the poor spellers merely form the low end of the continuum of spelling ability, with no other differences being apparent. A number of studies have examined these questions.

Hollingworth (1918) claimed that for the poor spellers she studied, there were some who differed in degree but not in kind from their peers who were good spellers. They were simply at the low end of the continuum for spelling ability and did not suffer from a 'special disability' with regard to spelling.[1] On the contrary, she noted that 80% of the poor spellers had some other reason for spelling poorly. These other reasons included general intellectual weakness, lack of interest, distaste for mental drudgery, intellectual inertia, previous learning in a foreign language, sensory defects and bad handwriting. It is possible that there is some confusion between cause and effect in this list since an inability to master spelling skills could well lead to a lack of interest, distaste for mental drudgery that produced no results, and intellectual inertia. Bad handwriting, even now, is one strategy adopted to conceal a lack of knowledge of how words are spelled (Frith, 1984), although good spelling is not necessarily associated with good handwriting.

Gates (1922) in reviewing Hollingworth's findings concludes that Hollingworth believes the basis of 'special disability' "...is to be found in the function of the central nervous system", but disputes the validity of this belief. He writes, "It is difficult to picture the neurological condition which might underlie the inability to form the particular connections involved in spelling, when the subjects can read and perform other verbal functions without difficulty." Gates does not dispute that there are individual differences in spelling ability, or that some types of learning disabilities may well be caused by a malfunctioning of the central nervous system. As is now well documented, dissociations in reading and writing ability after brain injury do indicate that damage to certain areas of the brain can lead to an acquired reading or spelling deficit. However, this is not to claim that poor spellers are brain-damaged. A cognitive deficit of some sort is apparent, but there is, as yet, little conclusive evidence that links this with a specific neurological deficit. Nevertheless, it is possible that the deficit may be linked to some inappropriate cerebral organization. (Inappropriate, that is, for effectively performing this particular task.) An inappropriate reliance on one or other cerebral hemisphere has been shown to be linked to certain sub-types of developmental dyslexia. It is thus not impossible that a spelling deficit might also be linked to a similarly inappropriate strategy.

The same difference in degree but not in kind as observed by Hollingworth is noted by Holmes and Peper (1977) in their examination of the spelling ability of normal and retarded readers. Boder (1973) had claimed that spelling patterns of dyslexic readers could be used diagnostically to indicate the type of reading disability present. Holmes and Peper, however, found that their retarded readers (aged from 9:0 to 11:11) had an almost identical pattern of errors to that of normal readers in grade 5 and differed only in that they made many more errors. Holmes and Peper suggest that possibly by this age, the more divergent patterns have been eradicated. It is Boder's claim, however, that the error patterns are, in fact, enduring ones.

Whiting and Jarrico (1980), in contrast to this, carried out a study of the spelling error patterns of <u>normal</u> readers in order to validate Boder's claim that there was, indeed, a 'normal' spelling pattern for 'normal' readers. Boder had claimed (1973) that normal readers can spell 70-100% of their sight vocabulary correctly and that 70-100% of their errors will be good phonetic equivalents (GFE's). Whiting and Jarrico found that when presented with words at grade level to read and spell, children in grades 3, 5 and 6, on average, spelled 80-91% of the words correctly, with no child getting less than 65% correct. The highest number of correctly spelled words was for grade 3, as was the highest number of words read correctly. The GFE's were 90% in grade 3, 75% in grade 5 and 82% in grade 6. The higher scores in grade 3 probably reflect, at least in part, the regularity of the words to be spelled and read since these become increasingly irregular as the grade level increases.

Kinsbourne and Warrington (1964) when looking at two groups of children with cerebral cortical deficits who also showed a verbal/performance IQ discrepancy found that those children with a higher performance than verbal IQ spelled less well than they read, and also spelled in a more deviant manner than those with a higher verbal than performance score. However, both groups were retarded, and both had neurological deficits. As Kinsbourne and Warrington point out, these groups probably represent only a very small minority within the population of retarded readers and writers.

Nelson and Warrington (1971) compared reading and spelling retardates and spelling only retardates. The former group made more phonologically inaccurate errors than did the latter group. Furthermore, this pattern remained the same at the absolute levels of spelling achievement indicating that the problem is not just a unitary lag in a developmental sequence. This finding may be compared to the results of a large scale study performed by Satz and Morris (1981) which showed that the language deficits of the children studied were also not merely the result of a developmental delay but reflected, rather, a permanent dysfunction.

Nelson (1980) looked at the spelling abilities of normal and dyslexic readers from the point of view of what types of error were made. Nelson took three popular and prevailing theories accounting for dyslexia: that it is a sequencing problem, that it is the result of an impairment of the visual perception and/or analysis of the written word, or that it is the result of a deficiency in the auditory process. The word list given to the children to spell was analyzed for order errors, orthographically illegal errors (visual analysis) and phonologically inaccurate errors (auditory analysis). When the first twenty errors made by both normal and dyslexic children were analyzed, virtually the same pattern of errors was observed for both groups. The dyslexics did make more phonologically inaccurate errors than did the normals, but the proportion was still low, and the majority of their errors were phonologically plausible, as were those of the normals. There were very few order errors and although the dyslexics made slightly more orthographically illegal errors, this was not significant even at the ten per cent level. This examination of spelling ability thus demonstrates that at least three of the popularly held beliefs about what constitutes the problem in dyslexia are unfounded, and that with regard to spelling ability, the types of error made by dyslexic readers are virtually the same as those made by normal readers.

Another study which examined sequencing ability and spelling was carried out by McLeod and Greenough (1980). They found that in Short Term Memory tasks given to good and poor spellers, although the good spellers showed a superior immediate gross memory for linguistic stimuli (i.e. they were better able to recall all the items given, whether in order or not), there was no difference in sequencing ability over and above the gross memory advantage of the good spellers. However, the good spellers were much better able to exploit sequential redundancy than were the poor spellers. This may be reflected in their superior spelling ability in that the good spellers are more aware of which letters go together in particular words than are the poor spellers who have been unable to internalize this redundancy and are therefore unable to exploit it. The children in this study consisted of the best and the worst spellers in each grade studied, but with no other abilities being taken into account.

Frith has been one of the first to examine the problem of the unexpectedly poor speller, the good reader who cannot spell. In Frith (1980) she looked at three groups of children: good readers/good spellers; good readers/poor spellers; and poor readers/poor spellers. The errors made by the first two groups were found to be very similar in that the errors they made were consistently phonologically accurate, whereas the third group, whose reading and spelling were both lower than would have been expected, made inconsistent and phonologically unacceptable errors.

Perin (1983), however, found that in a group of slightly older children divided into the same three types of groups, 67% of the errors made by the good readers/poor spellers were phonologically inaccurate, whilst 56% of the poor readers/poor spellers group's errors were of this type. The first group, the good readers/spellers, made too few errors overall for them to be classified in this way.

In a previous study (Perin, 1982), which involved school leavers and adult literacy students, Perin had found that the good readers tended to make phonologically acceptable errors, whilst the poor readers tended to make more phonologically unacceptable errors. Perin takes this to indicate that the poor readers either tended to rely on the general visual appearance of the word, or did not have sufficient knowledge of the rules relating graphemes to phonemes.

Similarly, Carpenter (1983) in a study of the spelling error profiles of able and disabled readers found that disabled readers produced more phonologically incorrect errors overall, and produced more unrecognizable errors than did children of the same age who were not disabled readers.

However, when compared to younger children of equivalent reading ability, a greater degree of similarity was found.

One other factor that has been considered in relation to children's spelling ability is that of word class, and whether there is a difference with regard to the closed, as opposed to the open class of words. (Closed class words are those words which belong to the class of grammatical words, the 'little words' of the language, prepositions, conjunctions, etc. By its nature, this class is closed and very rarely gains any new members, though members may fall into disuse and be lost. The open class, on the other hand, is made up of those words which have a greater degree of representational meaning. By its nature, this class is open-ended and may have new words added to it.) There is clear evidence that these two classes do have a psychological reality beyond the imagination of the linguist. For example, children learning to talk first use open class words, and later add members of the closed class (Brown, 1973). In addition, some brain-damaged patients with language deficits may display a differential loss with regard to the two classes, both in oral and written language. This difference may, however, also be related to access, or lack of access to abstract as opposed to concrete concepts (Bradley, Garrett and Zúrif, 1980; Morton and Patterson, 1980).

In view of this, Bruskin and Blank (1984) examined the spelling ability of two groups of subjects, one from grade 3 and the other from grade 5. The children were given a list of 16 nouns, 16 verbs and 16 non-content (closed class) words to spell, and their performance on the different types was compared. It was found that "non-content words were consistently more difficult than the nouns or verbs". However, interesting as this finding is, it should be noted that this study was unable to take into account the orthographic irregularity of the words spelled and a large number of the non-content words in the language also rejoice in some of the more improbable spelling patterns of the language.

In the present study, although several non-content words were included in the various word lists used, there are not enough for any useful comparison to be made.

From the findings of these researchers then, it appears that children who are good, or average readers, will, in general, make the same sort of spelling errors. The words they misspell sound correct, but fail to conform to the conventions of the English orthographic system. The picture for the poor, or below-average readers is less clear. Some researchers find they too conform to the normal pattern, differing only in degree (Holmes and Peper, 1977; Hollingworth, 1918; and Nelson, 1980). Others have found that retarded readers will also differ in the type of error they make (Frith, 1980, for otherwise normal children; Kinsbourne and Warrington, 1964, for neurologically impaired children; Carpenter, 1983, for reading disabled children; and Nelson and Warrington, 1971, for reading and spelling disabled children compared to spelling only retarded subjects).

The problem then remains to examine in what way the children who cannot spell differ from their peers, to investigate whether possibly giving them a different strategy for spelling might help the retarded spellers, and to speculate where in the process the problem arises which allows a child to learn to read adequately, or even very well, but which prevents the same child from being able to write down correctly those words which present little or no problem for children of the same age or level of achievement.

Formulating the model

In order to examine where the literacy skills break down, as they do in the case of the good readers who are poor spellers, it will be necessary to formulate a model of the unimpaired system so as to be able to indicate where the process may fail.

A child learning to read and write has already established a grammar of spoken language which has now to be expanded in order to incorporate the new information. It must also add what it is learning about written language to its mental representation of spoken language. This might be considered to be an easier task than learning to talk. The symbols in reading and writing are discrete and concrete. However, it must be borne in mind that the discrete, concrete symbols have to be mapped onto an phonological representation of the intangible, non-discrete stream of speech sounds.

In learning to deal with the world around it, the child has already had to solve numerous cognitive problems. Language learning, whether spoken or written, is just one more problem the child has to solve. One of the strategies the child has applied to solving cognitive problems, including learning to talk, is to extract regularities, and to generalize from them. This same process may appropriately be applied to learning to read and write. However, prior to any problem solving taking place, the problem has to be encoded in a form appropriate for manipulation by the intellect. That is, the concrete aspects of the problem have to be given some abstract representation. Consequently, it is claimed that in dealing with the problem of solving the relationship of written symbols to language, or relating spoken language to writing, the preliminary step taken is to make an abstract auditory or visual feature analysis which allows the problem access to the computational processes of the brain, which can thus deal with an abstract representation of perceived reality.

The model is intended to represent the process of both reading and writing, and to show the relationship between the two. However, in the interests of clarity, reading and writing will be dealt with separately, and we shall begin by looking at the model as it relates to reading (Figure 1).

The child has already developed a pattern recognition mechanism in its dealings with the world around it. The ability to extract, to encode and to store the abstract features necessary for recognition has been functional for some time, and most children are able to apply this skill to dealing with written language structures. There are reports of children as young as 12 months of age being able to recognize letters and even a few words, though they are not able to say either the words or the letters (Steinberg and Steinberg, 1975). However, this ability usually develops somewhat later for most children. Just what visual features have to be extracted to make an abstract feature analysis is somewhat difficult to determine, but it is likely that it will incorporate information about such things as word length, general shape of words and letters, etc.

In the early stages of learning to read, this abstract analysis may lead to the formation of specific, whole word images. For example, the names of soft drinks or cereals may be able to be read only in the type face with which they are most commonly associated. The images of the words have not been incorporated into the system but exist as individual items. A similar lack of generalization was demonstrated by the small girl who had learned to read two words by the sounding out method. She proudly displayed her knowledge, claiming that she could spell two words, [kə] [æ] [tə] spells pig and [pə] [I] [gə] spells cat. The items were stored, but not in a usefully systematized form. This initial acquisition of unanalyzed items can also be seen taking place when a child first learns to talk. Words learned in the early stages of acquisition may sound much more adult-like than they do as the child develops a phonological system of its own and fits words into it. These early words are what Moskowitz refers to as 'phonological idioms', unanalyzed wholes which are external to the system (Moskowitz, 1970). It is reasonable to assume that a similar process may take place in the very early stages of the acquisition of written language.

Once the abstract feature analysis of the stimulus has been made, the output from this analysis is passed to the central orthographic image component. If a matching image is activated, this in turn is encoded and sent to the response buffer for appropriate action.

The concept of the orthographic image was discussed above (page 19). In acquiring spoken language the child has already constructed a phonological, syntactic and semantic representation for all the items in its vocabulary and has now to add a further representation, an orthographic specification for all these items. Since the capacity of the brain is finite, an amalgamation of the written and spoken representations would make more economical use of the available capacity. This is what is involved in the formation of the orthographic image as proposed by Ehri (1980). The orthographic image amalgamates visual information with phonological, syntactic and semantic information, encoding the whole in an orthographic representation used for recognition in reading and for production in writing. The whole of the stored linguistic information is thus accessed by the activation of a single unit.

The question then arises as to whether this orthographic image is in fact part of one system serving both reading and writing, or whether there is one image for reading and one for writing. The uncertainty arises because the requirements of each activity, although related, do differ. To read, a partially specified image will suffice. Subjects can read degraded text with reasonable ease (Frith, 1980), and quite glaring errors can be overlooked when proof reading. Recognition, then, can come from partial cues, and it is probable that in skilled, fluent reading, only partial cues are accessed. Letter-by-letter reading would be very slow and inefficient. However, fully specified images are available for reading. Glaring errors are not always overlooked but will spring out of the text and halt the fluency of the reading process. The routinely accessed image may thus be a partially specified one which facilitates fast, and efficient recognition and processing of the written stimuli, but underlying the 'working image' is a fully specified one which runs a check on the routine functioning of the partially specified one. This fully specified image is also the one which is used to generate written words. Thus a single, two-level component may serve both systems of reading and writing.

In the very early stages of learning to read, the feature analysis performed by the child may give a generalized representation of the whole word which is sufficient for recognition, but which may also be general enough for false recognition to take place. If a new, or less familiar word being read has enough features in common with the stored representation of a more familiar word, an incorrect response may be generated, particularly if the child has not yet grasped the relevance of serial ordering. This would account for the frequent confusion between words such as was/saw in beginning readers. In the beginning reader, an incorrect analysis may provoke a response because the system has not yet stabilized and the thresholds are not fully established which will allow only a correct response to be generated. The stability will come with increasing exposure to reading and writing. (The concept of a threshold to be exceeded is based on Morton's logogen model (Morton, 1980), where a stimulus provokes a response when there is sufficient activation of the components of the entry for a particular word to reach a threshold, and for the word to be then passed to the response buffer which will enable it to be produced in the appropriate form. This aspect of processing will be dealt with in further detail below.)

The child will eventually learn that guessing at the words is only a partially adequate strategy for reading and it will then be combined with a letter-by-letter analysis of new words, which will also allow for the formation of a fully specified image. As reading experience increases, the two aspects will become integrated, allowing for fast access via a partially specified whole-word representation for reading, but with a fully specified image available for writing words that are in the child's sight vocabulary, and for monitoring the reading process.

It is obvious that actual orthographic images cannot be formed until the word has been encountered in written form. New words, and nonsense words, will thus have to have available an alternate route for processing. The most likely route would appear to be a route which involves the use of grapheme-phoneme conversion rules, as proposed by Coltheart (1978). This route runs parallel to the normal word recognition route which contains the lexico-semantic information, as well as a phonological specification. (This 'normal' route goes via the orthographic image component in the model being presented here). It is also suggested that although the new and non-words have no entry in the orthographic image component, there is a partial activation of similar entries in this component, which distinguishes this model from the one presented by Coltheart. The activation of such images is insufficient for them to reach threshold and be sent to a response buffer, but is sufficient to make these additional cues available to reinforce the GPC (grapheme-phoneme conversion) response.

Marcel (1980) has claimed that the normal, lexical route is, in fact, the only route and the analogous entries generated are sufficient for interpretation of all words, be they known, new or nonsense words. Although this would make for a more parsimonious system, it is difficult to demonstrate that NIST, for example, is being read by analogy with MIST, or NEST, as opposed to being parsed into graphemic units and converted into phonemes.

In support for the existence of a parallel non-lexical route, there is evidence to suggest that some adults with acquired reading problems following brain damage, are using a GPC route to read. In surface dyslexia, the patient reads regularly spelled words better than irregularly spelled words, reading <u>sew</u>, for example, as [su], on the model of the much more frequent correspondence as found in <u>new</u>, <u>blew</u>, <u>few</u>, etc. According to Coltheart (1984), using the GPC route "... permits correct reading of regular words, but produces regularizations in the reading of irregular words, since the GPC stage uses the most common orthographic phonological correspondences of English. Stress errors will also result from the use of the GPC route because, for many English polysyllabic words, there is no rule which correctly predicts stress: knowing what stress to use depends on knowing what the word is, and such word-specific knowledge is not available when the GPC route is used to read aloud." In this particular form of acquired dyslexia, spelling ability is also impaired. The errors, however, are typically phonologically acceptable, as would be the case if the GPC rules were being used. Some of the errors, however, suggest that there may be some input from the 'normal' orthographic image component; for example, hydraulic was spelled highdrolic; [hai] appears to have activated the irregularly spelled lexical item high, which has no connection with hydraulic, other than phonologically. It may also be possible, of course, that high, although apparently irregular, may be the most frequent orthographic representation of [hai] in the English language, and as such would be the most likely form for a surface dyslexic to choose. On the evidence of this one example, however, either speculation is equally valid.

When one looks at the surface dyslexic's performance, it is counter-intuitive to suggest that a GPC route would have been generated, de novo, in the damaged brain. Rather, it is preferable to claim that when access to the lexical route is impaired, the reader falls back on the secondary GPC route which has always been there, playing a subsidiary role. It is thus proposed that if there is no orthographic image for a stimulus, the GPC route is available for interpretation.

Before turning to the writing side of the model, it may be useful to review the process so far proposed. The reader, faced with a written word, first performs an abstract feature analysis of the stimulus. The output from this is then passed (a) to the central orthographic image component, and at the same time, (b) to the GPC conversion component. If the input can be matched to a stored image in (a), a response is activated which is encoded and sent to the response buffer for appropriate action. At the same time, the output from the abstract visual feature analysis has also been passed to the GPC component. Route (a) will normally be faster than route (b). However, in the case of infrequent words, the GPC route may produce a response before the orthographic image component can do so. It is assumed that since infrequent words have a longer latency in naming tasks, there must be some hierarchical organization within the central component. In the case of new, or non-words, for which no orthographic image is stored, only the GPC route will produce an overt response, although partially activated responses, below threshold, in the orthographic image component may influence which particular GPC is actually selected. Whichever component arrives at a response first, this will be encoded and passed to the response buffer for appropriate action.

When one comes to writing the words of the language, it is proposed that, again, an abstract feature analysis is carried out, whether it be of a word to be written to dictation, or of a word generated within the mind of the writer. The output of this abstract feature analysis is fed into the orthographic image component where the phonological and lexico-semantic components combine to produce the orthographic image of the word, which can then be passed to the response buffer and can be translated into the appropriate written form. In the case of unfamiliar, or non-existent words, there will be no stored image and the phoneme-grapheme conversion route will be brought into play. As in reading, there may be partial activation of the phonological and semantic entries associated with similar words and these may influence the decision as to which PGC rule to select (as was suggested in the case of hydraulic above). This factor may also account for the finding that good spellers, when spelling non-words, are both conventional and consistent, between trials and between subjects (Frith, 1980). Activation of the real word orthographic images influences the selection of the particular phoneme-grapheme conversion rule chosen. A previously activated orthographic image may also prime a non-word spelling, as was found by Campbell (1983).

It is proposed that the foregoing represents what takes place when subjects with average or good ability read and spell. Since it has not been the concern of the experimenter in this instance to examine the failure in the process that leads to a deficiency in reading skill, this aspect of literacy will not be discussed here. The problem with which the present enquiry is concerned is that of a partial breakdown in the acquisition of literacy skills, where the subjects appear to be average or good readers, but appalling spellers, the 'unexpectedly poor spellers', as Frith has categorized them. A child who reads at least a grade above the average level of achievement for its age group is not having any difficulty relating visual stimuli to language. However, if the same child is spelling one grade or more below the expected level for its age, it is evident that the child does not have a full command of the skills associated with literacy.

In order to account for this discrepancy, it is suggested here that at a crucial stage in the child's development of reading and writing skills, the 'unexpectedly poor speller' fails to acquire the ability automatically to make a dual entry in the orthographic image store. As has already been outlined, the dual entry consists of a partially specified working image sufficient for reading recognition, together with a fully specified image needed for monitoring reading, and also for generating written words. Normal reading is possible using only a partially specified image. With a partially specified image, it is feasible that more than one possible response could be generated. However, context of the passage being read will eliminate most of the inappropriate candidates. Proof-reading requires the use of a fully specified image, of course, but this is a specialized aspect of reading, and one may read for pleasure and for information without ever proof-reading. However, a partially specified image is not adequate when it comes to writing. For this, a fully specified image is necessary. The formation of this fully specified image has probably become automatic at an early stage in the process of learning to read and write, but failure to form the dual image will not become apparent until the child is expected to write irregularly spelled words.

In the early stages, children are expected to be able to read and write regularly spelled words, words, that is, that can be spelled using phoneme-grapheme conversion rules. Spelling deficits in the early grades are likely to be apparent primarily in those children who have other linguistic and cognitive deficits and are unable to grasp these rules. By the time they are expected to be able to spell more irregularly spelled words, the unexpectedly poor spellers have not established the correct strategy which would enable them to do this. That is, they have not learned to form a fully specified image of the words they read. Consequently, they continue to rely on the PGC rules which have worked in the past, but are singularly, or more particularly, plurally inappropriate for writing English words. Because of their reading experience, these children do build up some word-specific associations for these rules. For example, they know that certain words in English have (unspecified) silent letters in them, and conversely, that certain letters can be silent in English. This explains the reasoning of the 10-year-old who asked if there was a silent b in castle. Castle is one of the silent letter words, and b can be one of the English silent letters (as in subtle, and tomb, as he pointed out). Unfortunately, the two factors do not coincide in this instance. This knowledge also accounts for such spellings as coulf for cough. Cough may be labelled in the lexicon as being unusual in its spelling pattern, possibly as being one of the troublesome -ou- words. It also has a silent letter, and ends in [f]. Without a fully specified orthographic image to refer to, coulf is as good a way as any for a grade 3 or 4 student to spell the word. The pattern certainly looks no more deviant than does the orthographically correct version.

Failure to form a dual image - a partially specified one, plus a fully specified one - will not hinder these children in reading. A partial image may give them very fast access to the lexicon and thus time to make efficient use of context to resolve any ambiguity in possible responses generated by the partial image. It will not, however, enable them to be efficient spellers. Speed of reading is not necessarily associated with the formation and storage of only a partial image. There are fast, efficient readers who are also excellent spellers. Why these children (and adults) should have acquired the ability to abstract and store enough information to give them both a partial image and a fully specified one, whereas the others, with an equivalent educational background and overall level of cognitive ability have not done so, is difficult to understand. One of the aims of this present study is to try to see whether there are other differences separating the groups which might contribute to this deficit.

The proposed model is closely linked to current modes of thought in relation to the processes involved in reading and writing, differing primarily in emphasis. These related models are essentially modular in structure, reflecting the componential, non-unitary nature of the processes. The theory underlying current models is primarily a reflection of research carried out in the field of acquired deficits in reading and writing. Marked dissociations are frequently found in patients with such deficits, thereby indicating that there can be a breakdown in one or more components, resulting in different patterns of residual ability. This 'boxology' approach (the models consist of boxes linked by arrows), exemplified most clearly in Marshall's models of acquired dyslexia (Marshall, 1984), can also be applied, with profit, to the study of the developmental deficits of literacy.

The application is less clear-cut in developmental deficits since these tend to be more general than do some of the acquired deficits that have been described. An acquired deficit is frequently very specific in its effect. This is as would be expected. An acquired deficit affects a mature, fully-developed system, whilst the developmental deficit reflects failure to mature and develop. However, findings from the study of both acquired and developmental deficits are complementary and insights in both fields can be gained from consideration of the other. One further difference between the acquired and developmental studies of dyslexia is that in patients with acquired deficits, it is very often possible to demonstrate by use of sophisticated scanning techniques, or at autopsy, that the deficit is associated with a lesion to a particular area of the brain. This is less frequently possible with the otherwise normal child who has a reading or writing deficit. Overt lesions are not usually present and one cannot thus justify routine scanning of school populations, even were the facilities available. In addition, very few known developmental dyslexics have so far come to autopsy, although the 2 reported cases do suggest the possibility of anatomical abnormalities. However, in view of the wide range of variation in the anatomical structure of the 'normal' brain, it would be premature to draw conclusions from only two cases.

However, in spite of the differences between acquired and developmental dyslexias, as has already been indicated, it is unlikely that brain damage would lead to the development of a totally new system that just happens to be deficient, for example, in the ability to read or write some particular class of words. It is much more probably that it is what remains of the previously intact system that is unable to perform certain of the operations necessary for normal reading and writing. Consequently it is felt that the descriptive and predictive adequacy demonstrated by the 'boxology' approach to the acquired disorders make it reasonable to apply this approach to the construction of a model which is to represent the developmental aspects of literacy. What has been damaged in the acquired deficit may have failed to develop in the developmental deficit, but both are viewed as part of a modular system. Hence the squares and arrows, and occasional circles, of figure 1.

For those unfamiliar with Marshall's model of reading and writing it would be in order here to give a brief description (see Fig. 2). In Marshall's model there are two separate systems for reading and writing with only a lexical component in common. All other components are utilized exclusively, either in reading or in writing, with a separate route for each skill. Within each sector (reading and writing) there are two routes available for interpretation of the stimuli, a lexical and a non-lexical route. (In this respect, the model is similar to the one proposed here.)

Let us first discuss the non-lexical route as it applies to reading. After an abstract letter recognition process has taken place, the stimulus is passed to a graphemic parser which parses the individual graphemes into graphemic units, somewhat akin to Venezky's 'funcional spelling units' (Venezky, 1970). These graphemic units are likely to be stored hierarchically, ordered by length and probably frequency. As an example of how the parser works, let us take the example of the word sheep. After the abstract letter recognition has been made and the individual graphemes have been identified, these are then passed to the parser for arrangement into units. The parser then takes s - h - e - e - p and analyzes it to determine which units go to make it up. The parser takes the initial letter s. This can constitute a graphemic unit in English, as in sip. However, before passing this to the blender component, the parser runs a check to make sure that s is indeed the graphemic unit, or whether it is followed by other graphemes which can combine with it to form other graphemic units. In this case, s is followed by h, and sh does indeed form a graphemic unit in English. The only possible expansion of this in Standard English, is the addition of an r, to give shr. However, a check reveals that no r follows, so the first graphemic units is established as sh. The next grapheme, e, may also be a graphemic unit in English, but a check reveals a second <u>e</u>, to give the graphemic unit <u>ee</u>. This leaves only the final letter to be analyzed as a complete graphemic unit, and the parse sh - ee - p is passed to the GPC component to be given a phonemic representation, and from there to the blender, and finally to the response buffer.

Although this representation of the GPC, non-lexical route is incorporated into the model here presented, the lexical route proposed by Marshall does differ somewhat from the lexical route represented by the orthographic image component of the proposed model. In Marshall's model, there is a step-by-step progression from visual analysis, to letter representation, to whole word recognition, to lexico-semantic representation, to oral word representation. In the proposed model, transmission of the encoded abstract representation of the stimulus to the orthographic image recognizer simultaneously accesses a full specification - phonology, semantics and syntax - which is encoded for transmission to the response buffer component. There is also no connection between the lexical and non-lexical routes in Marshall's model. However, it is suggested in the proposed model that a partially activated response via the lexical route, the orthographic image component, influences the choice of a particular graphemic unit by the parser in the reading of non-words. A skilled reader faced with the stimulus <u>gacht</u>, since this is a non-word, will rely on the GPC route for an interpretation. However, the partially activated response of <u>yacht</u> (partially activated since there is not all the information needed to actually activate a response) influences the pronunciation of this non-word, leading to [g a t] rather than [g æ č t]. Similarly, in the writing system, the partial activation of real word orthographic images, influences the choice of the graphemic unit selected to represent the phonological analysis of the non-word stimulus which is to be spelled.

As in the proposed model, in Marshall's model the system for writing mirrors that for reading. The stimulus is analyzed into some sort of abstract auditory representation which is converted into a phonological representation, parsed into graphemic units - again in the case of non-words, influenced by concurrent activity in the lexical route, and from there, encoded and passed to the response buffer for appropriate realization.

The concept of a threshold to be exceeded before a response is made is drawn from Morton's logogen model (Morton, 1980). Logogens (from logos - a word, and genus - birth) are defined as "evidence collectors with thresholds". In Morton's model, after a preliminary auditory or visual analysis, which parallels the abstract feature analysis of the model being presented here, the output from this analysis is passed to the logogen system (Figure 3). This consists of two input logogen systems and an output logogen. The input logogens are passive categorization systems. They collect evidence as to the identity of a word but make no judgement as to meaning or whether the stimulus is a word or a non-word. Meaning is the province of the cognitive system. When the input logogen has collected sufficient evidence as to a word's identity for it to exceed its first threshold, this information is encoded and sent to the cognitive system. When the evidence exceeds a second threshold, this information is encoded and passed to the output logogen. The output logogen also receives information from the cognitive system, which has also been feeding contextual information (for example, from the continuous input associated with reading words in context) to the input logogen, thereby adding to the evidence to be collected for a threshold to be reached. The output logogen system produces a phonological code for the input it receives from the input logogen. The response buffer then channels the information to an appropriate output system - speech, silent rehearsal, or writing.

Nonsense words processed by the input logogens will not reach a threshold since there can be no entry for them there, and consequently, it will be impossible to collect enough evidence to reach a threshold. Thus they are interpreted via a grapheme-phoneme, or phoneme-grapheme interpretation route, according to the modality, and the output is passed to the response buffer for appropriate action.

Morton's system differs from the model being proposed here in that the cognitive system is separate from the logogen system. Information from it is fed into the logogen system but it is not part of it. In the proposed model, however, input from the abstract feature analysis of the stimuli is fed into the central component and the orthographic image, when operating optimally, activates the phonological, semantic and syntactic entries associated with a word when the threshold is reached for recognition. Furthermore, it is also claimed that below threshold activation of the entries in the central component affects the GPC/PGC component, influencing the interpretation of the non-word stimuli. This leads to consistency among good spellers, but poor spellers, with only a partially specified image, will activate a much wider range of possible responses, and their selection of a particular graphemic unit for spelling or reading a non-word will be influenced by a wider range of possible real words than will be the case for the good readers/spellers. Consequently, the poor spellers will be less consistent between trials and between subjects, as was attested by Frith (1980).

In the formulation of the model here presented, the initial perceptual analysis of the auditory or visual stimuli is taken for granted. There has been considerable work done on this particular aspect of the processing and production of written language. Since this initial analysis provides entry to the system, it is obviously of great importance. Nonetheless, because this study is more concerned with what happens further into the system, this particular aspect is not discussed at length, and the reader is referred to work by Henderson and Seymour for greater detail (Henderson, 1982; Seymour and Porpodas, 1980).

Formulating the hypotheses

The structural framework of the model here proposed, along with the foregoing discussion gives rise to the following hypotheses:

H1: it is hypothesized that spelling ability, like reading ability, is not a unitary skill. Therefore, children categorized either as good spellers, or as poor spellers, will constitute a heterogeneous population made up of numerous subgroups with different strengths and weaknesses.

This gives rise to the second hypothesis.

H2: it is hypothesized that since poor spellers who are good readers do not show any language deficits per se, the errors made by poor spellers will differ only quantitatively from those made by the good spellers. They will make more errors but these will not be qualitatively different from the errors made by the good readers/spellers.

However, it is further proposed;

H3: that children who are poor spellers will differ from their good reader/good speller peers in their reading subskills.

The model proposed that skilled readers/spellers store and have access to a dual image for items in the mental lexicon, a partially specified image adequate for reading and a fully specified image adequate for spelling.

H4: it is hypothesized that poor spellers have not learned to form and store a fully specified image for the words in the lexicon and instead must rely on alphabetic principles (Frith, 1984) when spelling.

Finally, it is suggested that the good reader/poor speller's reliance on partially specified images allows for fast access to the lexicon. This leads to the last hypothesis.

H5: it is hypothesized that the good reader/poor speller will be a fast reader of continuous text, able to correct any errors by reference to context. Reading words in isolation (naming) will also be fast, but without context, inaccurate.

A battery of tests was drawn up to test these hypotheses and is detailed in the following chapter.

Chapter 2

METHODOLOGY

Experimental framework

Research workers are becoming increasingly aware of problems of interpretation associated with large-group comparison experimental design and analysis. When large-group results are submitted to statistical analysis, patterns of individual variation are swallowed up and distortions occur. The relevance of this as applied to the study of language deficits in brain-damaged subjects has been discussed at some length by Caramazza (1984) and Shallice (1979). Nelson (1979) has also stressed its importance in relation to early language acquisition. Large-group studies are a valid part of the overall study of a problem, but in dealing with cognitive deficits, a large part of the problem relates to an individual's variation and it is important to take this into account (Sloboda, 1980). With this concern in mind, it was decided to use a single-case methodological approach to investigate what it might be that prevents some good readers from learning to spell correctly.

Single-case research designs have most frequently been used to investigate the efficacy of behaviour modification techniques, and particularly in the area of 'applied behaviour analysis' (Kasdin, 1982). A crucial feature of single-case experimentation is drawing inferences about the effect of various interventions on the subjects being tested. The particular experimental design selected for the current study was that of a multiple baseline, repeat measures design, across subjects and across tasks.

In such a framework, a baseline level of response is established for experimental and control subjects. An intervention is then made, and its effect is measured on a repeat measures test. When analyzing behaviour changes in individual subjects in a single-case research design framework, an ABAB pattern of analysis is frequently used. A baseline is established, followed by observation of the effect of an intervention. The pattern is repeated, first with analysis of the behaviour without further intervention, and then after a repetition of the intervention. However, in this instance, where the 'behaviour' was spelling, and the 'intervention' was a word visualization strategy, it was felt that an ABAB pattern of repetitions would not be useful, and that a simple AB format would be preferable. However, a simple AB framework has the potential for giving misleading results, particularly with children. If children are given a new strategy for performing a task, the first post-intervention results may not be representative of the true effect of the intervention. There may be a conflict between the old and the new strategies in performing the task. Consequently, an ABB framework was adopted for the two repeat measures tasks. A baseline was established, an intervention was made and the children were tested. The intervention was repeated, and the children were retested.

In presenting the data obtained, single-case designs have relied heavily on visual inspection rather than statistical analysis. The rationale for this is that the purpose of the intervention is to produce a very marked change in the behaviour under consideration. For example, in the present study, if a baseline of 11/21 words correct on a spelling test was established pre-intervention, and if post-intervention, the child scored 18/21 correct, visual inspection of the data presented in the form of bar graphs shows a marked difference (Figure 6, Subject CJC). However, although large differences in scores can be recognized by visual inspection of the data, more subtle differences, which are still significant may be overlooked. Consequently, it has been established that an appropriate conventional statistical analysis may also be usefully employed (Kazdin, 1982). In this study, the visual display is supplemented by matched t tests, and chi-square analysis of the relevant data.

It is to be noted that a single-case research design does not necessarily imply that the investigation is confined to the examination of only a single individual. Indeed, "thousands or over a million subjects have been included in some 'single-case' designs" (Kazdin, 1982). However, such an investigation does focus on individuals and their performance over time, whilst at the same time also examining the effects of interventions across subjects.

Single-case research is not intended to replace large-group studies, but to complement them.

Subjects

Sample population

Subjects were selected from the children in grades 3, 4 and 6 at Mutchmor Public School, a K-6 elementary school under the jurisdiction of the Ottawa Board of Education; 131 children were tested initially, 29 in grade 3, 46 in two grade 4 classes and 56 in two grade 6 classes. The grade 6 classes consisted of a regular and an enriched class. To be in an enriched class, a child has to score highly on intelligence tests of various kinds, and has to read at an advanced level. The parents also have to consent to the child being placed in such a class, so that not necessarily all children who would qualify academically and intellectually are in this enriched class.

Experimental group

In order to be included in the experimental group, a child had to be reading at or above grade level, as identified by the standardized reading tests as administered within the Board's schools, but spelling at least 1 SD below the mean for the class, as measured by the experimenter, and at least one grade below the child's reading level.

Spelling ability was measured by the experimenter in a test using words drawn from the Schonell and the Morrison McCall Spelling Scale graded word lists. These tests revealed 16 poor spellers who were also good readers. They were distributed as follows: 1 child in grade 3; 6 in grade 4; 5 in grade 6; and 4 in grade 6E (Enriched). An experimental sample of this size is close to the sample size of 4-12 subjects which is recommended as being suitable for single-case research using a single subject, multiple baseline; repeat measures design.

Control group

Three sub-groups were identified as controls: a group of average readers/spellers who were spelling and reading at grade level; a group of very good readers/spellers who were spelling and reading above grade level; and a group of superior spellers/good readers who read at or above grade level but were spelling at least 2 grades higher.

The average spellers/readers were located as follows: three in grade 3, two in grade 4 and two in grade 6. There was one very good reader/

speller in each of grades 4, 6 and 6E. The distribution of the superior spellers subgroup was two in grade 3, four in grade 4, and one in grade 6.

Among the poor spellers, 6 were girls and 10 were boys. However, this appears to reflect the overall ratio of girls to boys in these grades at this school. Of the 131 children tested, 57 were girls, and 74 were boys, a ratio of 6.6 : 9.4, which reflects statistically the human distribution of 6 : 10. This apparently represents a local anomaly with respect to the population in general, where there are usually more girls than boys.

Measures

A battery of 7 tests was devised and administered. All except two of the tests were administered to all the children in the classes concerned. This had the double advantage of contributing to the ecological validity of the tests since they became part of the class routine (Bracht and Glass, 1968; Snow, 1974) and also provided class means for the children's performances on these tests. Two of the tests were administered on an individual basis where individual responses had to be timed and recorded. It will be indicated below which were group, and which individual tests.

Selection measures

i) Diagnostic spelling test (Group administration)

A list of words drawn from the Schonell and the Morrison McCall graded word lists was administered as a spelling test to all the children. The words were dictated to the whole class by the teacher during a regular language arts period in the presence of the experimenter. The teacher first pronounced the word, used it in a sentence and then repeated it. The words dictated became progressively more difficult. The children in grade 3 were given a total of 80 words in two sessions of 40 words each; the children in grade 4 were given 100 words in two sessions of 50 words each; and the children in grade 6 and 6E were given 120 words in two sessions of 60 words each. The first 20 errors made by each child selected as an experimental or control subject were collected for analysis of error types. The test was thus both a selection and an experimental measure.

Experimental measures

ii) Spontaneous writing (Group administration)

A timed sample of spontaneous written work was collected from each child. In order to provide the children with a topic, and a possible format, the experimenter read a story to them from the Canadian children's magazine, Owl. The children were then given a choice: they could retell the story, write a critique (a task with which they were already familiar from work in class), or they could give free rein to their creativity and write whatever they wished. This task was also administered during a regular language arts period and the children were allowed ten minutes for their writing after the story had ended. The errors made by those children identified as experimental subjects or controls were collected for analysis, and the average number of words written was calculated for each class.

Visualization enhancement tasks (Group administration)

iii) Grade level spelling test (repeat measures task)

The grade level spelling tests were based on Canadian norms as given by Thomas (1979). The task was administered three times to each class. The first administration provided the baseline measurement. The two subsequent applications were made in conjunction with an 'intervention', in this case, a visualization enhancement strategy. On the first administration of the test, the children were given no preparation for the task. On the two subsequent occasions they were presented with a randomized list of the words to be spelled. The experimenter then instructed them to form a visual image of each word. This was done by first asking them to shut their eyes and to try to see their own names in their mind's eye. When they had grasped this concept, they were then instructed to look hard at the first word on the list, then to shut their eyes and try to see the word in their mind's eye. This was repeated for each word on the list. To further emphasize the truly visual aspects of this strategy, the children were instructed to imagine the words in different colours, and in upper, rather than lower case letters in specific instances. The word lists were then collected and the spelling test was given in the same manner as before, with the teacher dictating the word, using it in sentence, and then repeating it. The grade 3 children were given 10 words to spell each time. The grades 4 and 6 children were given 21 words to spell on each occasion.

iv) Word recognition task: word squares (Group administration)

Word squares (see Appendix I) were constructed using the 500-1000 most frequently used words in Canadian written English[2] (Thomas, 1979). The children were instructed to identify, to circle and to write down as many words as they could find in the square in five minutes. To ensure that the task would be carried out in the same orientation as a normal reading task would be in English, the children were instructed to circle only those words which ran from left to right or from top to bottom of the square. Arrows were also drawn on the sheet to reinforce this instruction.

On the first occasion, the children received the word square without any preparation. This gave the baseline measure. On the two subsequent occasions, the intervention consisted of giving them a list of approximately 100 words which could be found in the square and they were instructed to study the words and to try to fix them in their mind's eye, as they had done with the spelling tests. They were left to do this on their own without further direction from the experimenter. After two minutes, the lists were collected and the children again spent five minutes identifying, circling and writing down the words they found in the square. A different set of words was used for each square, although, inevitably, the arrangement of the words in the squares led to the coincidental creation of some words that had appeared in previous squares.

v) Word recognition: naming task (individual experimental subjects and controls)

A list of high and low frequency words (Carroll et al. 1971) was drawn up in the following categories: predictable, unpredictable and weird spelling patterns, along with a group of non-words. The categories were defined as follows: a word was classed as predictable if it could only ever be pronounced one way correctly in English, so this category included grass which is quite predictable and regular, and also included walk, which although predictable in that it can only have one possible pronunciation in English, as in balk and talk, is also irregular in its orthography. The unpredictable words were those which contained combinations of graphemes that could have more than one correct pronunciation in English, as for example, fork and great (as compared to work and treat). The weird words were both unpredictable and unique, including yacht and colonel which are infrequent, but also ocean and eyes, which are no more predictable but are more commonly encountered. High frequency words were defined as those words with a frequency greater than 780 (Carroll et al., 1971), and low frequency words had a frequency of lower than 385. The frequencies ranged from 10085 to 3. The non-words were either predictable, as in bish, or unpredictable, as in mough.

The words were printed on white card using Letraset Helvetia lower case letters and were then photographed onto 35 mm slides. They were projected using a Kodak Carousel projector with a Gerbers tachistoscopic shutter linked to a voice-activated timing device. When the shutter opened, the word was projected onto a screen and the timer started. When the child pronounced the word, the voice-activated timing device caused the shutter to close and the timer to stop. There was then an interval of 3-5 seconds before the next slide was projected. The first six words served as familiarization trials and were not scored. The children were also told there would be some 'funny' words that had been made up but which they were to try to read anyway. They were also given examples of non-words, mib and grock, and asked how they would say them to make sure that they understood what was expected of them. The experimenter recorded the latencies of all trials except the first six, and transcribed any deviant pronunciations. (The words and non-words are listed in Appendix 2.)

vi) Reading task: reading a passage aloud and silently (individual experimental subjects and controls)

The children were given a 400 word passage to read divided into two sections, the first 200 words to be read aloud and timed, then the second 200 words to be read silently and timed. The children were also told that the experimenter would ask them questions to see how much they remembered about the passage. The passage was again taken from Owl magazine, but was very slightly simplified for the grade 3 readers.

vii) Spelling error recognition task (group administration)

This test was administered to all the children in the grades being tested, during a regular language arts period. Word lists were constructed for each grade incorporating errors made by the poor spellers in these grades. These words were combined with other words used in the initial diagnostic spelling test. The children were then asked to go through the list, identifying and, if possible, correcting any misspelled words. The grade 6 list contained 50 words which included 18 errors, for grade 4 there were 26 words with 10 errors, and for grade 3, 25 words including 10 errors. The words used for each level were different, but there was some overlap in the actual words chosen, either as errors, or as correct versions of the word (see Appendix 3).

Because of the interrelated nature of both, there is no one-to-one link between individual hypotheses and the individual tests. Data from a combination of tests are used to support each hypothesis. The following, however, will indicate which tests are related to which hypotheses (see also Figure 4).

H1, being the most general, will draw on all tests for support. H2 will be supported primarily by data gathered from tests i and ii, which measure basic spelling skills in writing to dictation and in spontaneous written work. Test iii, as a grade level spelling test, will also provide data for this hypothesis. Data from the naming (test v) and reading (test vi) tasks will be used to substantiate H3. H4 will draw primarily on the results of tests i, ii and iii, which are all tests of spelling, and test vii, which taps ability to recognize misspelled words. In addition, the results from tests iii, and iv, the visualization enhancement tasks, will demonstrate the effect of encouraging the children to form a fully specified visual image. H5 will be demonstrated by the reading task (test vi) and the naming task (test v).

Chapter 3

RESULTS

Diagnostic spelling test

The distribution of ability revealed by the diagnostic spelling test is displayed in Figure 5. In the two lower grades, spelling ability is distributed over quite a wide range, with a mean slightly above actual grade level. In grade 4, a bimodal distribution is observed, with one group clustering close to the mean, and another group at the higher end of the scale. In grade 6 there is a more marked clustering around the mean, with only a few individuals at either end of the scale. In grade 6E, the distribution is again more widely distributed. In all grades, the mean was above the actual grade level. As already indicated, in grade 3 only one child was identified as an experimental subject. In grade 4, six subjects were identified and in grade 6, there were five in the regular class, and four in the enriched class.

An analysis of the first 20 errors made by those children identified as experimental subjects and controls was carried out. Four error types were selected for analysis: i) phonologically inaccurate, ii) orthographically illegal errors, iii) order errors, and iv) cluster reduction errors (see Tables 1 and 2). Of these four, the phonologically inaccurate errors were the most frequent. However, they formed only a very small proportion of the errors overall, 4.9/20 for the poor spellers; 3.6/20 for the good spellers. A matched t test of the errors made by both groups showed there to be no significant difference between the groups for any category. (Phonologically inaccurate errors: $t = .6811$; orthographically illegal errors: $t = .9078$; cluster reduction errors: $t = 1.979$, all with $d\,f = 15$. There were too few order errors to analyze statistically.) The majority of errors were, in fact, found to be phonologically acceptable representations for the target word.

Spontaneous writing

The passages of spontaneous written production were analyzed for errors and for the number of words written in comparison with the class mean. The same pattern of errors was found as in spelling to dictation, most being phonologically acceptable. Of the four error types, phonologically inaccurate ones were the most frequent, but again, were very few in number. There was no statistically significant difference between the groups with regard to the number of errors ($t = 1.3186$; $df = 15$) or in the length of the passages written. More poor spellers than good spellers were above the median number of errors made, but a chi-square analysis showed this difference was not significant ($X^2 = .5019$). With regard to the number of words written, both groups presented the same pattern. In each group, 10 subjects wrote more than the average number of words for their grade level, and 6 wrote below the average number (Table 3).

Grade level spelling (test and intervention)

The results of this repeat measures task are displayed in Figure 6 and Table 4. Visual inspection reveals a considerable difference in the pre- and post-intervention scores for the experimental group, with less dramatic improvement for the control group, many of whom were already performing at ceiling. A matched t test indicated a significant difference in the improvement between the groups ($t = 3.255$; ($df = 15$); $p < .001$). The improvement for the poor spellers was significant at the level of $p < .001$. The good spellers improvement was not significant.

Word recognition: word squares (test and intervention)

The results are displayed in Figure 7 and Table 5. Visual inspection reveals a considerable difference in pre- and post-intervention scores. Chi-square analysis showed that the difference between the two groups on the pre-intervention scores just failed to reach significance at the 10% level. However, there was a trend towards lower than grade average scores for the poor spellers (8/16, as opposed to 3/16 for the good spellers). There was also a significant difference in the degree of improvement shown by each group in their post-intervention scores. Percentage improvement scores were calculated and a matched t test showed $t = 2.052$ ($df = 15$); $p < .05$.

Word recognition: naming

A matched t test of naming latencies revealed no significant differences between the good and poor spellers ($t = .2276$). However, a matched t test of the errors revealed a very significant difference ($t = 5.149$ ($df = 15$); $p < .001$). The poor spellers thus made significantly more errors than did the good spellers (Table 6).

As far as the pattern of response times was concerned, a standard regular pattern was observed for all grades. Latencies gradually increased from the predictable, high frequency word response times, getting slightly longer through predictable low frequency words, unpredictable high and low frequency words and then a drop in response times for the weird, high frequency words, and rising with decreasing degrees of steepness the higher the grade level, for the weird low frequency words, with a slight drop for the non-words (Figure 8). The standard deviations around the mean for each stimulus type also decreased with increased grade level. At the level of grade 3, the SD for all classes of stimuli types ranged from 144 msecs to 765 msecs, with actual mean latency ranging from a low of 682 msecs for the predictable high frequency words, to a high of 1.467 secs for the weird low frequency words. By grade 4, the spread of both response times and variability had decreased. Response times ranged from a low of 757 msecs, again for the predictable high frequency words, to a high of 1.096 secs. More revealing was the decrease in variability, with a range of from 120 msecs to 287 msecs. In grade 6, the trend to decreasing response times and decreasing variability continued. The range of mean response times went from 571 to 800 msecs, with variability ranging from 113 to 233 msecs. The standard deviations around the mean are also represented in Figure 8.

Reading: aloud and silently

The mean time per grade for the combined experimental and control groups at each level was obtained for reading both aloud and silently. A chi-square analysis indicated no significant difference in the times for reading either aloud or silently. There were more poor spellers who were slow at reading aloud (8/16) than there were good spellers who read slowly (4/16), but this difference was not significant. Table 7 reveals the pattern of fast and slow reading times on both parts of the task, and also the error rate for responses to the questions asked after completion of the reading task.

Error recognition

A marked difference between the groups was found. Of the poor spellers, 12 made more than the average number of errors for their grade. (This was a group test in which all the children participated and class means were obtained.) Only two of the poor spellers made fewer than the average number of errors for their grade level. An almost exact opposite pattern of distribution was obtained for the good spellers, two of whom made more than the average number of errors, 14 of whom made fewer than average. (One of the poor spellers had left the school and one was not in class when this test was carried out, hence the smaller number of subjects in the poor spellers group.) A chi-square analysis showed this result was significant at the .001 level ($X^2 = 13.2738$).

As was indicated in the section in which the experimental framework is discussed, single case research does not lend itself to the statistical analyses performed in large group studies. Any further statistical analysis of the data is thus inappropriate since the numbers are too small to allow for valid conclusions to be drawn from such analysis.

Chapter 4

DISCUSSION

Because of the somewhat complex interrelationship between the hypotheses and the individual tests, the results will be discussed with reference to each hypothesis in turn.

Hypothesis 1

It becomes readily apparent when one looks at the results of the tests as a whole, that one is not dealing here with a homogeneous population of poor spellers who all perform alike on all the tasks in a way that clearly differentiates them from the good spellers. Nor, it should be noted, do the good spellers present a clear pattern of task responses to allow one to classify them as a homogeneous group either.

Consideration of the test results as a whole appears to indicate that apart from a difference in their ability to spell, there is little else that unequivocally defines either of the two groups of good readers under consideration, those who have, and those who have not mastered the English orthographic system. Table 1, for example, shows that some of the poor spellers make a large proportion of phonologically inaccurate errors (MD and DM). However, so do a number of those who are classified as spelling at an acceptable level for their age (BH, KI and YR). In both groups one finds children who, in the spontaneous writing task, wrote more than the average number of words for their grade level, whether they were good or poor spellers. Conversely, one also finds both good and poor spellers who write less than the average number of words (Table 3). When we look at the reading tasks (reading aloud and silently, and the naming task) we find fast and slow readers and namers in both groups , (Tables 6 and 7). Even in the grade level spelling task we find good and average spellers who get 35% of the words wrong, whilst among the poor spellers, there are those who only get 25% incorrect (Table 4).

There is thus evidence here for the claim made in H1 that children categorized as poor spellers will constitute a heterogeneous population made up of numerous subgroups.

As a first step towards trying to identify what factors, if any, do differentiate a poor from a good speller, given that both are good readers, we may start by making a between grades comparison of the distribution of spelling ability within the different grades as revealed by the diagnostic spelling test (Figure 5). When this is done, two interesting factors emerge. First, one is struck by the increase in the numbers of poor spellers from grades 3 to 6. It is possible, of course that this grade 3 class was exceptionally able and therefore produced only one poor speller who was also a good reader. However, it is also probable support for the claim that it is not until the higher grades, when children are expected to be able to write irregularly spelled words, that their spelling ability will become fully apparent. At the level of grade 3, only an exceptionally poor speller will be unable to make a reasonably correct guess at how to spell a word.[3] The grade 3 poor speller, MD, not only made a large number of phonologically inaccurate errors, cluster reductions and orthographically illegal errors (see Table 1), he also made 17 errors in his spontaneous writing. As will be noted in Table 2, the mean number of errors for the poor spellers on the spontaneous writing task was 5.8. This appears to indicate that it is only a really poor speller who will stand out at this grade level. By grade 4, the picture is beginning to change. More children are identified as poor spellers whilst still reading at or above grade level. By grade 6, these numbers have increased yet again.

In establishing the criteria for selection of subjects for this study, it was felt that children could not reasonably be expected to have systematized their knowledge of orthography until at least the beginning of grade 3. Hence, this was the earliest level selected for testing. However, on reflection, it would have been preferable to include younger children in the study. In examining the acquisition of spoken language it is invalid to wait until the system stabilizes before studying and describing it. The stages leading up to stabilization are important indicators of the processes involved in the genesis and development of the mature system. The same holds true for the acquisition of written language and it would have been valuable to have looked at what happens in kindergarten to grade 2 that produces the spellers in grades 3 to 6, and, of course, beyond.

The study does indicate some developmental differences. At the level of grade 3 there is a much wider variation of ability. This can be seen in the distribution of scores on the initial diagnostic test (Figure 5) and on the naming latency task (Figure 8). There are several compatible explanations for this finding concerning eight-year-old subjects. At about this age, or a little before, a considerable degree of reorganization is taking place in the brain. That area of the brain comprised of the junction of the parietal, temporal and occipital lobes matures at this time (Luria, 1970; Yakovlev and Lecours, 1967). The functions associated with this area are the making of complex simultaneous and spatial syntheses which involve visual, tactile, vestibular and auditory analyzers

(Luria, 1966). At this age too, a shift is seen in the psycholinguistic development of the child who appears to change from using an iconic, situational approach to language to an abstract and symbolic approach (Patel, 1977). It is also at this stage in the Piagetian scheme of cognitive development that the child begins to move into the stage of concrete operational thought and is able to co-ordinate the different dimensions of a situation and to gain an overall interpretation. It is conceivable that these skills should also relate to the acquisition of written language where symbolic representations have to be co-ordinated with abstract concepts. It is claimed that by the age of nine years, normal children will have acquired all the component parts that go to make up skilled reading ability and all that remains is for the child to co-ordinate and unify these skills (Patel, 1977). It would appear that in writing also, the children are acquiring the subskills - the auditory analysis of words, the ability to link phoneme to grapheme, and to the graphemic units allowed in the language, and knowing which orthographic rules to apply to which situation. JK and TL (grade 3 superior spellers) would appear to have integrated these in that they spell far ahead of their grade level, and also read above grade level. The wide variation of responses observed in this grade in particular, however, would seem to indicate that for many, the integration is incomplete, and possibly unstable. Cromer (1976) reported that this instability in respect of language processing was very typical of children of this age. Constructions they might appear to have mastered one week, were beyond their ability to process the following week.

When we look at the latency aspect of the naming task, we see that the variability shown in this task by beginning readers and spellers is observed to decrease as grade level increased (Figure 8). It was also noted that the very good readers/spellers, at all levels, displayed a much more consistent pattern of responses with very little variability in their response times to any of the stimuli. There tended to be a little greater variability in response times to the weird high frequency words, and the non-word stimuli, but the difference here for these good readers was in the order of a variability of 100 msecs, as opposed to 50 msecs for the other stimulus types. This is a very minimal difference if one compares it to the response times of one of the grade 3 subjects whose variability ranged from 59 msecs to nearly 3 seconds. However, reduced variability appears to be a reflection of reading ability rather than spelling ability as one could see if one looked at the response times of some of the good readers/poor spellers. NX, for example, had very consistent response times, read well above grade level, but spells below grade level. He has fast access to the lexicon, and in context, he is able to read efficiently (in that he answered all the questions on the passages read correctly). (Table 7.) In the naming task, however, although the response times were consistent, the responses themselves showed a higher than average number of errors (Table 6). NX's response times, however, were almost exactly the same as those of NB, a superior speller in the same grade.

It thus appears that the interaction of the various subskills relating to literacy that were tapped in this series of tests can result in quite different sub-groupings of subjects, both among the good and the poor spellers.

Hypothesis 2

We turn now to a more specific proposal put forward in H2 that in these heterogeneous populations of good and poor spellers, since the poor spellers are good readers and do not appear to have any language deficits per se, the errors made by them will differ only quantitatively and not qualitatively from those of the good spellers.

It was decided to base the analysis of the errors on that of Nelson (1980) in which the first 20 errors made on the initial diagnostic spelling test were selected for analysis. The rationale for selecting only the first 20 errors, rather than the whole corpus, was that it was felt that these would be just beyond the level of each child's ability. If the whole corpus of errors were to be analyzed, for the poor spellers in particular, the words at the end of the graded list would be far beyond their level of ability. This could result in the creation of artefacts within the results since the more difficult words could represent wild guesses, or an ability to perform a phonological analysis and to transcribe it, but would not necessarily reflect word specific orthographic knowledge.

The categories selected by Nelson for analysis (as already discussed, pp. 36-37) were phonologically inaccurate errors, order errors and orthographically illegal errors. A further category was added for the present analysis, that of cluster reduction errors. Cluster reduction is a common phenomenon among children acquiring spoken language in the early stages, and was also observed among beginning spellers by Read (1971) and by Treiman (1983). In an earlier pilot study it had been noted that cluster reduction occurred even among older children, and in view of the surprise expressed by a grade 4 teacher that this should be so, it was decided to include cluster reduction as an error category here. Other more complex error analysis criteria have been suggested (Avakian-Whitaker and Whitaker, 1973; Spache, 1940 - for a critical analysis of various error classification schemes). However, these are more useful for a fine-tuned analysis of the errors made by language disabled spellers than in the analysis of errors made by otherwise normal children. The categories selected here are, however, fine enough in definition to reveal a more gross deficit. The errors of subjects thus identified could then be analyzed in greater detail. However, that was not the intention of the present study which specifically excluded language disabled readers and spellers.

As already noted, statistical analysis revealed no significant difference between the groups in any category of error. Of the four error types selected, the most frequent was the phonologically inaccurate error, where the written representation could not represent the spoken pronunciation of the target in English, representations such as nececary (necessary) and sem (seem). However, though the most frequent, they were few in actual number (Tables 1 and 2). The poor spellers made slightly more such errors overall, 4.9 to the good spellers 3.6, but the majority of errors, in the case of most of the subjects, were phonologically acceptable. However, it will be noted that some of the poor spellers made a considerably higher number of such phonologically inaccurate errors. For example, DM makes 10, NX makes 8 and DB, 7. On the other hand, so do some of the good and average spellers. YR makes 14; RS, a very good speller, makes 6, as does LG, a superior speller.

In general, very few of the errors made were orthographically illegal, and the number of these decreased as the grade level increased, in both good and poor spellers. It is, therefore, evident that the children do have sufficient orthographic knowledge for them to be able to produce English-like representations of the language. Although such children were not included in the analysis, the reading delayed children in these grades tended to produce more orthographically illegal errors than did their peers who were reading at or above grade level.

Again, with regard to ordering errors, very few of these were made and they tended to be made on words such as friend and height which because of the variety of uses to which ei/ie can be put in English orthography, can cause at least a momentary hesitation for the best of spellers.

These results echo Nelson's findings, both with regard to the infrequency of the error types, and with respect to the lack of difference between any of the categories of spellers involved. The poor spellers make more errors, but not markedly different errors.

In this study, cluster reductions were found to occur, albeit infrequently, in all the grades studied. They also occurred at all levels of spelling ability, though to a lesser degree among the good spellers. Most of the reductions occurred in the N + C clusters, as in groud (ground), hugry (hungry), and youg (young). It is true that the nasality of these clusters may be perceived to be part of the vowel, but that does not alter the fact that English orthography requires that it be expressed as a consonant. When one looks at the more difficult words at the end of the list where this reduction occurred, as in lutenat and aquatance (lieutenant and acquaintance), it seems very likely that orthographic knowledge will change perception of the word. A person unfamiliar with the orthography of lieutenant and acquaintance may well not even hear that there is a nasal in the word at that point. Other clusters were also reduced, so that fifth became fith or fithe, interest became interes, and perfect, perfick. This again may reflect perception, and production, but it also reflects a lack of word-specific orthographic knowledge.

There were also some few instances of the letter name being used to represent the sound. It will be recalled that this is another strategy used by beginning spellers (Reid, 1971; Bissex, 1980). However, even at the level of grade 6 there was one example of its use, in the spelling of readily as readle.

On occasion, vowels were omitted in words such as rmain (remain), srch (search), prfect (perfect), the r being possibly interpreted as being syllabic without an accompanying vowel. Phonetically, the vowel may be reduced to an almost non-existent state, but orthographically it has to be present in English.

Overall, the results show that it is a knowledge of phonological analysis and transcription which is the most frequent substitute for a correct orthographic representation, in both good and poor spellers. Most of the children revert to the alphabetic phase (Frith, 1980) when in doubt. This is also influenced by their knowledge of possible graphemic representations of the sound in other words, so that one child spelled method and separate as meathod and seaperate, drawing on her knowledge that -ea- is one way to represent [ε] in English, although it is the wrong representation in these instances. The majority of the children's errors, no matter what the level of spelling ability, were phonologically accurate representations of the target word.

The same type of analysis was carried out with regard to the errors made in the spontaneous writing task, although here all the errors were analyzed since even the worst spellers made fewer than 20 errors (Tables 1 and 2). Furthermore, since the words were the children's own choice, the artefactual considerations present in the spelling-to-dictation task would not obtain here. As with the initial spelling test, there was no statistically significant difference between the two groups. The mean number of errors for the poor spellers was 5.8, with a range of 0-17; for the average spellers the mean was 5.4 errors with a range of from 0-12, but for the very good and superior spellers, the mean was 1.4. As will be seen from these figures, even average and good spellers make spelling errors in their spontaneous writing. On the other hand, being a poor speller does not necessarily mean that errors will be made when the subject chooses what to write. In this connection, it is interesting to look at poor speller CJC. He made no errors on the spontaneous writing task, but only wrote 23 words. In addition, on the grade level spelling test, on the unprimed administration of the test, CJC made 10/21 errors. It is possible that CJC deals with his spelling problems by limiting his output.

As was the case with the initial diagnostic spelling test, of the four categories under which errors were classified, the phonologically inaccurate was the most frequent, but as before, for most of the children, such errors formed only a very small proportion of errors overall. The majority of errors made, whether by good or poor spellers, were phonologically acceptable. Once again, some cluster reduction errors were found at all grade levels though they were more common in the two lower grades, and in fact, only one such error was seen among the grade 6 subjects. This type of error was also seen more frequently in the writing of those children who produced a large number of all types of error.

With respect to the grade level spelling test which formed part of the single subject repeat measures subsection of the tasks, of the errors made, most were again phonologically acceptable. The two groups, the good and poor spellers, were distinguished by number, not type of error made, although, as already mentioned, there were good spellers who made a surprisingly high number of errors on this task, and also some poor spellers who made surprisingly few.

These analyses thus bear out the hypothesis that this particular group of poor spellers, that is, poor spellers who are also good readers, are differentiated from their peers only by the number of errors they make, but not by the type of error made.

Hypothesis 3

Having established that there is little, if any, qualitative difference between the two groups with regard to their spelling ability, let us now turn to H3, which claims that although these children are reading at or above grade level, and far in advance of their spelling level, when one looks at the actual subskills related to reading, they will perform differently from their peers who both read and spell at or above grade level. The sub-skills tested in this study were reading aloud and silently, and word naming.

The reason for putting forward this hypothesis was that since reading and writing are related skills, it is probable that a deficit in one aspect of literacy would be linked to a deficit in the other. This would not necessarily be an absolute deficit. Less than optimal functioning of one of the sub-components which make up reading skills might be masked by a compensatory mechanism which allowed other skills to supplement the deficit. Such compensation might be more difficult in writing than in reading so that this would lead to children who could read well, but who could not spell correctly.

It has been suggested in the past that speed of silent reading may correlate with spelling ability. Fast readers should be good spellers. However, this was not the case in this study. Chi-square analysis of the reading speeds of the two groups in the reading aloud and silently task, showed no significant difference between the groups (Table 7). Speed of reading was assessed in relation to the subject's peers, so that grade 3 readers were fast or slow in relation to other grade 3 readers, and not to the group as a whole. This was felt to be more indicative of their ability. Reading is a relatively new skill for the younger children in the groups being studied and what is acceptable for a grade 3 reader may not be so for a grade 6 reader. This can be seen in a comparison of the grade 3 good reader, BH, with the grade 6 good reader, TK (Table 7). Both read the 200 word passage in 92 seconds, but BH is above the mean for his grade, whilst TK is below the mean for his grade. This does not mean that BH is a better reader, but rather that he brings different sub-skills to bear on the task of reading aloud.

Although there was no significant difference between the groups for reading aloud or silently, there was a trend among the poor spellers to be slower at reading aloud than were the good spellers; 8/16 of the poor spellers took more time than the mean to read the 200 words aloud, whilst only 4/16 of the good spellers were slow on this task. It is clearly apparent that fast, or slow reading, does not of itself predict spelling ability.

With regard to the reading task, there was one anomalous result within the structure of the task. In order to encourage the children to read for meaning (as one does in a normal reading task), and to ensure that they did indeed read the silent reading passages, the children were told that the experimenter would ask questions about the passage when they had finished reading. Almost all the children in both the good and poor spelling groups were able to answer 4/4, or 3/4 questions correctly (Table 7). (The same questions were asked in each instance; two referred to the part of the passage read aloud, two to the silent portion.) However, the group of superior spellers, those who are reading above grade level but spelling at an even higher level, were able to answer only 1 or 2 of the four questions on what they had just read. Reference to the table will show that there is no obvious pattern to these responses. Correct responses do not appear to be linked to recency, or to modality (aloud, or silent reading). (The small number of questions and subjects would preclude statistical analysis of these results.) This inability to answer questions was taken as a failure to process for meaning. By way of confirmation, at least one of the children also showed a comprehension deficit when tested by his teacher on the regular, standardized reading tests. It has, in fact, been claimed that asking questions after a passage has been read, is not a good test of comprehension, and that cloze tests do this more effectively. Be that as it may, 22/32 of the children tested were able to extract and retain sufficient information from these passages to enable them to answer at least 3 of the experimenter's questions correctly, whereas none of the superior spellers was able to answer more than two.

Unfortunately, on the evidence of this particular set of tests, there is no indication of why this sub-group of good spellers should perform differently from their peers. Reading without comprehension is not unknown. It is one characteristic of hyperlexia (Aram, Rose and Horwitz, 1984) and has been observed in dementia (Schwartz, Saffran and Marin, 1980). However, in such cases, lack of comprehension is total, rather than partial as here. It may merely have been that, in spite of instruction to the contrary, these subjects utilized an inappropriate strategy of reading as fast as possible, with only marginal attention being given to content. It is, however, further evidence as to the heterogeneity of the skills that combine to achieve a particular level of literacy.

The existence of this group is in itself anomalous since it has been claimed that in normal subjects, spelling ability does not exceed reading ability (Hanson _et al_., 1983). However, these otherwise normal children do show this discrepancy, and in this study, they only differ from their peers on this one measure of comprehension, or recall, or retention as the case may be, and the discrepancy is in an unexpected direction.

The reading of a passage aloud and silently, then, has shown that there is no statistical difference between the groups as a whole with respect to this particular type of reading. In the main, both good and poor spellers understand what they read, or can at least extract and retain sufficient information to answer questions on the passage if questioned about it immediately upon completion of the task.

The second reading related task to be discussed is the word recognition task where the children were required to name words and non-words that were presented to them. Their performance was assessed on two factors: latency and accuracy. With regard to latency, once more, there was no statistically significant difference between the poor spellers and the good spellers (Table 6). In both groups there were some very fast response times, and some very slow ones. One of the poor spellers, NX, had the fastest mean response time of 495 msecs, whilst one of the very good spellers, RS, had one of the slowest times (1.047 secs). In this latter case the slowness was probably related to something other than reading ability. A portion of the longer response times arose from her apparent unwillingness to make a mistake. A number of the non-words among the stimuli could be pronounced more than one way. RS found it almost impossible to produce any response for these items. She gave the impression of being a very good, careful worker, anxious both to succeed and to please. Her work was very neat and attractively presented. (In fact, she illustrated the output for the spontaneous writing task, which no doubt depressed her word score, but did make a pleasing and attractive offering.) In reading the non-words, she had no clear indication of what would be the 'correct' response, even though all subjects were told that there was not a right and a wrong way to pronounce a non-word and that the experimenter was interested in how fast they could guess how to pronounce it. However, RS's caution appears to have outweighed her reading ability. Again, this is a further indication that not all members of a group will achieve their level of ability in the same way.

As already noted, variability around the mean for response times for each of the different categories of stimuli presented for naming decreased as grade level increased (Figure 8). The individuals themselves showed greater consistency of response time within the various classes of stimuli, and also in the consistency of response time between classes, the higher up the school they were. This applies to both the good and the poor spellers and appears to be a function of a developmental increase in reading skill. The grade 3 subject with the slowest response times also showed the greatest degree of variability, whilst the grade 3 child with the fastest response times, also showed a very small degree of variability. Obviously if all the naming responses are fast, variability will be decreased, but it would also be logically possible for all the responses to be slow and for variability also to be reduced. However, this situation does not obtain here. Where latency was greater, so was variability.

In general, the expected pattern of response times was obtained. Response times were fastest for the predictable, high frequency words (see the methodology chapter for a full description of categories), increasing for predictable low frequency items, rising again for unpredictable high frequency words. In general there was a decrease for the weird high frequency words, possibly because the children's attention had been drawn to them, either consciously or automatically because of the unusualness of the spelling pattern. The weird low frequency words tended to have the longest response times, partly because for a number of children it appeared that these were, in effect, non-words, and non-words with very deviant spelling patterns (see Appendix II). For most of the children, for example, yacht was pronounced [y æ č]. If they had not met the word in print, yacht would be a very strange looking word to pronounce. The weird low frequency words thus looked even stranger than the actual non-words, most of which were modelled on words with a more frequently found spelling pattern than is found in yacht.

Although there is no significant difference between the good and the poor spellers in latencies on the naming task, there was a very significant difference in their error scores (Table 6). Ten out of sixteen of the poor spellers, but only 3/16 good spellers made more than the average number of errors on this task, and it may be relevant that the 3 good spellers were also in the lowest grade. All the grade 4 and grade 6 good spellers made fewer than average errors on this task.

The errors themselves were of four types: omissions - a complete inability or unwillingness to pronounce a word, almost always a non-word; phonologically inaccurate pronunciations which could not possibly be directly linked to the stimulus (e.g. [ɛčər] from enchor); possible, but incorrect, pronunciations, (as in [l o‿u z] for lose, [k o‿u m] for come); and substitutions of another word for a real or non-word stimulus (e.g. knife for kive).

There is a difference between the two groups with respect to the type of error made. For the good spellers, the errors were primarily errors of substitution, either of a word for a non-word (knife for kive) or of one word for another (e.g. through for though). On occasion, the substitution was of a more frequent word, as in the case of bike for pike, but usually this was not so. (It should be remembered that the stimulus remained in view until the subject named it, so that subjects were not obliged to pronounce the word until they thought they had accumulated sufficient information to identify it.) The poor spellers, on the other hand, made errors of every type noted.

It would appear that the poor spellers, although apparently able to read continuous text as well as their peers, are considerably less efficient at naming individual words where there is no context to supplement their interpretations. Naming is, of course, only one of the subskills associated with reading, but the greater number of errors made by the poor spellers, and the wider variety of error type made, suggest that this is one area in which the poor spellers do differ in their reading subskills from their peers who, although reading at the same level, spell consistently better.

Hypothesis 4

This brings us to what is claimed here to be the key factor differentiating the poor from the good spellers as put forward in H4, which states that poor spellers have not acquired the ability to form and to store a fully specified orthographic image, relying instead on only a partially specified image in the lexicon. This results in them having to rely heavily on alphabetic principles (Frith, 1984) when spelling. It is claimed that a good reader/speller does form a dual orthographic image. This consists of a partially specified working image for reading, and a fully specified image for monitoring performance, and for generating written output.

If this is indeed the case, one would anticipate that those children who were good readers but poor spellers would tend to score lower on tasks involving precise visual recognition since they lack a precise visual image for reference. This is not to say that they have an actual physical visual deficit, nor that they have a defective visual memory, although neither this nor auditory memory was tested in the present study. One prime reason for this was that in an earlier pilot case study, the subject was tested on standardized auditory and visual memory tasks and scored at or above the mean for his age. This would cast doubt on the causal relationship of these factors to the type of spelling disability here being discussed.

Plainly, auditory and visual memory are involved in being able to spell. Short term auditory memory will be used to recall what has been heard, with long term memory being available for use at the checking stage. Short term visual memory would appear to have little or no role in spelling, but long term visual memory could also be involved in checking. However, a study reported by Day and Wedell (1972) found that differing auditory or visual memory scores did not affect error scores in spelling, although they affected error types. It was also noteworthy that a higher auditory memory score, did not, as might have been expected, lead to a higher number of phonologically plausible spellings. The children with higher auditory memory scores made fewer syllable confusions and substitutions, and those with higher visual memory scores made fewer letter insertions, omissions and inversions. Day and Wedell conclude that children with high visual or auditory memory scores can capitalize on these high memory functions in learning to spell, whilst those with low or average memory scores will have to use alternative strategies. However, the children in Day and Wedell's study were grouped only according to their visual and auditory memory scores. These correlated with error type, but not with overall spelling ability. Indeed, Day and Wedell conclude that whether a deficiency of function in the matter of visual or auditory memory also results in a deficiency of function elsewhere will depend on the level of the child's other skills.

This is further confirmation of the proposal that spelling ability depends on the interaction of a number of subskills. It could, however, be instructive to look at the visual and auditory memory aspect longitudinally, examining pre-literate auditory and visual memory scores in the light of later orthographic ability in order to elucidate whether, indeed, on closer examination, there is any natural correlation between these functions and spelling ability.

Leaving aside the roles played by these particular functions, one can look at the responses of the children as they relate to the visual aspects of the stimuli to see whether there is any difference between the good and the poor spellers in this respect.

Of particular relevance here will be those tasks involving word recognition - the word square task, the naming task, and the error recognition task. Performance on the reading of a passage might also be relevant.

Let us start with the word square task, which was both a recognition and production task. As noted, although not statistically significant, there was a trend for higher spelling ability to be associated with a higher initial score on this task (in relation to grade mean). There were members of each group who scored unexpectedly high or low on words found, but overall, the trend was for the better speller to find more words. This pattern of association would fit well with the proposal that the poor spellers lack a fully specified image for reference. The extraneous letters surrounding the possible words in the square would take more time to discount if a fully specified image of possible words were not readily available. (This was also a timed task so that it was not just the ability to find words, but also the speed at which they could be recognized which was relevant to the score).

The naming latency task is also a test of word recognition skills, and has already been discussed at length in relation to H3 above. The proposal that the poor spellers lack a fully specified orthographic image would accord well with the differences observed with respect to the error scores of the two groups. The poor spellers, it will be remembered, made significantly more errors than did the good spellers. The good spellers were not completely error-free, but most made fewer than the average number of errors. The greater variety of errors made by the poor spellers also suggests that they do not have one efficient decoding strategy, but instead rely on a number of different strategies, mainly matching to a partially specified image, and by a grapheme-phoneme conversion route for decoding.

There is also a tendency for the slow namers in the group of poor spellers to have identified a lower than average number of words in the word square task. As already noted, the number of subjects make it inappropriate to perform any further conventional statistical analysis. It is valid, however, to note tendencies; 7/16 of the experimental subjects were slow namers, and 6 of these also had low word square scores (Table 8). Reference to Table 6 will show that a slow response time is not necessarily confined to those subjects who were poor spellers. Six of the good spellers also had slow response times on the naming task. However, it is only among the poor spellers that one finds this tendency for a slow response time to appear in conjunction with a low score on the other word recognition task of locating words within a letter matrix.

Another factor which appears to be associated with the formation of a dual image is suggested by a phenomenon observed particularly among the grade 6 readers, who may be considered very skilled readers since they are reading above grade level. Frequently, their initial response on the naming task would start out as an incorrect response. It appeared that they were arriving at a response by using the GPC route. This would lead to colonel beginning to be read as [k ə l o n ə l]. However, before the pronunciation was completed, it would be corrected and the real word substituted. It would seem, then, that particularly when a word is very infrequent, and somewhat strange in its orthographic representation, it takes longer to search the central orthographic image file than it does to use the GPC route. In skilled readers, however, the correct response will 'catch up' with the GPC output and override the incorrect response. Frequency does affect response times, as shown by the response time curves for the naming task (see Figure 8) and this two-level response can be usefully accounted for in this way.

With respect to the more generalized reading task, that of reading a passage aloud and silently, it will be remembered that speed of reading had no apparent relation to spelling ability, but that when it came to reading aloud, there were rather more slow readers among the poor spellers than among the good (8/16 v. 4/16). Again, with the same proviso that the numbers are too small for a statistical analysis, a number of these slow readers (6/8) also scored low on word recognition in the word square task, and 6/8 also had slow response times on the word naming task, so that, once more, a trend is seen among some of the poor spellers, to be slower at word recognition (Table 8).

Slowness to process visual stimuli for reading aloud would fit in with the proposition that a dual image is not formed by the poor spellers. A partial image, it has been suggested, may activate a number of possible responses. The choice of actual response may be influenced by the addition of contextual input, along with the slower response generated by the GPC route, which is then translated into an articulatory pattern, eventually producing a response. By contrast, a dual image will allow for more efficient access to the lexicon, a correct response being generated by a partial image, monitored simultaneously by the fully specified component of the orthographic image, and also supplemented by context in the reading of continuous text.

This does not account for those poor spellers who also have fast response times in the naming task, and who find more than the average number of words in the word square. However, it will be recalled that one of the claims being made is that spelling is not a unitary skill, and poor spellers do not form a homogeneous group. It is the interaction of the various subskills and deficits which is reflected in the level of spelling achievement. Some of these subskills and deficits are revealed by the particular battery of tests devised for this study, but it is very likely that there are other aspects which were not investigated.

The final task relating primarily to the visual aspect of word recognition was the error recognition task. If the poor spellers have not stored a fully specified image of the word, they have no point of reference for comparison purposes. The use of errors made by the children themselves contributed to the ecological validity of the task. One may fabricate possible errors, and come up with some which are more likely than others.[4] However, these reflect the experimenter's bias rather than necessarily representing what actually takes place. Even so, even ecologically valid misspellings are also open to misinterpretation. One child corrected fited (fitted) as fighted, which says more for his knowledge of orthography than of morphology.

Not only do the poor spellers fail to recognize misspellings, they also miscorrect words whether orthographically correct or not to start with. The errors presented for correction were generally phonologically acceptable variants, reflecting the tendency at all levels to produce this type of error. Errors ranged from miscorrections of misspellings, corrections of already correctly spelled words, and acceptance of misspelled words as correct. This inability to judge whether the appearance of the word is correct is a reasonably clear indication that no fully specified visual image is available for consultation. Some of the children miscorrected their own incorrect spellings. For example, one grade 6 child's seaperate was somewhat improved. The ea became e, but the second e remained to give seperate. It is true that this is a common error, but it should look wrong if a correct, fully specified image has been formed and stored. Some of the grade 6 poor spellers remarked that they knew a word was wrong, but they did not know what was wrong. This seems to be further confirmation for the 'partial image' deficit. They have enough information available to recognize the word is not correct, but insufficient information to produce the correctly spelled version.

It is thus apparent that the lack of access to a fully specified visual image is at least one convincing attribute of poor spellers. This would help account for their reduced scores on the word recognition (word square) task and could explain both slow or fast naming responses. The slow responses may be produced because, in isolation, the stimulus may activate conflicting responses which have to be checked by the slower GPC route. The fast responses, on the other hand, are generated by the subject's fast access to a partially specified image which may or may not produce an accurate response. Whether fast or slow, most of the poor spellers did produce a higher than average number of errors on the naming task, and on the recognition of spelling errors.

There are subgroups among the subjects, but these subgroups are probably linked indirectly by their individual strategies which they have adopted to cope with their failure to form a fully specified image, rather than directly by any rigorously defined set of 'poor speller' responses. It is for this reason that apparently contradictory characteristics, for example, fast and slow naming responses, can be linked to the overall spelling deficit. For some children, reliance on a slower GPC route produces a slow response, whilst others are willing to rely on the partial specification and make a fast selection of a possible response, or they may even use one strategy in some instances, and the other on other occasions. For this reason, the association of poor spelling with a fast response and a high error score, for example, should not be taken as an indication that a slower, more careful approach to written language would cure the problem. The problem lies not with speed of access and response, but with what is actually accessed by the child that enables it to spell a word, or in the case of the poor spellers, does not enable the child to spell a word correctly.

This brings us to the effect of the 'treatment intervention' on the children involved. The 'treatment', the modification introduced in the repeat measures section of the test battery, was to introduce the children to the strategy of paying full attention to the actual appearance of a word and visualizing the word in their own mind's eye. It was hoped that the introduction of such a strategy would encourage the children to form a fully specified image of the words to be spelled or located, which in turn would reduce the number of errors made on the spelling task, and increase the number of words found in the word squares.

The two tests designed for this multiple baseline, single subject research part of the battery were a grade level spelling test, and a word recognition (word square) task. As noted, matched t tests run on pre- and post-intervention scores for the grade level spelling test revealed a significant difference for the poor spellers, but not for the good spellers. This was, however, to be expected. Although those children classified as average spellers and readers made errors on the first unprimed administration of the test, the very good and superior spellers were performing near ceiling already. If a child made only 1 error on the initial administration of the task, for it to make no errors after the intervention was introduced is not as striking as if a child who makes 10 errors then drops down to only one (as was the case for one of the poor spellers).

As in the initial diagnostic spelling test, and the spontaneous writing task, the errors were predominantly phonologically acceptable. The spelling test was administered in the same way as the initial test, with the teacher dictating a word, using it in a sentence and then repeating it. One of the teachers pronounced thrown and shown as [θrouən] and [ʃouən], which were faithfully reproduced by two of the poor spellers as <u>throwen</u> and <u>showen</u> - an indication that at least two of the subjects were not willing to abandon completely an alphabetic approach to spelling.

Since introduction of a new strategy may, initially, cause confusion in processing, the intervention was repeated. However, this did not change the pattern of responses to any great extent, so that the first post-intervention results were a valid reflection of the effect of the strategy.

There was one child who failed to make any improvement. KH made just over the mean number of errors in the pre-intervention test, and failed to improve on the post-intervention tests. One may speculate on the possible reasons for her failure to improve. At this point there is no way of knowing whether she did, or indeed could form images of the words in her mind's eye. She was not one of the students who obviously did not co-operate. (In the rare case where it was obvious that a child was not co-operating, the results were excluded from analysis.) KH was in the enriched grade 6 class and the children here are encouraged to develop individuality, so that it may have been that her individual judgement was that this was not a strategy she could use. She did tend to be slow on most of the tasks, but her scores were similar to those of AC (in the same class) who did improve, so slowness is not necessarily a causative factor. It is also possible that KH may have had a poor visual memory and if this were the case it could conceivably have affected her utilization of the intervention strategy.

On the word recognition (word square) task, matched t tests revealed significant pre- and post-intervention differences in the scores for both groups. A matched t test of the percentage improgement for each group showed a significant difference at the level of $p < .05$. The poor spellers thus appear to benefit more from a visualization enhancement strategy than do the good spellers. Again, this is what one would expect. The good spellers, it is proposed, do already form and store a fully specified image of the words they encounter. Exposure to the words will be likely to have some facilitating effect, but this will not be as great as the effect it has for the poor spellers who do not automatically pay full attention to the words they read and write.

The visualization enhancement strategy was somewhat different for this task. The children were given a list of approximately 100 words which could be found in the letter matrix. However, it had been found with the grade level spelling test, that visualizing 21 words was beginning to strain the powers of concentration of some of the children. Consequently, in the word square task, the children were given lists of words and told to study them, paying particular attention to such unusual features as double consonants or vowels, or unexpected letter combinations, in the same way as they had with the spelling test words. The time allowed, two minutes, is probably not long enough if the words were being studied for production, as in a spelling test. However, it was felt to be an adequate period for a recognition task. It was assumed that if a full image were to be stored, the particular words would be more easily picked out from among the extraneous letters in the word square. The order of the words on the lists did not appear to bear any relationship to the order in which they were located in the word square. (The children were required to write down the words they found so it was usually clear which words were found first.) However, there are several factors here which were not controlled for. The children were free to study the words in any order they pleased. Although the logical way would have been across the rows, or down the columns, there may have been other ways used by individual children. In addition, some of the children were very methodical in their search for words, going across all the rows in the square, and then down all the columns. They were thus likely to be more efficient than those who picked here and there at the matrix. The grade 6E class found the highest number of words whether they were good or poor spellers, and this, no doubt, reflects their advanced cognitive skills in comparison with most of the children in the regular classes.

The results of these two tests do thus appear to be evidence for the claim that the poor spellers do not form a dual image of the word, a partial and a fully specified image, since when encouraged to form such a fully specified image, their performance improves, and improves to a greater extent than does that of their peers who do spell well, and who, it is claimed, do already form a dual image automatically.

Hypothesis 5

We come now to the final claim in H5 that use of a partially specified image will lead to the poor spellers being fast readers of words in context, and fast, but not necessarily accurate namers of isolated words. This is not borne out completely by the results of the tests. There are very fast readers and namers who are also inaccurate on the naming task. But there are also slow readers and namers who are inaccurate. Some are slow readers and fast namers, or fast readers and slow namers, and all of these may be either good or poor spellers. However, if this hypothesis is looked at in the light of the findings supporting H1 which claims that poor spellers will be a heterogeneous population made up of a number of subgroups, the hypothesis is, in part, justified. One of the subgroups of poor spellers will be fast readers and fast, but inaccurate, namers. However, it is not the speed of reading and naming that is important for this group, but rather it is their inaccuracy, which is a reflection of their basic deficit, that of failing to form a fully specified orthographic image. The good spellers who are assumed to form both a fully specified and a partial image can be fast readers and namers, but they are also accurate.

Chapter 5

SUMMARY AND CONCLUSIONS

A number of factors emerge from this study, the first being that to classify a child as a poor speller really tells us very little about what the actual deficit might be. At the most basic level, the poor speller makes more errors in writing words than do his or her peers. This, however, tells us nothing about how one might distinguish the poor from the good speller at any other level. Indeed, on other levels, the good and poor spellers may look very similar.

With respect to the particular sub-group of poor spellers who are good readers, the question was raised as to whether these good readers were, in fact, reading in the same way as the good readers who were also good spellers. With regard to speed of reading of a passage, and with regard to speed of response time in the naming task, there was no significant difference between either of the groups. There were fast and slow readers and namers in both. However, there was a low degree of accuracy in the naming responses of the poor spellers. This is what had been predicted. It had also been predicted that this inaccuracy would be linked to very fast naming response times. This part of the prediction was not fulfilled. Some of the poor spellers who were inaccurate in their responses were very fast in their response times, but not all of them. It seems preferable, thus, to attribute the inaccuracy to a basic deficit underlying all of the poor spellers' performances, that of a deficit in the area of visual recognition. The fact that these children, the experimental group, are all good readers indicates that this is not an absolute recognition deficit. Rather, the pattern of performances supports that what these children lack is access to a fully specified orthographic image, and the reason they lack this access is that they do not routinely store such an image. The improvement in performance after the visual enhancement strategy was introduced suggests that the children are able to store such an image, and to have access to it, at least for a short time. Whether this image is retained, and whether, by training, the children can be induced to utilize this strategy automatically would be one direction in which the study could be extended. It is suggested that such an investigation could be carried out with two groups matched carefully for spelling, reading and general cognitive ability, one of which was taught the visual enhancement strategy for spelling and one which was only given whatever aids the teacher would routinely give.

Having revealed some aspects of the diversity of the components which may be working together to produce either good or poor spellers, and in what general area the deficit may lie which produces a poor speller, the study does not throw any clear light on the root cause, or causes, of this deficit. And indeed, the intention of the study was to examine the nature of the phenomenon of the good reader/poor speller, without claiming to reveal its cause.

However, one possible direction for further study which might elucidate this would be to attempt to build up hemispheric laterality profiles of the sub-groups. The suggestion was made that it may be an inappropriate utilization of hemispheric capacity which leads to an inadequate orthographic image being formed by the poor spellers in this study. The dual task/time sharing paradigm (where concurrent linguistic and non-linguistic activities are measured) would be one possible method of examining this. Ideally, such a profile would be built up on a longitudinal basis, in order to see whether maturational factors are also involved. The paradigm is not without its problems (Hughes and Sussman, 1983). However, Sussman himself writes, "Despite the negative tone of the implications of the Hughes and Sussman study for the future of the time-sharing procedure, we remain confident in viewing the paradigm as still being the best and only behavioral index of language output lateralization". It is suggested that an undue reliance on the right hemisphere in the early stages of learning to recognize words could lead to a neglect of the more analytical left hemisphere processes, particularly if such reliance appeared to be an efficient modus operandi for the child involved.

The possibility that a deficit in the area of visual memory may contribute to the failure to form an adequate orthographic image was raised in connection with one of the poor spellers who failed to improve after being given the visualization strategy. Although Day and Wedell (1972) concluded that deficits in auditory and visual memory do not of themselves cause spelling problems, but rather influence the type of error made, the children they were testing performed at a rather low level all round and it would be of interest to see whether poor spellers who were otherwise performing well academically, showed any such deficit as compared to their peers who were good spellers.

From the point of view of remediation, the most important point to stress is that a spelling disability is not a unitary disability. There will not, necessarily, therefore, be only one approach to improving performance. It has been noted, anecdotally, that dyslexic children who can be given a great deal of individual attention will often show more improvement than those not able to be given such attention. It may be that it is easier to discover the individual components of the overall deficit in such situations, thus enabling the therapist to deal with the individual's problem in an appropriate way. This may also be true for spellers. If individual attention could be given to their problem, the particular aspects of their deficit could be dealt with, rather than the general deficit. Two individuals may appear to spell at the same level, but different sets of subskills may be responsible for this, as has already been suggested.

The results of the tests performed in this study, however, do go some way towards indicating what may be a common failing for those poor spellers who are not language disabled. This is their failure to form an adequately specified orthographic image. Several different factors may contribute to this - low visual memory skills and inappropriate hemispheric processing have already been suggested as two possibilities. If it is indeed the case that the underlying deficit is this failure to form a fully specified image, it would be of value to emphasize this aspect of literacy skills from the very beginning, before it becomes apparent that some children are not storing an adequately specified image. It seems that good spellers do not have to be taught to do this, but do it automatically. The poor spellers, on the other hand, do need to be taught, and it may be that by the time it becomes obvious that they cannot spell, it is too late to change the way they form their mental representation of language. Spelling may, indeed, be caught, not taught. However, if this is the case, effort should be made to help children 'catch' spelling ability before it gets too late and they become immune. Whilst not being able to spell, in the absence of any other disabilities, is not an insuperable handicap, it is a cause of frustration, particularly in the school environment. The findings in this study suggest a possible direction towards alleviation of this frustration.

The findings also suggest the probability that, although the errors made by the good and poor spellers who are both good readers differ only quantitatively, not qualitatively, it is very probable that this quantitative difference springs, in fact, from a qualitative difference in the mental representations these individuals have constructed for their language, and that this qualitative difference underlies the differences in performance that were observed in this study.

Notes

1. The 'special disability' appears to be an inability "to form the bonds involved in learning to spell words" (Hollingworth, 1918).
2. The words were drawn from essays written in schools across the whole country and from words which occurred in a group of letters written to one of the country's national magazines.
3. It would be interesting to retest the three grade 3 average spellers/readers, BH, KI and YR, in a year or so's time. These three children make a high proportion of phonologically inaccurate errors, and also a number of other errors. Their spelling is not so poor as that of MD, the only grade 3 poor speller, but their errors are unlike those of the other good or average spellers. This may only be a maturational feature, since they are all in grade 3.
4. Pitman (1905) for example, claimed: "Scissors is one way of spelling 'sizurz'. Another way is psozzyrrhzz which is justified by ps in psalm; o in women; zz in buzz; yrrh as in myrrh. There are 81,977,919 other justifiable ways." However, it is doubtful if most children would know what psozzyrrhzz was meant to represent (and justifiably so) let alone be able to correct it. In addition, bearing in mind the morphophonemic characteristics of English orthography, this is not one of the more likely ways to spell scissors.

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Sample of word square used in word recognition task

E	L	E	P	H	A	N	T	B	C	A	T	S
V	E	R	Y	E	P	O	H	E	R	F	O	X
E	A	R	E	A	P	T	R	E	E	T	O	T
R	F	P	A	R	L	I	O	T	H	E	R	E
Y	O	U	R	D	E	C	U	T	U	R	N	L
W	I	T	C	H	B	E	G	R	E	A	T	E
H	A	P	P	E	N	S	H	U	T	B	B	V
E	Q	U	E	E	N	U	T	S	O	B	I	I
R	A	T	D	O	W	N	S	T	A	I	R	S
E	B	E	S	T	H	A	L	F	S	T	D	I
H	A	V	E	M	O	U	S	E	T	E	N	O
A	B	L	E	A	F	T	E	R	N	O	O	N
M	Y	O	U	R	F	H	A	U	N	T	E	D

Appendix II

Word list for word recognition: naming task.

Predictable High frequency words	Frequency
grass	781
winter	1004
make	8333
letter	1738
ship	1021
walk	831

Predictable low frequency words	
coffee	280
pike	14
bunk	16
lamb	94
ping	3
carp	16

Unpredictable high frequency words	
great	3855
either	1033
sure	1956
though	1339
were	17031
come	4676

Unpredictable low frequency words	
lose	269
comb	64
weapon	62
shoulder	385
fork	122
dwarf	19

Weird high frequency words	
eyes	2303
water	7194
two	10085
once	2435
people	7989
ocean	843

Weird low frequency words	
yacht	16
subtle	33
choir	30
colonel	41
aisle	15

Non-words

malk
gomb
bish
gair
bettle
bour
breat
woung
gacht
enchor
rown
kive

Appendix III

Sample word list for spelling error correction (Grade 6)

acquaintance	freeze	surplus
anual	friend	topic
anxious	genuine	type
arange	geuss	various
assist	hight	welfare
attendance	intrest	
avoid	judgement	
caracter		
capacity	mechanical	
career	method	
celibration	neccessary	
comitee	omit	
consert	pleasent	
cough	popular	
damage	principle	
dancinng	readily	
deasire	recent	
demestic	reference	
description	remain	
disaplen	ritten	
duties	seaperate	
egde	signature	
exceptionally	successful	

ERROR TYPES

POOR SPELLERS

Grade	Subject	Phonologically inaccurate		Cluster reduction.		Orth. ill.		Order error	
		Spelling	Writing	Spelling	Writing	Spell.	Wrt.	Sp.	Wrt.
III	MD	9	6	3	4	4	1	-	-
IV	MB	8	-	3	2	4	-	-	-
	SC	4	-	-	-	1	-	-	-
	FW	4	-	-	-	2	-	-	-
	CC	3	1	-	-	1	-	-	-
	DM	10	1	1	-	-	-	-	-
	DF	4	1	-	-	-	1	1	-
VI	CJC	4	1	-	-	2	-	1	-
	CC	2	1	-	-	1	-	-	-
	MX	8	3	4	-	1	-	-	-
	TK	2	4	-	-	-	-	-	-
	CG	4	-	1	-	-	-	-	-
VII	KH	3	-	1	-	1	-	-	-
	TL	4	2	2	1	-	-	-	-
	AC	2	-	-	-	-	-	1	-
	DB	7	2	3	-	-	-	1	-

AVERAGE SPELLERS/READERS

Grade	Subject	Phonologically inaccurate		Cluster reduction		Orth. ill.		Order error	
		Spelling	Writing	Spelling	Writing	Spell.	Wrt.	Sp.	Wrt.
III	BH	9	1	-	1	4	-	3	-
	KI	9	1	-	-	-	-	1	-
	YR	14	4	-	3	1	-	1	-
IV	EJ	4	7	-	1	-	-	-	-
	SH	3	4	2	-	2	1	1	-
VI	DA	2	1	1	-	1	-	-	-
	TK	4	4	-	-	-	-	-	-

VERY GOOD SPELLERS/READERS

Grade	Subject	Phonologically inaccurate		Cluster reduction		Orth. ill.		Order error	
		Spelling	Writing	Spelling	Writing	Spell.	Wrt.	Sp.	Wrt.
IV	RB	6	-	1	-	1	-	-	-
VI	BM	1	-	-	-	-	-	-	-
VII	MF	-	-	-	-	-	-	-	-

SUPERIOR SPELLERS (GOOD READERS)

Grade	Subject	Phonologically inaccurate		Cluster reduction		Orth. ill.		Order error	
		Spelling	Writing	Spelling	Writing	Spell.	Wrt.	Sp.	Wrt.
III	JK	1	2	-	-	1	-	-	-
	TL	2	-	-	-	1	-	-	-
IV	CW	1	-	-	-	-	-	-	-
	LG	6	2	1	1	-	-	-	-
	SD	4	-	-	-	1	-	-	-
VI	HB	-	-	-	-	-	-	-	-

Table 1

Errors for good and poor spellers

Poor spellers	Good spellers
Spelling test: Phonologically inaccurate: $\bar{X} = 4.9$ (SD = 4.6)	Spelling test: Phonologically inaccurate: $\bar{X} = 3.6$ (SD = 3.7)
Spontaneous writing: Total errors: $\bar{X} = 5.8$ (SD = 4.8) Phonologically inaccurate: $\bar{X} = 1.4$ (SD = 1.7)	Spontaneous writing: Total errors: $\bar{X} = 3.6$ (SD = 3.8) Phonologically inaccurate: $\bar{X} = 1.6$ (SD = 2.09)

Table 2.

Spontaneous writing task - number of words; number of errors

Grade	Subject	Number of words written	Number of errors
Poor spellers			
III	MD	79*	17**
IV	RB	85*	14**
	SC	71*	1
	FW	53	3
	CC	69*	9**
	DM	86*	5**
	DF	61	4**
VI	CJC	23	0
	CC	86	3
	NX	59	7**
	TK	224*	6**
	CG	129*	2
VIE	KH	69	5**
	TL	163*	4**
	AC	143*	3
	DB	170*	10**
Good spellers			
III	BH	53	1
	KI	75*	5**
	YR	58	8**
	JK	92*	6**
	TL	48	1
IV	EJ	115*	7**
	SH	93*	12**
	RS	52	2
	GW	57*	0
	LG	109*	3
	SD	25	0
VI	DA	71	4**
	TK	160*	9**
	BM	158	0
	NB	122*	0
VIE	MF	169*	0

* More than the average number of words at that grade level
** More than the average number of errors at that grade level

Table 3.

Grade level spelling test

Poor spellers				Good spellers			
MD*	4	2	1	BH*	5	2	0
RB	7	3	6	KI*	2	0	0
SC	3	0	0	YR*	3	0	1
FW	6	2	5	JK*	0	0	0
CC	7	4	3	TL*	0	0	0
DM	11	2	5	EJ	0	0	0
DF	10	3	4	SH	7	2	1
CJC	10	1	0	RS	2	0	0
CC	6	2	3	GW	2	0	4
WX	7	4	5	LG	4	1	1
TK	7	0	1	SD	1	0	0
CG	4	0	0	DA	7	3	4
KH	4	5	4	TK	7	0	1
TL	8	1	2	NB	0	0	0
DB	7	4	5	MF	0	0	1

* Grade 3 children tested on 10 words each time. Others tested on 21.

Table 4.

Word square scores

Poor spellers			
MD	15	22	21
RB	18	25	21
SC	21	27	24
FW	17	24	21
CC	14	15	15
DM	20	28	27
DF	16	21	21
CJC	27	29	35
1. CC	40	36	45
NX	28	30	37
TK	26	39	36
CG	28	39	40
KH	25	33	34
TL	25	34	37
AC	24	35	42
DB	25	38	40

Good spellers			
BH	21	27	31
KI	19	18	21
YR	27	35	32
JK	22	29	25
TL	19	22	17
EJ	19	27	23
SH	16	23	33
RS	26	32	33
GW	20	21	27
LG	24	29	25
SD	22	18	20
DA	24	24	32
TK	29	35	36
BM	31	24	28
NB	40	52	53
MF	35	46	55

Pre-invervention scores do not differ significantly between the groups. Post-intervention differences are statistically significant. (t 2.052, p .05). The poor spellers show a greater post-intervention improvement.

Table 5.

Naming latency and error rate

Grade	Subject	Naming latency (msecs)	Error rate +Av.	Error rate −Av.
Poor spellers				
III	MD	1051*	x	
IV	RB	769*	x	
	SC	1004*		x
	FW	1094*	x	
	CC	562	x	
	DM	828*	x	
	DF	1174*	x	
VI	CJC	621	x	
	CC	624	x	
	NX	495	x	
	TK	737*		x
	CG	712	x	
VIE	KH	730		x
	TL	771*		x
	AC	762*		x
	DB	616		x
Good spellers				
III	BH	1266*	x	
	KI	1135*	x	
	YR	584		x
	JK	777*	x	
	TL	721		x
IV	EJ	559		x
	SH	844*		x
	RS	1074*		x
	GW	694		x
	LG	688		x
	SD	757*		x
VI	DA	727		x
	TK	738*		x
	BM	691		x
	NB	535		x
VIE	MF	528		x

* Longer than average latency

Table 6.

Grade	Subject	Aloud (seconds)	Silently (seconds)	Questions correct
Poor spellers				
III	MD	140*	69*	2 3 4
IV	RB	98	72*	2 3 4
	SC	97	66*	1 3 4
	FW	163*	50	1 2 3
	CC	122*	71*	1 2 4
	DM	108*	46	1 2
	DF	127*	91*	1 2 3 4
VI	CJC	100*	41	2 3 4
	CC	71	56*	2 3
	NX	69	30	1 2 3 4
	CG	71	56*	2 3
VIE	KH	73	53*	1 2 3 4
	TL	88*	45*	1 2 3 4
	AC	76*	50*	2 3
	DB	70	41	1 2 3 4
Good spellers				
III	BH	92	68*	2 3 4
	KI	128*	71*	2 3 4
	YR	102*	92*	2 3 4
	JK	76	53	2 4
	TL	79	51	3
IV	EJ	68	30	2 3 4
	SH	99	57*	1 2 3 4
	RS	82	30	4
	GW	86	54	2 3
	LG	80	53	3 4
	SD	76	49	2
VI	DA	90*	68*	2 3 4
	TK	92*	63*	2 3 4
	BM	57	40	2 3 4
	NB	59	31	2 3
VIE	MF	65	35	1 2 3
Superior spellers sub-group				
III	JK	76	53	2 4
	TL	79	51	3
IV	GW	86	54	2 3
	LG	80	53	3 4
	SD	76	49	2
VI	NB	59	31	2 3

* Slower than the average time for that grade level

Table 7.

Poor spellers slowness on intertask performances compared

Subject	Slow latency	Low number of words Word square task	Slow reading performance	
			Aloud	Silently
MD	+	+	+	+
RB	+			+
SC		+		+
FW	+	+	+	
CC		+	+	+
DM	+		+	
DF	+	+	+	+
CJC		+	+	+
CC				+
NX				
TK				
CG				
KH		+		+
TL	+		+	+
AC	+	+	+	+
DB				

Table 8.

Orthographic Image Model of Reading and Spelling

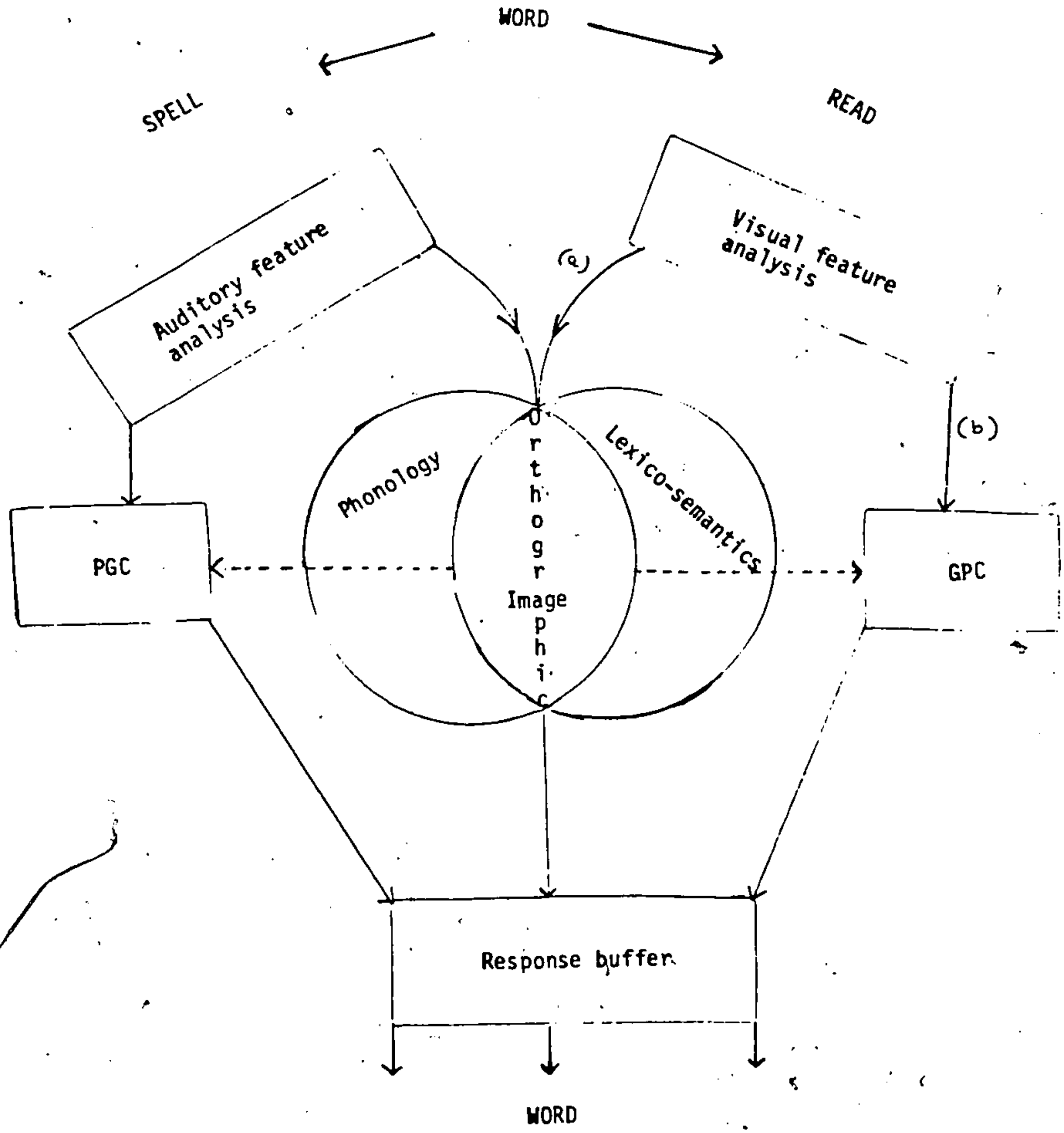


Figure 1.

READING (After J. C. Marshall, series of lectures given at University of McGill, March/April 1984).

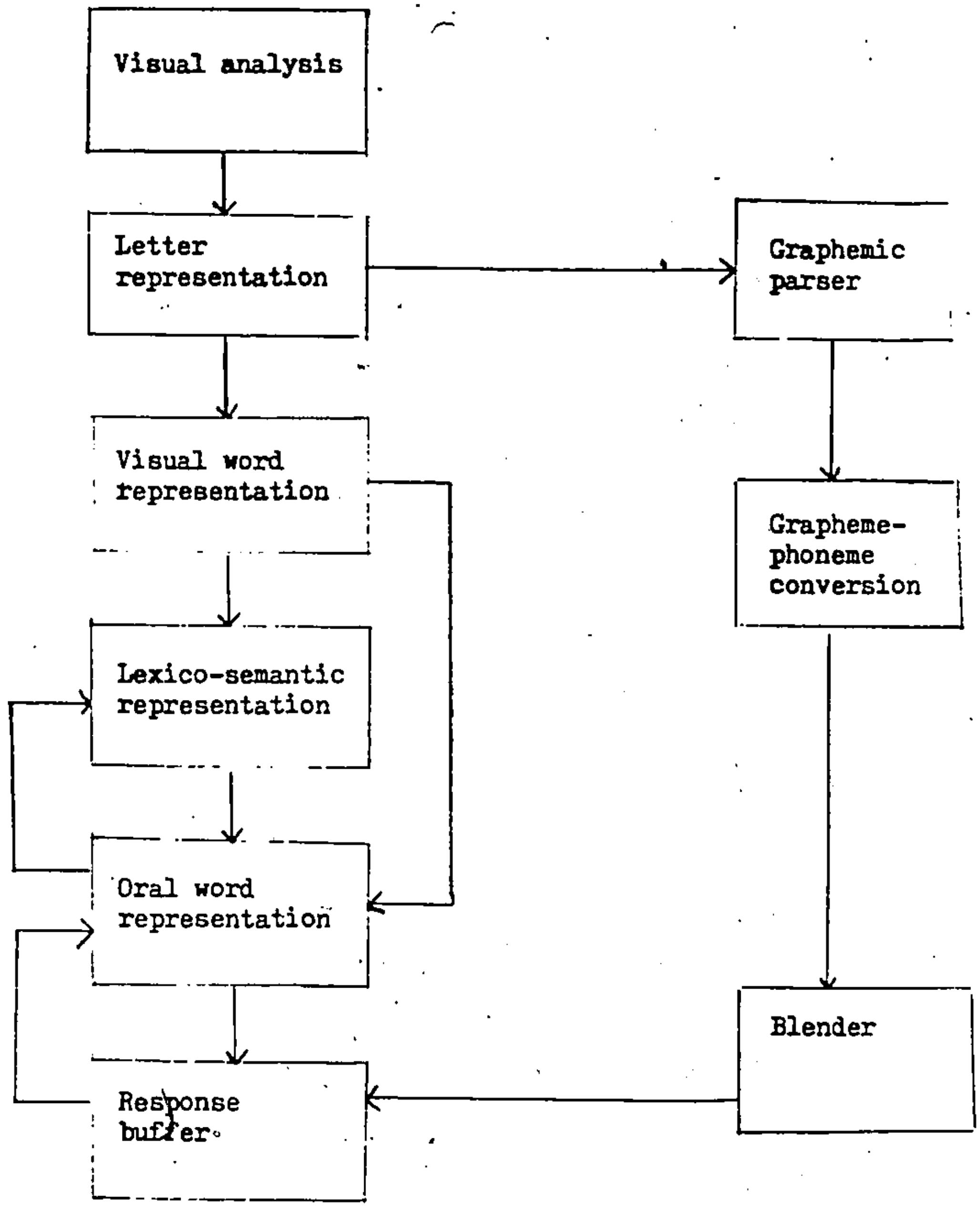


Figure 2.

THE LOGOGEN MODEL (Based on Morton, 1980)

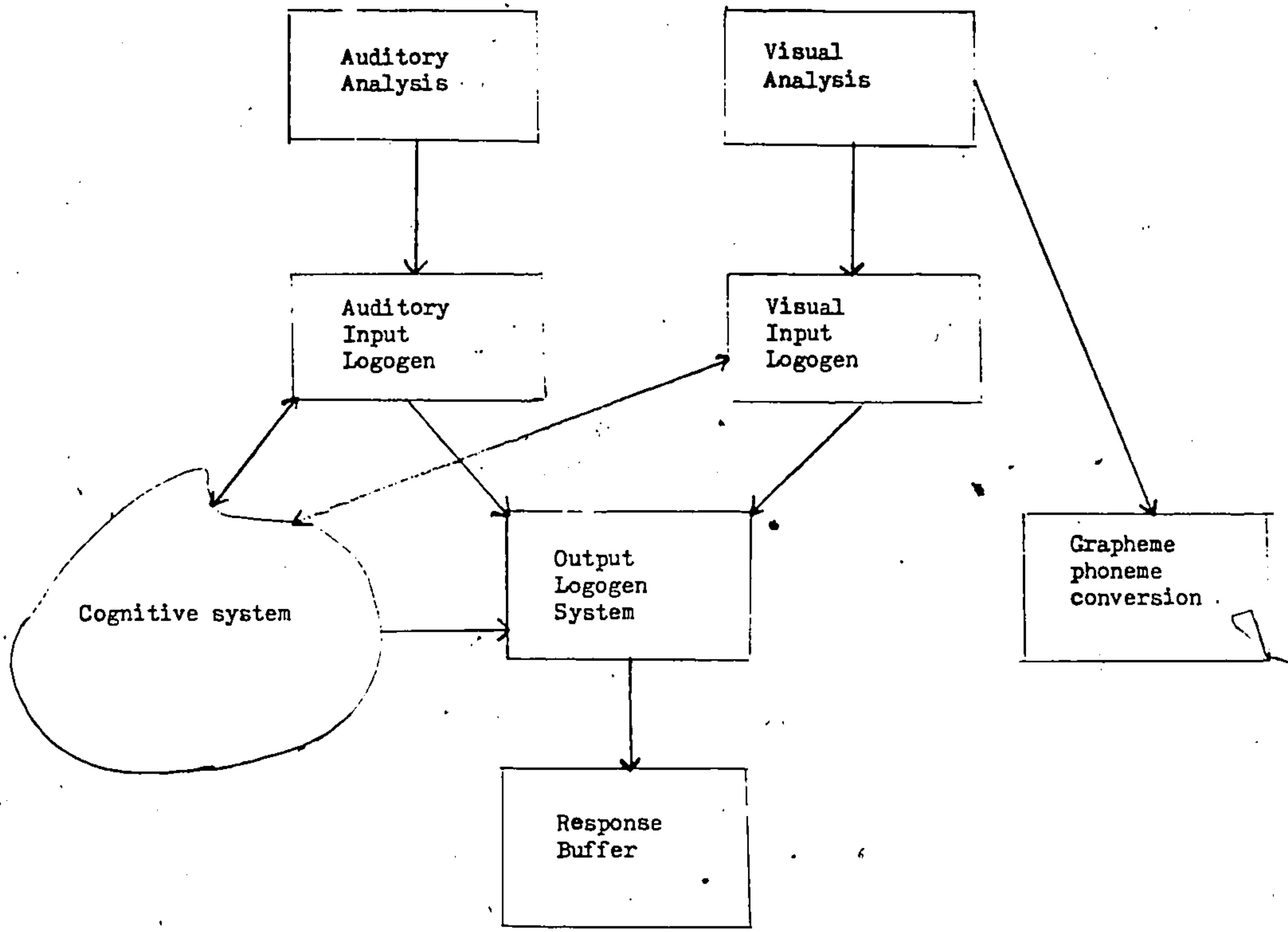


Figure 3.

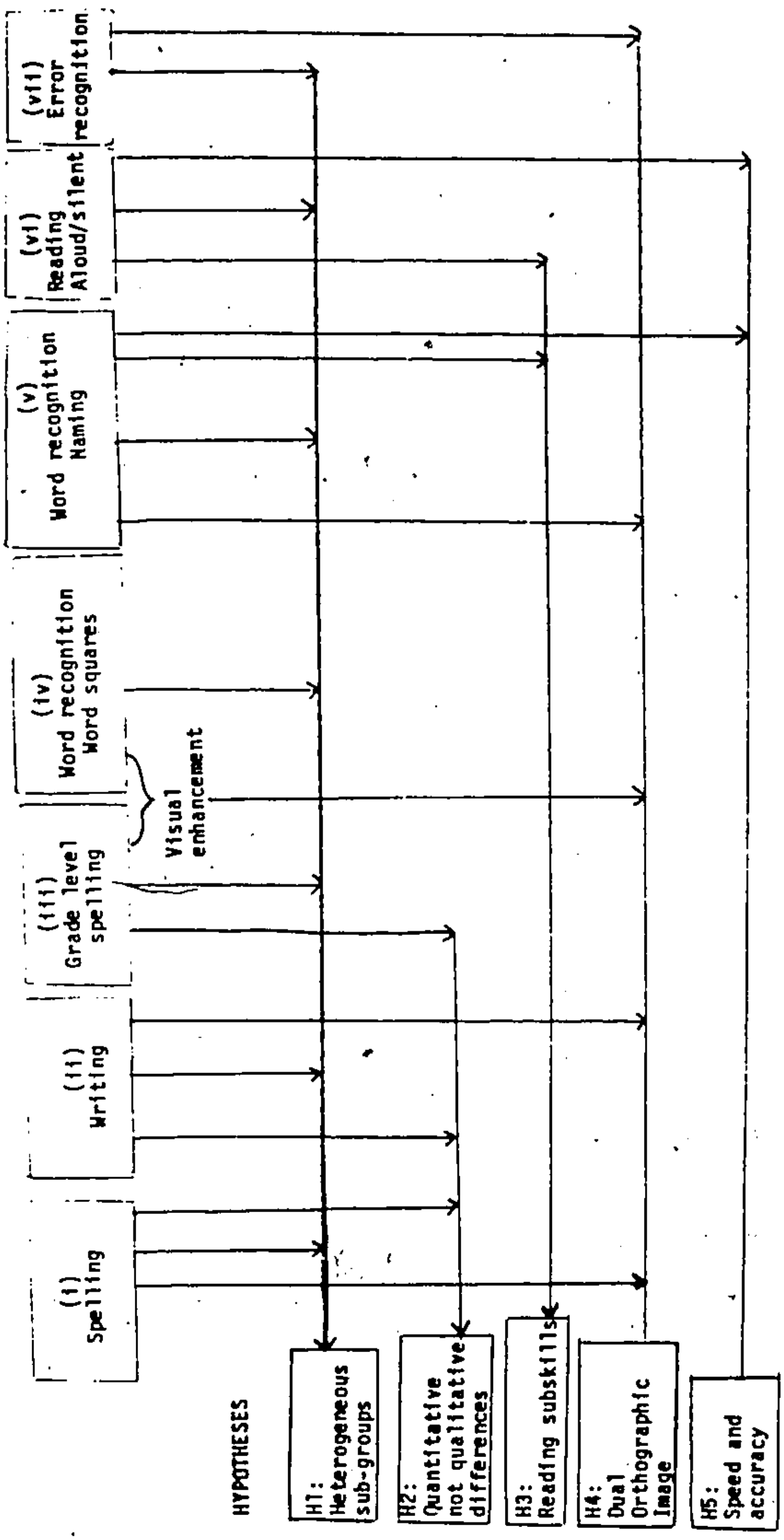

TESTS
(i) Spelling
(ii) Writing
(iii) Grade level spelling
Visual enhancement
(iv) Word recognition Word squares
(v) Word recognition Naming
(vi) Reading Aloud/silent
(vii) Error recognition
HYPOTHESES
H1: Heterogeneous sub-groups
H2: Quantitative not qualitative differences
H3: Reading subskills
H4: Dual Orthographic Image
H5: Speed and accuracy

Figure 4.

Distribution of spelling ability by grade level

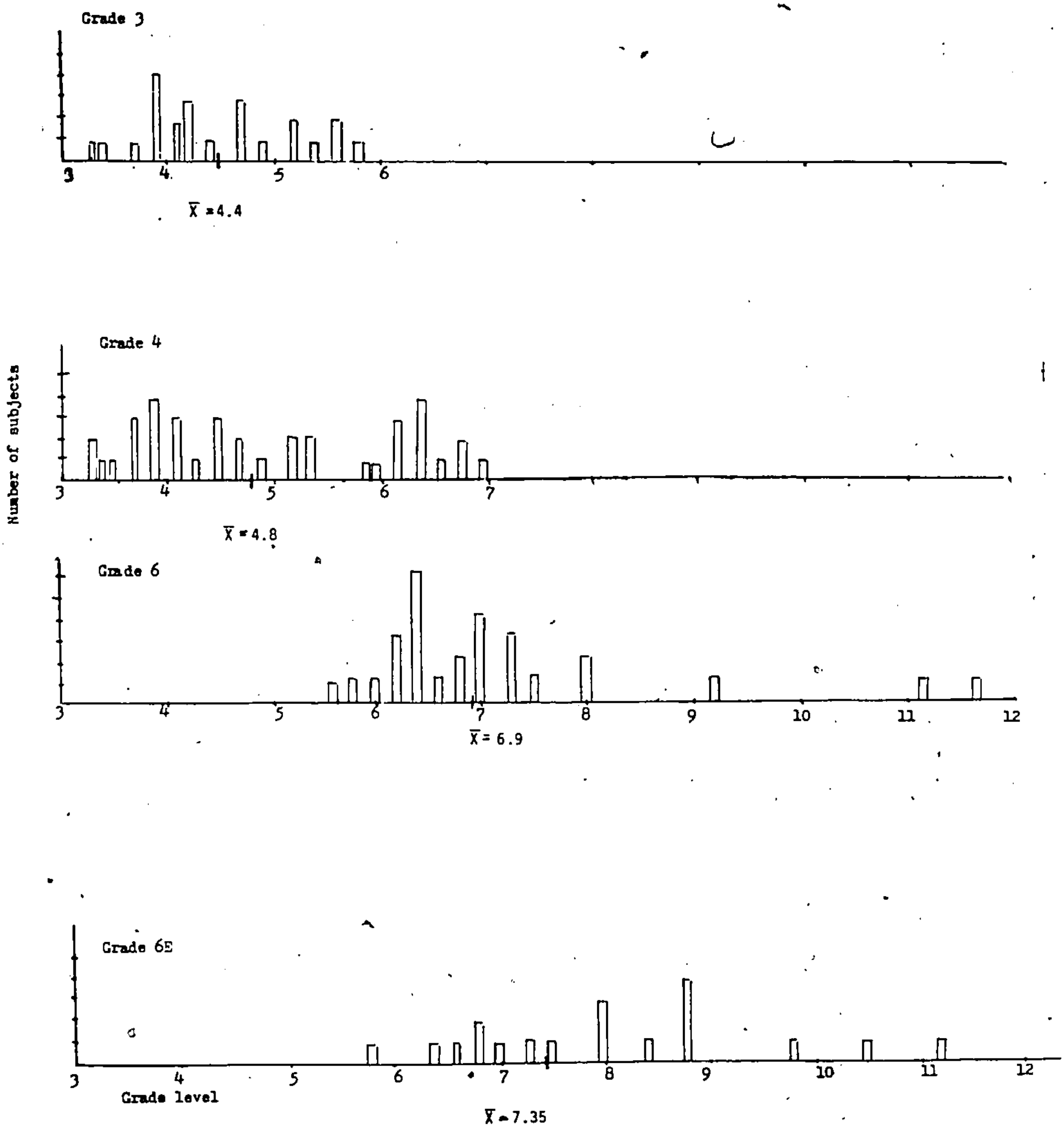
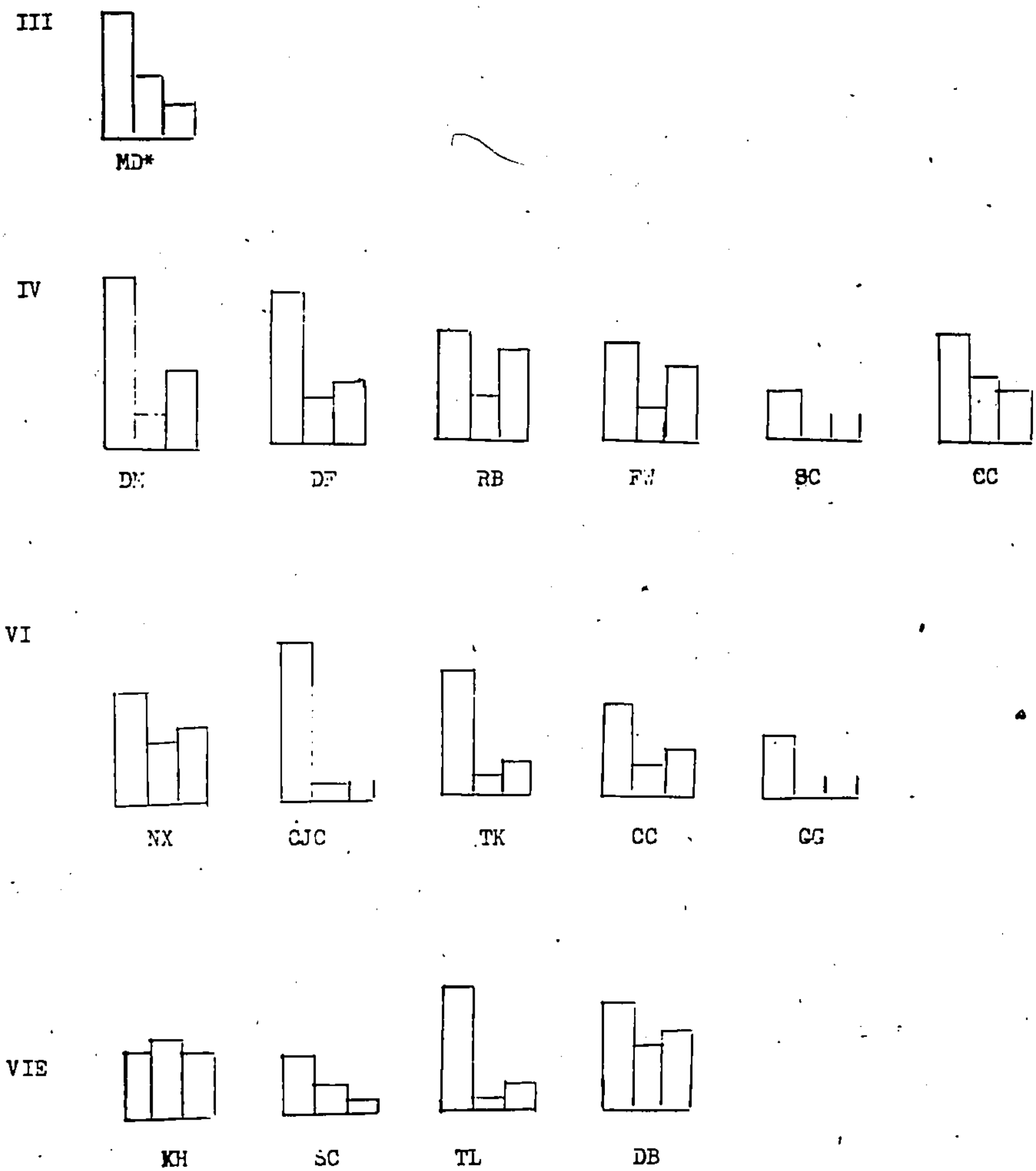


Figure 5

Spelling test: pre- and post-intervention scores
Poor spellers

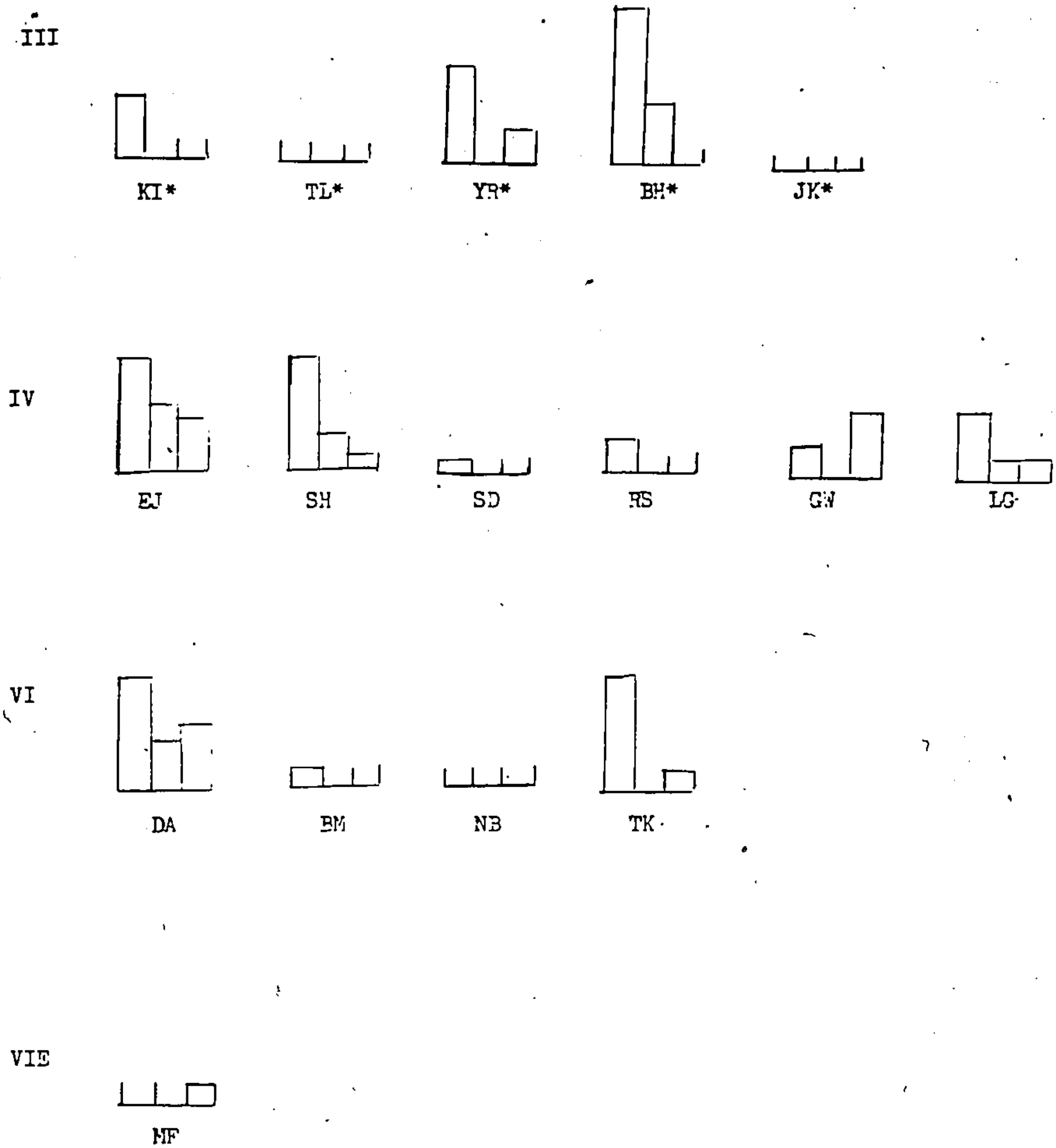


* The bar graphs are adjusted for the grade 3 scores to reflect the same proportion of errors (out of 10) as do those in the othre grades (out of 21)

Figure 6.

Spelling test: pre- and post-intervention scores

Good spellers



*The bar graphs are adjusted for the grade 3 scores to reflect the same proportion of errors (out of 10) as do those in the other grades (out of 21)

Figure 6 (cont).

Word square scores: pre- and post-intervention

Poor spellers

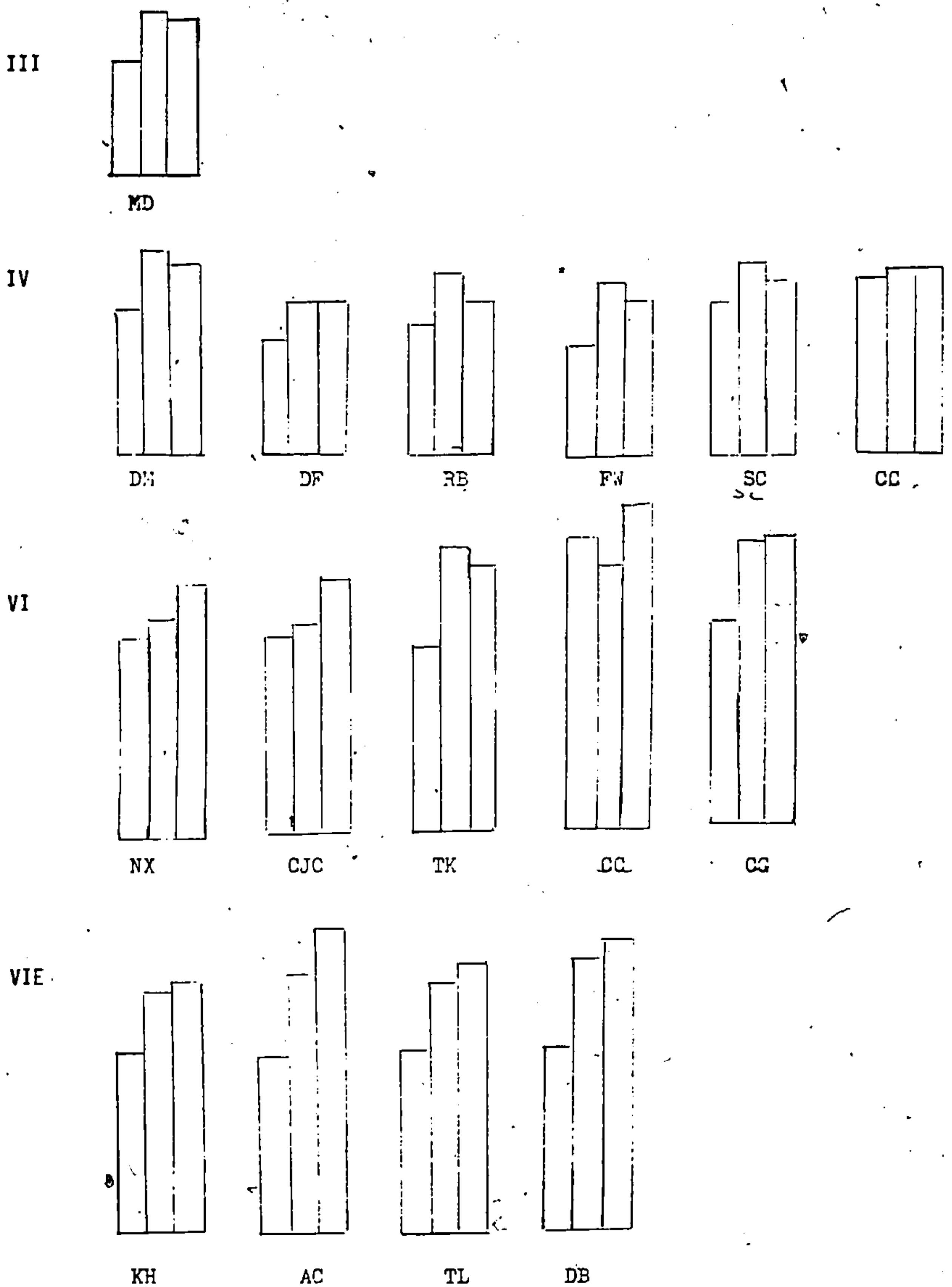


Figure 7.

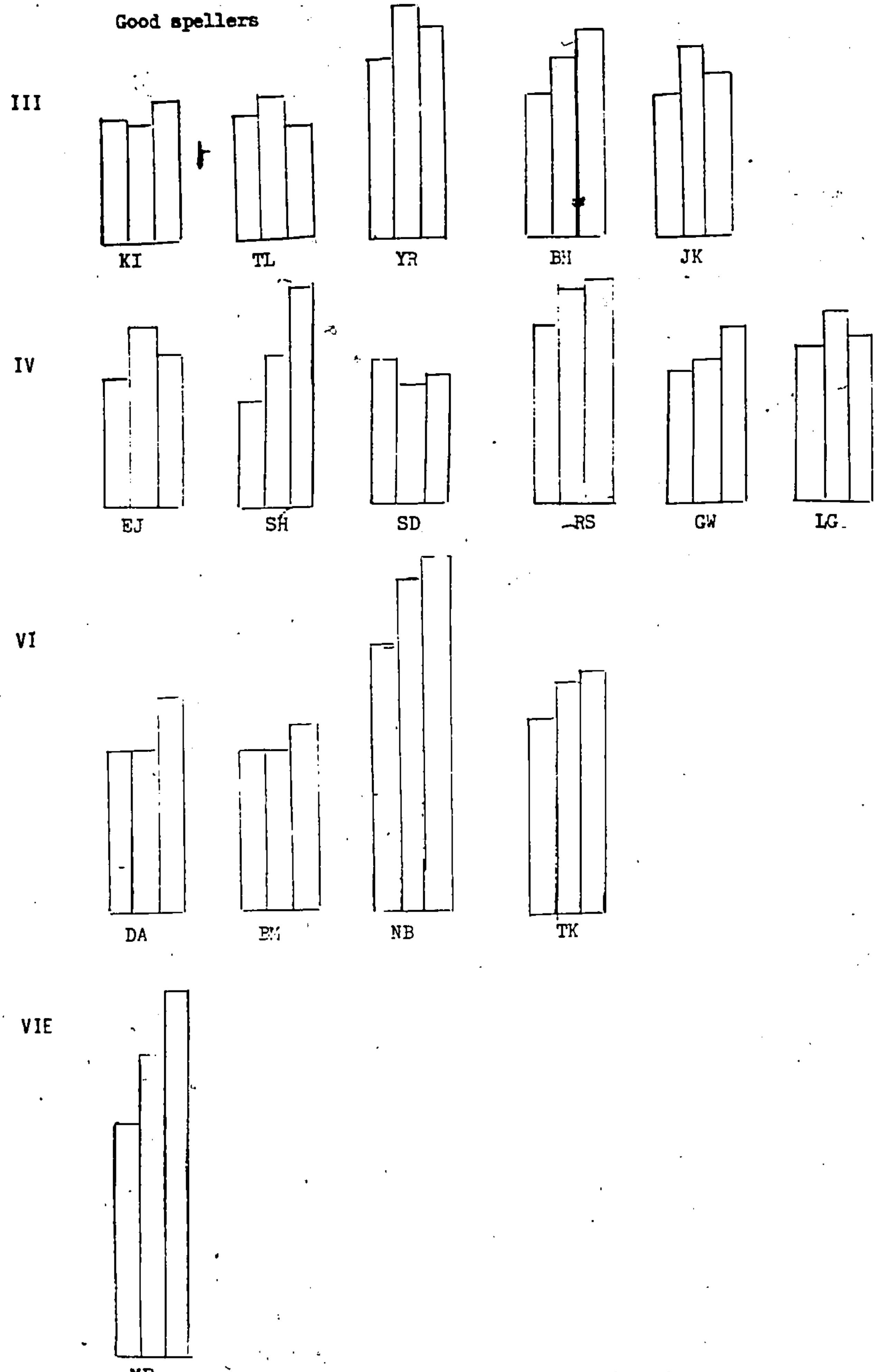


Figure 7 (cont).

Naming task: response times and variability